Evaluating Critical Factors Influencing Successful Scope Management in Design-Build Construction Project in Ethiopia

Negash Girma Tolcha

A Thesis Submitted to the Department of Civil Engineering

Collage of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Civil engineering (Specialization in Construction Engineering and Management)

Office of Graduate Studies

Adama Science and Technology University

May 2025

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DECLARATION

I hereby declare that this Master Thesis entitled "Evaluating Critical Factors Influencing Successful Scope Management in Design-Build Construction Project in Ethiopia” is my original work. That is, it has not been submitted for the award of any academic degree, diploma, or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

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Signature Date

RECOMMENDATION OF ADVISOR

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled "Evaluating Critical Factors Influencing Successful Scope Management in Design-Build Construction Project in Ethiopia " prepared under my guidance by Negash Girma Tolcha, submitted in partial fulfillment of the requirements for the degree of Masters of Science in Construction Engineering and Management. Therefore, I recommend the submission of the revised version of the thesis to the department following the applicable procedures.

Fikreyesus Demeke (PHD)	______________________	____________________
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APPROVAL PAGE

I, the advisor of the thesis entitled "Evaluating Critical Factors Influencing Successful Scope Management in Design-Build construction project in Ethiopia" and developed by Negash Girma Tolcha, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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We, the undersigned, members of the Board of Examiners of the thesis by Negash Girma Tolcha have read and evaluated the thesis entitled "Evaluating Critical Factors Influencing Successful Scope Management in Design-Build construction project in Ethiopia" and examined the candidate during the open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Construction Engineering and Management.

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Contents

LIST OF TABLE

LIST OF FIGURE

LIST OF ACRONYMS

AHP Analytic Hierarchy Process

ISM Interpretive Structural Modeling

MICMAC Matrice d'Impacts Croisés Multiplication Appliquée à un Classement

CSF Critical Success Factor

DB Design-Build

BIM Building Information Modeling

ABSTRACT

The rapid expansion of the construction sector in Ethiopia, driven by national development and urbanization, has increased the adoption of design and construction integration project models. However, these projects frequently face challenges in scope management that result in cost overruns, delays, and substandard quality. Scope management is critical in defining and controlling what is included in a project and ensuring alignment among stakeholders. This study aims to identify, prioritize, and analyze critical factors influencing successful scope management in design build construction projects in Ethiopia. 34 factors were identified through a comprehensive literature review. These factors were prioritized based on their relative importance using a pairwise comparison method, and among them the top 28 critical success factor can were analyzed using Interpretive Structural Modeling, The result shows that social environment, effective communication, stakeholder alignment and collaboration, compliance with regulatory systems, and flexibility are the most critical success factors. Among these, social environment was found to be the most influential and consistently important across all analytical models. Furthermore, the study found that several critical factors are strongly interrelated and reinforce each other. The hierarchical structure developed from the analysis clearly visualizes how foundational factors support the achievement of higher-level outcomes. Based on the findings, the study recommends enhancing communication practices among stakeholders, investing in capacity building for scope planning and control, and improving regulatory oversight in the construction sector. The results are expected to help policymakers, project managers, and industry professionals make informed decisions to improve project outcomes and reduce the risks associated with poor scope management.

Key word: Critical success factor, Design-build, Design-build project, Scope management

CHAPTER ONE

1.1 Background

In the field of construction project management, scope management is considered a foundational element that significantly influences the success or failure of a project. Construction projects are receive complex, time-bound, and resource demanding projects involving diverse stakeholders with diverse expectations and requirements. Within this context, scope management plays a critical role by clearly defining the boundaries of the project and ensuring that all necessary work is included and properly executed, while avoiding unnecessary tasks (Institute, 2021). This clarity helps mitigate the risk of scope creep uncontrolled changes or continuous growth in a project's scope which can lead to cost overruns and schedule delays (Kerzner & Saladis, 2017). Beyond its role in establishing work boundaries, scope management serves as a strategic tool for decision-making across key project parameters such as time, cost, and quality. It involves structured processes ranging from initial planning and scope definition to change control and validation that cover the entire project lifecycle (Mubarak, 2015). The finding of Turner et al. (1999) demonstrate the early alignment of stakeholder expectations through scope management significantly reduces ambiguity and conflict, which are common challenges in construction projects. In other words, scope management not just enhanced communication between the participants, but also increased the chances that the project deliverable will fulfill the client's needs, while working within the scope constraints (Fewings & Henjewele, 2019).

General scope management principles to its application in various approaches to project delivery. The Design-Build (DB) model is a distinct context in which the increased significance of effective scope control is even more pronounced when integrating design and construction. The Design-Build system is characterized by one party providing both design and construction services and, therefore, the accountability for the services is more unified (Ling & Poh, 2008). Many have suggested that the Design-Build approach has served to minimize conflicting relationships, shorten timeframes, and encourage effective decision making (Chan & Kumaraswamy, 2002). From a scope management perspective, increased integration of roles may lend itself to more rapid responses to changes and early problems resolution (Gransberg & Molenaar, 2019).

However, the same integration also presents challenges. Because design and construction are conducted simultaneously, changes in scope affect design and construction concurrently and must be carefully coordinated to prevent misalignment. Additionally, incomplete designs at early stages (due to fast tracking) often contribute to scope ambiguities (Ling & Poh, 2008). Finally, the internal consistency that must be achieved within the multidisciplinary teams comprising the Design-Build entity is also critical, as quality disputes can arise when the understanding of scope requirements are misaligned (Molenaar et al., 1999). Together, these points provide the foundation for the argument that the discussion on the practice of scope management is important to the success of Design-Build projects overall, where the over-lapping responsibilities increase the susceptibility to scope mismanagement.

The difficulty is even more apparent in the case of the context of developing countries such as Ethiopia where the construction industry faces different constraints. The construction industry in Ethiopia has undergone a significant transformation with rapid urbanization and infrastructure growth in recent years and the construction sector has emerged as the most significant contributor to the country's GDP growth (Misrak, 2021). The popularization of the Design-Build model in Ethiopia is due to the need to address these developmental demands, but the systemic constraints in Ethiopia still impede the successful implementation of the model (Gebrehiwet & Luo, 2017). These constraints include the lack of skilled labor, the use of traditional project management methods, and a lack of modern project management software that hampers the efforts to maintain scope integrity.

Furthermore, fragmented institutional frameworks, vague procurement controls, and poor regulatory enforcement also contribute to vague scope definition and control. These factors often lead to unclear project scopes, varying deliverables, and reactive scope change control. The study by Dinka (2018) notes, the absence of standard contract components and oversight in Ethiopian Design-Build projects create an opportunity for misinterpretation of project responsibilities and consequently increase the probability of disputes. When weak scope and management controls are present, this typically leads to project inefficiencies, cost overruns, and quality outcomes that diminish the advantages of the Design-Build model.

Given these conditions, there is a great need for the exploration of how scope management is currently implemented within the Ethiopian Design-Build environment and how it can be improved. While existing literature offers insights into general project issues in Ethiopia, such as delays and cost overruns, few studies focus on scope management as a distinct issue. Most research applies broad or externally developed frameworks to an environment that may not have the small detail of the Ethiopian construction context, which creates a critical gap in understanding the local context and its impact on the scope management process.

More specifically, there is limited research examining the interplay between various factors such as contractor capacity, communication quality, and institutional barriers and how they collectively influence scope management in Ethiopian Design-Build projects. The absence of such integrated analysis prevents the development of context-specific recommendations, thereby limiting progress in improving project delivery performance. This gap in the literature introduces a valuable opportunity for targeted investigation that can bridge theoretical insights with practical realities.

Consequently, this study is not only timely but also necessary. It intends to bridge the identified research gap by exploring systematically the factors that affect scope management in Ethiopian Design-Build projects. The focus on the local context will generate academically relevant and practical useful findings. Good scope management is an established predictor of successful cost, time and quality performance of projects. However, its systematic use for achieving strategic project goals is lacking in the Ethiopian context. The results from this study will make recommendations based on findings for construction professionals and policy makers, which will contribute to more effective and reliable project delivery in Ethiopian is growing construction industry.

1.2 Statement of Problem

Design-Build (DB) construction, projects where both design and construction activities are performed under a single contract, scope management is an important, yet often problematic, consideration. Scope management, as defined for this explanation, is the process of defining, validating, and controlling inclusion and exclusion for a project (Guide, 2017). Even with benefits such as improved communication and quicker turnaround time, the Design-Build method poses significant challenges. Typical problems encompass scope changes, altered project parameters, and lack of consistent definitions for terms used by different members of the project (Molenaar & Songer, 1998). These concerns are superimposed on the already inadequate design and construction time concurrently experienced in DB projects, which severely restricts the time available for meticulous planning, resolution of complex responsibilities, and constant modification (Ling & Chong, 2005).

Ineffective scope management results in tremendously negative impacts on project results. Study by Mir and Pinnington (2014) stated that frequently, poorly defined scope results in schedule slippages, budget exceedances, and substandard deliverable quality all hallmarks of failure. Boundless projects, without any preliminary control measures, are likely to result in boundless rework, endless arguments regarding changing designs, and exhausted assets through resource misallocation. In fast design build environments, where decisions are made at a rapid pace and there is a need for high collaboration among stakeholder teams, inadequate scope delineation can lead to severe disconnects among client wishes, designer vision, and contractor implementation (Zuo et al., 2018). Poor scope management directly decreases stakeholder satisfaction, increases expenditure, compromises on-schedule delivery, and overall, reduces value. Effective scope management, on the contrary, improves value by precise definition of project deliverables, which streamlines resource allocation and improves communication throughout the project.

These disputes are more pronounced in Ethiopia, which is experiencing rapid growth in the construction industry as a result of urbanization and national development strategies (Weldegebriel, 2016). This growth however comes with poor frameworks in managing project, which in turn fuels scope management issues. In Ethiopia many Design-Build projects are plagued with repeated delays and schedule setbacks as well as budget overruns and subpar construction quality which are all attributed to poor scope management (Ayalew et al., 2016). Skilled professionals who are eager to succeed in Ethiopia's infrastructure goals because of poor scope control and fragmented project planning increase lapses in document verification. Effective scope control accomplishes national project goals and helps resource allocation during project execution. The avoidance of setting clear contract terms results in inefficient project.
Scope management is critical in the broader context of national development, and works as a motivating factor for undertaking more detailed analysis of addressable components of Design-Build projects. The majority of existing research centers on Construction Management as a broad topic, lacking attention to specific characteristics of Design Build delivery. Even fewer studies address the specific Ethiopian context of developing country institutional and technical

frameworks, which have more serious scope oriented challenges. As a result, project managers are left with limited guidance on which factors matter most and how these elements interact within the Design-Build environment.

Addressing this gap requires identifying and prioritizing the critical factors that influence scope management outcomes. Prioritization helps practitioners focus on areas that offer the greatest potential for improvement, allowing for targeted interventions rather than broad, unfocused efforts (Olawale & Sun, 2010). However, to be truly effective, this prioritization must consider not only the importance of each factor but also the ways in which these factors are interconnected. In practice, elements such as stakeholder coordination, communication clarity, and resource availability influence one another in complex and dynamic ways. For example, inadequate communication may lead to poorly defined requirements, which in turn increases the probability of scope changes and disputes during construction. Understanding these interdependencies is essential for managing scope more effectively.

Unfortunately, most existing research does not employ analytical tools capable of uncovering these relationships. Techniques such Analytic Hierarchy Process, Interpretive Structural Modeling, MICMAC analysis and Quadrant Analysis (Warfield, 1978). This creates a major gap in the knowledge, especially in understanding the systematic character of scope-related issues in Design-Build projects. Without these insights, attempts to enhance scope control remain reactive and divided, usually not addressing underlying issues. Further complicating this problem is the dearth of complete models integrating both the significance and the interactions of important elements. The research by Amoatey and Ankrah (2017) argue that existing models often regard variables in isolation, therefore failing to capture the bigger picture of their interaction and impact. One would need a more complete strategy that combines the complexity of individual relationships with the weight of each element. Here, Quadrant Analysis provides a useful answer as it lets you group elements according their degree of influence and significance. Together with ISM, AHP, and MICMAC, Quadrant Analysis gives an all organized overview of scope control issues in Design-Build projects. This can help planning, more strategic decision-making, and better outcomes to follow.

Considering these problems and gaps in knowledge, this research is timely and important. With its recognition and ranking of the most critical factors contributing to project success under the context of Ethiopia, this seeks to enhance scope management practices in Design-Build projects. By doing so, it will further examine the problematic interdependencies among the factors utilizing sophisticated analytical approaches. The research objective is to address important gaps in knowledge and contribute to better project delivery in Ethiopia's growing construction industry by providing relevant insights and solid frameworks. Better scope management will ultimately result not just in projects that are more successful but also in better infrastructure and national development aid. The research aims and chapter three methodology with the purpose of investigating these urgent matters will be elaborated in the next section, thus establishing the groundwork for better scope management and effective project delivery.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of this study is to assess the key factors influencing the effectiveness of scope management in Design-Build construction projects, with a focus on the Ethiopian construction industry.

1.3.2 Specific Objectives

To identify critical factors to successful scope management in design-build projects based on their level of importance.

To examine the influence of each identified factor on one another to understand their interrelationships.

To analyze the combined critical factors with the importance and influence for successful scope management

1.4 Research Questions of the study

What are the critical factors that contribute to successful scope management in Design-Build projects, and how can they be ranked based on their level of importance?

How do the identified critical factors influence one another**,** and what are the interrelationships among them in the context of scope management in Design-Build project?

What is the combined impact of the critical factors on the success of scope management, considering both their importance and influence?

1.5. Scope of the Study

This study is focused on identifying, analyzing, and prioritizing critical factors influencing the effective scope management of design-build construction projects in Ethiopia. It focuses on projects currently in progress. Which are roads, railways, residential developments and other large-scale public and private infrastructure projects. Geographically, the study encompasses major urban centers such as Adama, Addis Ababa, Sheger city, Bushoftu and Semera city where significant DB projects have been under construction. This approach ensures the collection of reliable data and insights, as projects with significant progress provide a better understanding of the challenges and factors affecting scope management. The study is limited to design-build construction projects across the country, providing a comprehensive analysis relevant to the country's unique construction industry context.

1.6 Significance of the Study

This study provides valuable insights into effective scope management in design-build construction projects, particularly in Ethiopia. It bridges a gap in academic literature by focusing on scope management challenges in developing countries and offers practical recommendations to improve project performance. The findings will benefit construction professionals by identifying critical factors to minimize delays and cost overruns while supporting policymakers in enhancing industry practices and standards. Ultimately, the study contributes to improved project outcomes and sustainable construction practices.

1.7 Research Organization

The research is organized into five chapters, each serving a distinct purpose in the overall study. Chapter one begins with an introduction that provides the background of the study, a statement of the problem, and the objectives of the study. It also outlines the significance of the study, research questions and scope. Chapter Two delves into the literature review, encompassing relevant related literature on the concept and overview of project success factors, criteria for success, and the general principles of project management. Chapter Three details the methodology, explaining how the research was conducted, including the research method, target population, instruments of data collection, data collection techniques and procedures, and the data analysis method. Chapter Four presents the results and discussion, providing a detailed analysis of the data collected from questionnaires and interviews, along with in-depth analysis using the Analytic Hierarchy Process, (MICMAC), and Interpretive Structural Modeling (ISM). Finally, Chapter Five concludes the research by summarizing the findings and offering recommendations based on the conclusions drawn.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

In this literature review, contents related to construction project success, particularly the evaluation of critical factors influencing successful scope management in Design-Build (DB) construction projects in Ethiopia, were covered. The review is divided into two parts. The first part explains the theory behind construction projects. It gives an overview of the construction industry in Ethiopia, talks about what DB projects are, explains important terms, project stages, and what makes a project successful. It also looks at the key factors that affect project success. The second part reviews real-life research done on scope management in DB projects. It captures what different studies have determined, pinpoints what still needs to be filled in research, and shows how such data can be applied to improve future projects. Through the unification of theory and empirical research, this review allows to understand better what contributes to scope management success in DB construction projects in Ethiopia.

2.2 Importance of Scope Management in Construction Projects

Scope management is a pivot of project management, especially in construction projects, since construction projects are complex, have many stakeholders, and involve large resources (Kerzner, 2009). Scope management outlines, schedules, and regulates project components what to do, how to do it, and what not to do in order to fulfill objectives. This is especially critical in construction industry, since aspects like changing client requirements, unexpected site conditions, and regulatory need to be assign with. By defining the scope of a project, scope management prevents scope creep, which can lead to misunderstandings, delays, and cost overruns (Nabet et al., 2017). A well-defined scope provides guidance and helps teams plan, particularly in the case of issues like changing client requirements and site conditions (Stackpole, 2013). Work Breakdown Structure (WBS) also decomposes work, splitting projects into manageable pieces to be controlled, enhancing communication and tracking (Agistin et al., 2021). Project teams can prevent overlooking key tasks by decomposing the scope in parts, thereby enhancing project outcomes.

Change cannot be avoided in construction, but unchecked changes will disrupt timelines, budgets, and quality. Having an official change control process, through which changes are assessed, authorized, and executed, is critical to minimize disruption (Cooke-Davies, 2002). Some research shows that effective scope management systems in projects ensure fewer cost overruns, and the necessity of controlling change to stay on time becomes apparent (J. Wang et al., 2023). Moreover, effective communication between stakeholders clients, architects, engineers, and builders establishes a shared view of the scope of work and prevents conflict and disputes (Flyvbjerg, 2014). Early communication, especially on unexpected site conditions, helps in fast resolving problems and prevents delays (Dodgson & Gann, 2023). Scope management is also crucial in the reduction of risk by incorporating safety and regulatory considerations in planning to ensure that seismic activity in earthquake regions, among other risks, are handled well (Hooshmand, 2020). Lastly, scope management enhances cost-effectiveness, schedule adherence, and stakeholder satisfaction since it provides a structured means of managing construction projects while empowering teams to counter complex issues with confidence and agility (Kerzner, 2009).

2.3 Overview of Design-Build (DB) Project Delivery Method

Design-build (DB) delivery method has been a new age method in the construction industry, which has replaced the design-bid-build (DBB) method using outsourcing design and construction services under a single contract. The DB method began centuries ago, when it comes to mega projects such as Roman aqueducts and Egyptian pyramids, as master builders had done design and construction (Migliaccio & Shrestha, 2023). Design-build (DB) delivery method has been a new age method in the construction industry, which has replaced the design-bid-build (DBB) method using outsourcing design and construction services under a single contract. The DB method began centuries ago, when it comes to mega projects such as Roman aqueducts and Egyptian pyramids, as master builders had done design and construction (Beard et al., 2001). Increased complexity of infrastructural projects and weakness of fragmented project delivery methods also necessitated transition to integrated approaches like DB (Molenaar & Songer, 1998).

In the last two decades, some critical landmarks have characterized the mass recognition of DB. The most significant of these include the enactment of enabling legislation in most countries, including Ethiopia, enabling public bodies to adopt the DB technique for large-scale infrastructure projects (Love et al., 1998). This transition went with modifications to procurement policies and contractual arrangements, with cooperation, creativity, and risk sharing among Stakeholder. In addition, improvements in digital technologies such as Building Information Modeling (BIM) have supported the DB method by increasing real-time communication and integration between disciplines (Azhar et al., 2012). As a result, DB has been used more in the public and private sectors due to its ability to speed up project delivery and minimize conflicts.

In project management, the Design build method has significantly influenced the definition and control of scope. The majority of DBB projects follow a linear sequence with scope defined prior to construction. DB projects, on the other hand, call for preliminary and flexible definition of scope since design and construction phases often overlap (Ling et al., 2004). This convergence presents opportunities as well as challenges: while it accelerates delivery, it also requires more resilient and responsive scope management practices to cope with design changes, evolving client requirements, and stakeholder coordination. Research by Hale et al. (2009) highlights that early involvement of stakeholders, effective communication, and flexible planning all key to effective scope control as characteristics of successful DB projects.
Despite these advantages, scope management for DB projects is more complex due to the interrelated nature of the work. If the scope is not well-defined in the early stages or varies quickly without proper documentation, it can lead to scope creep, contractual issues, or quality issues (Chan & Kumaraswamy, 2002). As a result, scope management in DB has evolved from a static documentation to an iterative, dynamic one with greater emphasis on cooperation, early decision, and risk aversion. The evolution is especially important in the Ethiopian construction industry, where DB application is on the rise while facing challenges like paucity of regulation, misaligned stakeholders, and scarcity of resources (Othman & Ali, 2024).

Generally, the DB approach of project delivery is a construction project management encourages integration, acceleration, and collaboration. Its evolution has been prompted by institutional transformation and practical pressures, with associated new expectations for scope management. Acknowledgment of this transformation is essential in order to evaluate the principal success factors that influence scope management in DB projects, particularly within the special case of Ethiopia's growing infrastructure business.

2.4 General Overview of the Construction Industry

The building industry is the pillar of global economic development and significantly contributes to GDP, jobs, and infrastructure growth throughout the world. It is a diverse sector that contains all types of activities involving housing, buildings, industrial, and infrastructure activities like roads, bridges, airports, power plants, and water supply systems. As one of the global biggest industries, it contributes significantly to the urban development, accommodating population growth, and meeting the needs of society. This chapter gives an overview of the industry at a general level, starting with a local to the global construction industry.

2.4.1. The Global Construction Industry

The construction sector of the world is pivotal to economic growth. It makes about 13% of the world's economy (Bank, 2017). Construction serves a unique role in each region because of their financial goals and degree of development. In the developed world, rehabilitation and upkeep of old buildings and infrastructure is the focus. In the developing world, urbanization and industrialization at a fast pace are driving the construction sector.

In the global construction sector, the regions react differently. The Asia-Pacific area is the largest thanks to huge projects in China, India, and Indonesia. China itself contributes about 25% of all constructions globally (Bank, 2017). North America and Europe are engaged in enhancing already constructed buildings, using green technology, and adopting new technology in order to be more efficient (T. Wang et al., 2023).

There are also some important trends that are changing the construction industry today. One of them is building parts of buildings in factories and then assembling them on site. This solves the problem of not having sufficient labor and accelerates work (Songer & Molenaar, 1996). Another important area of focus is being eco-friendly. That includes building offices and homes that do not impact the environment, using renewable energy, and recycling material (Liu et al., 2017). In addition, new technologies like BIM are helping to enhance project management and delivery (Lee et al., 2022). Governments and companies are also cooperating more to fund and carry out big projects (Gransberg & Molenaar, 2019). Industry players forecast the industry to grow by 4.2% each year up to 2030 (Taher, 2021).

Therefore, even for the construction industry, challenges like resource shortages, lack of human resources, and stringent laws, new ideas and smart investments are creating plenty of avenues for growth. Through new technologies, going green, and partnering, the industry can meet the challenges of a changing world.

2.4.2. The Ethiopian Construction Sector

Ethiopia's construction industry has record growth over the last two decades as a result of high urbanization, rising population, and government-led infrastructure development. The study by Ayele et al. (2021) highlight that Ethiopia's construction industry is very vital to Ethiopia's Growth and Transformation Plans (GTPs) since it aims at improving infrastructure, connectivity, and enhancing living standards. Urbanization and population growth have also contributed to increasing the demand level for commercial and housing properties. This higher demand has opened opportunities for both foreign investors and domestic contractors and has driven the expansion of the industry (Tafesse, 2020). Despite its expansion, the Ethiopian construction sector is confronted with a myriad of challenges that hamper it from developing. Delays in projects rank among the major challenges that typically arise as a result of bureaucracy, poor planning, and resource scarcity. The study by Imiru (2020) pointed out that delays are further caused by the lack of skilled personnel, building materials, and modern equipment. These constraints not only inflate costs but also lower the quality of projects. Excess costs are another significant issue. The study by Flyvbjerg (2014) observed that mega infrastructure projects in developing nations are likely to be more costly than projected due to weak risk management and modifications of project scope. The research conducted by Gransberg and Molenaar (2019) noted that the Ethiopian construction has a high proportion of small and medium enterprises (SMEs) working autonomously, and this leads to inefficiencies and issues with communication. Apart from that, traditional procurement methods, Design-Bid-Build (DBB), are likely to contribute to conflicts between designers and contractors, hindering the project completion process (Lee et al., 2022).

In order to address such challenges, the construction sector in Ethiopia is gradually adopting new technologies and techniques. Among the new trends is the increased interest in using alternative project delivery methods, Design-Build (DB).

Overall, the Ethiopian construction sector is at a crossroads, balancing rapid growth versus longstanding issues. Although the industry has made considerable strides in infrastructure, delays and cost overruns must be addressed if the industry is to ensure sustainable growth. With new approaches and teamwork, Ethiopia can make the most of the use of the construction industry to position it toward reaching its goal of being a middle-income economy by 2030.

2.5. Theoretical Framework of Scope Management

Construction project scope management has evolved in succession of theoretical models and frameworks, each of which gives a systemic methodology for determining, controlling, and delivering project scope. Of the most frequently cited is the Project Management Body of Knowledge (PMBOK) framework of the Project Management Institute (PMI), which lays down six critical processes: scope planning, scope definition, creation of a Work Breakdown Structure (WBS), scope verification, and scope control (Guide, 2017). This method is highly used because of its process-based nature and alignment with traditional project environments. It has a very strong emphasis on formal documentation, stakeholder involvement in the planning phase, and strong change control processes throughout its life.

Another well-known model is the PRINCE2 (Projects in Controlled Environments) methodology that includes scope management as an important part of it. PRINCE2 differs from PMBOK in emphasizing more on stages, business case, and continuous verification of the project's objectives (Commerce, 2009). Although PMBOK is industry-neutral and more adaptive, PRINCE2 is a highly prescriptive, governance-oriented approach, ideal for the public sector and bureaucratic environments. However, critics criticize that PRINCE2 is overly prescriptive for projects with rapid changes and design-build projects where the requirements evolve faster (Osei-Kyei & Chan, 2017).

Unlike such prescriptive models, Agile-based models have been in the spotlight in recent years because of their iterative, customer-focused philosophy. While originally intended for use in software projects, agile practices such as adaptable planning, ongoing interaction, and flexible scope are increasingly applied in complex construction industry. The Agile Project Management (APM) framework is independent of complete scope definition up-front. Instead, it allows for scope to fluctuate throughout the project life cycle and even continual feedback from the stakeholders (Conforto et al., 2014). While this model is highly capable in uncertainty and varying requirement management, it may not offer the accuracy required in large-scale infrastructure projects that include obligatory regulatory compliance and predetermined deliverables.

Some researchers also propose hybrid models by combining the strengths of PMBOK, PRINCE2 and agile methodologies. These models use large amounts of initial planning for critical elements but allow for iterative development of non-critical elements. For instance, the research conducted by Barbosa et al. (2021) highlight describe a hybrid model integrating WBS and Agile sprints where control along with flexibility in scope delivery is achievable. This model is appropriate for design-build construction projects in which designing and execution would concurrently proceed in parallel and would have to be continuously synchronized.

To the extent they are alike, they share similarities: the importance of early stakeholder engagement, the helpfulness of good documentation, and the necessity of continuous scope validation. Yet also contrast in their handling of uncertainty and change. PMBOK and PRINCE2 methodologies tend toward predictability and control, while Agile and hybrid methodologies prefer flexibility and reaction. This variance prompts us to think that one model cannot be a one-size-fits-all, but instead it is dependent on the project complexity, contract type, and organizational culture.

Scope management model variation, therefore, is typically a reflection of the flexibility of the construction sector. PRINCE2 and PMBOK are appropriate for linear, clearly defined projects, but hybrid models and Agile are more applicable in iterative, interactive project environments like design-build. Use of these models in context-specific ways rather than a one-size-fits-all methodology can result in improved scope definition, reduced miscommunication, and translates into improved project outcomes.

2.5.1 Scope Creep and Its Impact on Project Success

Scope creep, largely defined as uncontrolled growth in the scope of a project without corresponding changes, changes in resources, time, or money, is largely considered one of the most substantial project threats to successful projects. Study by Kerzner (2009), discovers that scope creep is typically induced by poorly defined requirements, changing client needs, or poor communication among stakeholders. In design-build construction, where design and construction occur simultaneously, such problems are even more pronounced. Without well-documented scopes, teams may struggle to coordinate deliverables, and this will lead to cost overruns and schedule slips.

Various studies have highlighted the manner in which scope creep negatively influences project performance. For instance, the research by Hwang and Ho (2012) found that scope creep is among the top three causes of construction project failures and largely leads to compromised quality, rework, and stakeholder dissatisfaction. Similarly, study by Alotaibi (2018) reported that showed scope creep has the tendency to greatly increase risk in big-ticket infrastructure projects, especially without an established change management process when scope modifications occur. The findings of these outcomes underscore the imperative for strict definition of scope, early involvement of stakeholders, and monitoring. Alternatively, other researchers hold the view that not all changes in scope are bad. The research by Park and Peña-Mora (2003), in highly dynamic environments, for example, changes in scope can be considered adaptive responses that improve long-term project performance if they are responding to unexpected client requirements. In this view, the issue is not the changes themselves but the management of them. This compares with more conventional models that have seen any deviation as peril, showing a trend within the literature away from more prescriptive project strategies.

Despite these implicit opinions, there is general agreement that uncontrolled scope creep particularly without instituted approval procedures leads to inefficiencies. Literature is indicative of the fact that an effective change control process, good documentation, stakeholder communication, and impact assessment are essential to scope creep prevention (Zwikael & Smyrk, 2011). In design-build projects, where the overlap of design and construction phases is likely to compound complexity, proactive and early scope creep management is crucial to meeting schedule, budget, and quality goals.

2.5.2. Connection between Scope Management and Project Success

Project scope management and project success is a widely studied area in project management literature. Successful scope management helps to ensure that projects are delivered on time, and under budget, and to the desired project success (Flyvbjerg, 2014). Inadequately managed scopes are among the major causes of failure in very large infrastructure projects, because unexpected alterations have the potential to substantially overestimate costs and delay completion (Flyvbjerg, 2014). On the other hand, The research conducted by Ayele and Derseh (2020) state that clearly defined and controlled scopes serve the interest of stakeholders satisfaction and improve project results, particularly in difficult environments such as Ethiopia, where socioeconomic and institutional constraints are extensive.

Scope management not only defines project boundaries but also promotes stakeholders' coordination, reducing disagreements and consistency. The study by Lam et al. (2008) describe that traditional project delivery methods are plagued by misalignment due to inefficient scope management, whereas the early contractor involvement in Design-Build (DB) projects helps address construct-ability issues before they become costly disruption. This shows the importance to coordinate scope management with general project scope, such as time, cost, and risk management. The study by Liu et al. (2017) point out that scope changes directly affect timelines and budgets and need joint efforts to mitigate their effects. Despite its significance, scope management is fraught with challenges such as resource constraints and bureaucratic red tape in contexts like Ethiopia (Ayele & Derseh, 2020). The study by Tafesse (2020) argues that overcoming such challenges entails not only technical management but also efforts to break through cultural and institutional inefficiencies. It is therefore evident that proper scope management minimizes uncertainties, enhances collaboration, and decreases risks, and therefore aids in the success of a project.

2.6. Critical Success Factors for Scope Management in Design-Build Projects

In construction projects, determining project success factors goes much beyond being completed within budget and on time. Critical success factors (CSFs) in scope management are pivotal to guaranteeing that project scope is defined, controlled, and delivered as planned. These factors help project managers focus on the most important factors that lead to successful delivery of projects. Understanding and management of these CSFs in the scope management process are critical to preventing scope creep, project focus, and stakeholder expectations.

Critical success factors (CSFs) for scope management can be traced to seminal project management literature. The research by Poon and Wagner (2001), CSFs for scope management are circumstances or factors that should be fulfilled and coordinated for a project's scope to be clarified and delivered effectively. They include ensuring clearly stated project goals, alignment among stakeholders, detailed planning, and proper change control practices. These are considered important in effective management of a construction project's scope. They help in establishing by project managers what is in and out of the project, to avoid confusion and scope creep that could lead to cost overrun, delay, or failure of the project.

Scope management critical success factors are not abstract concepts but practical tools that have direct implications on the ability of the project to meet its scope objectives. Study by Ika (2009), CSFs for scope management are the events and circumstances of the project that influence the success of the scope definition and its application. They are either internal, for instance, the ability of the project team to manage scope, such as changes in regulation or unforeseen site conditions. The research by Sanvido et al. (1992), such critical considerations have a significant influence on the project scope, for they dictate whether the scope has to be provided as intended. Efficient and effective communication is among the most vital elements of CSFs in scope handling. Poor communication between the stakeholders of a project can result in confusion on the project scope, resulting in scope creep an uncontrolled expansion in the project scope without reconciling changes in resources, time, and cost (Cooper, 2008). Effective communication ensures that all stakeholders are on notice and in consensus on the scope from the start and prevents conflict during the later stages of the project. The same goes for effective change control procedures in maintaining effective management of scope changes. When there are changes that need to be made, having a systematic procedure ensures that these are evaluated, authorized, and implemented without neglecting the project timeline and budget.

One of the other CSFs for scope management is stakeholder alignment. This refers to having a shared perspective of the project scope by all the stakeholders like clients, contractors, and consultants. Misalignment can lead to conflicting expectations that can negatively impact the project scope and ultimately the project success (Ika, 2009). Study by (Cooper, 2008),establish that engaging stakeholders in scope planning during the initial stages and keeping regular contact can prevent such issues.

Further, an effective scope baseline is also essential in scope management. It offers the foundation to control and track scope through the project life cycle. The project managers will be unable to track progress and identify scope changes in the absence of it (Poon & Wagner, 2001). The research by Sanvido et al. (1992) argue that a well-defined scope baseline allows setting boundaries of the project and controlling any adjustment required during the execution phase.

Generally, the critical success factors for scope management in construction projects are open communication, good stakeholder alignment, solid planning, and strict change control processes. They are the secrets to ensuring that the scope is accurately defined, maintained under control in the project, and delivering to all the stakeholders' expectations. By keeping these factors in mind, project managers can avoid scope creep risks and deliver the project within its planned scope, on schedule, and at cost. It is not only a requirement for the project's success but also to ensure the project is delivered to the anticipated quality standard required by the stakeholders.

2.6.1 Categorizing Critical Success Factors

In the project of construction, the management of the scope of the project is one of the most vital tasks to ensure success. Scope management is concerned with planning, defining, and controlling what is included in the project and what is not. To do this, however, some of the critical success factors (CSFs) must be well managed. These are the key conditions or areas that have a direct impact on whether the scope is well handled and the project goals are met. Understanding and organizing these CSFs helps project teams focus on what truly matters for scope control and successful delivery.

In the early research on CSFs, Pinto and Slevin (1988b) were among the first to attempt organizing these success factors into a classification model. Their framework grouped CSFs into ten categories, including project mission, top management support, project schedule and plans, client consultation, personnel, technical tasks, client acceptance, monitoring and feedback, communication, and troubleshooting. Though their work did not focus specifically on scope management, many of these categories like project mission, client consultation, and communication are highly relevant to scope definition and control. These factors are all central to avoiding misunderstandings and ensuring that project goals and expectations are clearly understood by everyone involved.

Later, the research by Belassi and Tukel (1996) introduced a more refined classification system that addressed some of the weaknesses in earlier models. They argued that grouping all success factors into a single list failed to show where each factor came from or how much control the project team had over it. Their model separated CSFs into four major groups: (1) factors related to the project, (2) factors related to the project manager and team, (3) factors related to the organization, and (4) factors related to the external environment. This allowed the easy determination of which areas in a project needed attention and how different stakeholders contributed towards success. In scope management, this grouping comes in useful especially because scope can be affected by all four factors such as imprecise project objectives (project-related), poor leadership (manager-related), bureaucratic organization (organization-related), or legislative amendments (external).

The research, which was more recent, went on to develop these earlier frameworks in more detail. The research conducted by Chan et al. (2004) classified CSFs into five groups: human-related factors, project-related factors, project procedures, project management actions, and external environment. The research conducted by Gudienė et al. (2014) extended this by further sub-classifying human factors into client-related, contractor-related, and project manager-related categories to establish how various individuals in a project may uniquely influence scope success. Similarly, the research conducted by Saqib et al. (2008) included categories like procurement and design team-related factors, establishing the extent of the role delivery methods and design coordination has in managing scope.

So, now if connect these categorizations back to scope management in particular, by defining five critical areas where CSFs are essential. The first of these is scope planning and definition, which connects to Pinto and Slevin’s concept of "project mission" as well as Belassi and Tukel (1996) "project-related" classification. A well-defined project mission means the scope is properly defined at the beginning, minimizing future confusion. The second area is communication and coordination, as vital in terms of managing expectations and avoiding scope misunderstandings. This is the equivalent of Pinto and Slevin’s "communication" factor and Gudienė et al. (2014) "project manager and client-related" categories. The third one is change and risk management and how well a project manages unexpected changes or external pressures. This is similar within Belassi and Tukel (1996) "external" and "project management team" categories, emphasizing the need to control scope creep and redesign plans as appropriate. The fourth most critical one is stakeholder involvement; ensuring clients' and stakeholders' needs and input are incorporated into the scope. This is closely linked to Pinto and Slevin’s "client consultation" and Chan et al.'s category of "human-related" factors. Lastly, Scope control and monitoring such as legal, political and environmental changes can heavily influence scope. These are consistently recognized across frameworks under the category of "external environment." Together, these five areas help to group and better understand the most important success factors that influence scope management in construction projects. From this comparison, it is clear that the CSFs affecting scope management are not new, but their importance has grown as construction projects have become more complex. What see across the literature is a shared understanding that scope success depends not just on technical planning but also on people, processes, and external circumstances. Each classification system offers a slightly different perspective, but most agree on the key areas that influence success.

Generally, the classification of critical success factors whether from Pinto & Slevin's early project lifecycle model, Belassi and Tukel (1996) influence-based framework and more modern studies like Gudienė et al. (2014) helps us better understand how to manage scope in construction projects. Categorizing this CSFs into groups that explain internal and external factors, project managers can focus on where it critical most and reduce likelihoods of scope creep, delay and failure. The categorizations continue to be an important element of project planning and evaluation, offering meaningful information regarding what it takes to keep construction projects on schedule and in scope.

2.6.2 Importance of Identifying Critical Success Factors in Scope Management

Identification of critical success factors (CSFs) in scope management is one of the significant elements in leading construction projects towards successful outcomes. Different scholars argue that early identification of these essential factors enables project managers and stakeholders to prioritize the most important factors that enhance the performance of projects. Instead of splitting effort evenly between all regions, the CSFs identification process enables the prioritization of attention to those tasks that significantly affect clarity of scope, control mechanisms, and overall success. For instance, study by Cooper (2008) argues that CSFs identification helps ensure that project teams do not miss key aspects of scope planning, including stakeholder requirements, risk management, and communication channels, which are typically significant sources of project scope failure. Similarly, the research by Saqib et al. (2008) emphasis on the evaluation and prioritization of Critical Success Factors (CSFs) as an early warning system, thereby enabling project managers to predict the potential success of a project according to its alignment with a number of fundamental criteria.

Such proactive knowledge is not only useful for the realization of individual projects but also facilitates more integrated strategic planning within construction firms. Study by Abraham (2003) discusses that the identification of Critical Success Factors (CSFs) provides organizations with the capability to assess their internal capacity to deliver project specifications. By having identified such factors, organizations are able to ascertain if they have the requisite technical and managerial competencies to fulfill client requirements and adhere to industry standards. This reflective procedure enables firms to strengthen their internal processes and invest in the right competencies in a way that they will be ready to effectively deliver future projects. In so doing, CSFs serve as a project-level guide and a tool for strategic development.

In addition, the recurring determination of CSFs on different projects empowers knowledge creation and benchmarking within the industry. Once organizations are aware of what scope factors continually affect project outcomes such as scope definition, stakeholder alignment, or change control they can then create stronger frameworks that prevent project overruns or scope creep. Hence, the benefit of determining CSFs is not just in improving present project performance but also in improving organizational learning and readiness in the long term.

Identifying critical success factors in scope management tends to enhance decision-making processes, optimize resource planning, and provide assurance that all the significant aspects of scope planning and control are effectively addressed. A technique like this constitutes a platform for continuous improvement and strategic direction and hence a vital practice for efficient construction project delivery.

To decide which success factors (CSFs) influence most for managing a project's scope, researchers use clear criteria. First, they look at how much a factor affects the project's main goals, like cost, time, or quality. Studies show that factors directly influencing these goals such as scope clarity reduce redesign costs by 18% (Adeyemi & Amhana, 2024). Second, they check how often a problem occurs. For example, communication gaps cause 35% of scope changes in Ethiopian projects (Mengistu & Mahesh, 2020). Third, they consider if stakeholders agree on the factor's importance. Clients, contractors, and regulators often prioritize different things: clients focus on costs, contractors on resources, and regulators on safety (Aragaw & Cherkos, 2025). Finally, they assess if the factor fits the project's context. In Ethiopia, where resources are limited, factors like budget planning and regulatory compliance are critical (Ayele, 2019).

Comparing global and Ethiopian studies reveals gaps. While global research emphasizes technology and innovation, Ethiopian projects often struggle with basic issues like unclear goals and poor communication. The Ethiopian Construction Works Corporation (ECWC) improved accuracy by 40% using Building Information Modeling (BIM), showing how technology can support CSFs (Azhar, 2011).

Generally, determining CSF importance requires balancing global best practices with local needs. Using criteria like goal impact, problem frequency and stakeholder agreement.

2.6. 3 Examples from Studies

Real-life examples show how important good scope management is for Design-Build (DB) projects. Design build was used in Ethiopian road project to finish earlier and at a lower cost by including contractor's right from the starting point of the design process. The approach solved construction issues before construction, hence eliminating delays and reduce costs (Lee et al., 2022). Similarly, in Addis Ababa hospital project applied DB in building modern facilities quickly. Stakeholder collaboration facilitated the implementation of energy-efficient technology and creative solutions (Melaku Belay et al., 2021). These instances illustrate the success through proper objectives, timely cooperation, and communication.

However, poor scope management causes problems. Ambiguous plans and weak risk handling in Addis Ababa housing projects caused delays and conflict among clients and contractors (Ayele, 2019). Limited resources and cultural resistance intensified the issues. Another example is a large Ethiopian project where poorly defined goals led to scope creep extra work without management leading to additional costs and extended timelines (Zewdu, 2021). They indicate the importance of proper documentation, well-established roles and increased monitoring. Early contractor involvement, communication, and risk planning are instrumental to DB projects. Where all these elements are balanced, projects stay on track. However, where they are not listened to, projects costs spiral out of control, and there is conflict. In Ethiopia, where infrastructure demands are massive, these elements must be initiated through policy reform and training. Combining these practices with technology such as Building Information Modeling (BIM) can assist Ethiopia in reaching its infrastructure objectives effectively.

2.7 Interrelationships among Critical Factors in Scope Management

It is necessary to understand inter dependencies of CSFs in scope management to improve performance in design-build construction projects. CSFs do not operate in isolation, but interact dynamically with one another, sometimes in complicated ways, with synergies and conflicts that have the potential to play a dominant role in shaping project outcomes. Researchers have emphasized that successful management of project scope requires a common perception of these major determinants rather than treating them as separate entities (Ika (2009) and (Sanvido et al., 1992)).

One of the most powerful interdependencies is the interdependence between scope planning and stakeholder involvement. Scope definition that makes sense is all but impossible to achieve without the active participation of stakeholders, particularly during the early phases of a project. The research by Pinto and Slevin (1988b) identified "client consultation" as a key factor, citing that unless the clients are consulted effectively, the project scope is not clear, and as a result, it has high change orders and scope creep. This dependence is also solid in Yang et al. (2009), who argued that insufficient stakeholder involvement may cause objectives to be nonaligned, ultimately put at risk project coherence and outcome.

Communication and coordination also play a key role in reinforcing and destroying other critical success factors such as stakeholder alignment and risk management. The research conducted by Belassi and Tukel (1996) suggests, clear channels of communication among the project team and external parties are of critical importance in order to deal with expectations and ensure that scope change-related risks are actively recognized and managed. For instance, a case study by Durdyev et al. (2017) case study of Malaysian construction projects confirmed delays in scope approval were only caused by communication failure between the contractors and the design team with evidence of cause-effect between mismanagement of scope and poor communication. Risk and change management, being strongly connected with environmental and organizational factors, also show strong connections with external drivers such as changes in regulations or economy. These external pressures often require scope changes, and therefore it is necessary that projects have flexible planning and strong contingency plans. The research by Zwikael and Globerson (2006) explain that projects incorporating early risk analysis and adaptive measures are more capable of responding to changes in the scope without compromising time and cost performance. This establishes a chain reaction: one-way poor risk definition has the potential to lead to un managed change, which consequently leads to devastation with project schedules and budgets.

In addition, some CSFs are identified to occur in reinforcing loops. For example, mutual trust and responsibility among stakeholders can improve communications and stakeholder engagement, leading, in turn, to improved scope clarity. The study by Ofori (2016), examined the research wherein cooperative relationships among project actors were capable of significantly reducing disputes over scope modification and creating an environment for effective scope negotiation.

One of those impactful connections is the connection between leadership of the project and success with scope control. Leadership stipulates how communications are performed, conflict resolution is carried out, and decisions related to scope changes are taken. Project managers with strong leadership and interpersonal skills. The research by Müller and Turner (2007), re more likely to handle tough stakeholder politics and alter the scope when necessary without losing focus on the project objectives.

Case and empirical studies reveal that such interaction among these variables is not linear but systemic. In other words, a change in one aspect, say stakeholder demands, may cause ripple effects in other areas like planning, resource allocation, or even contract specifications. Such synergy demands that project managers be adaptive and comprehensive in scope management. Ignoring such relationships can result in breakdown efforts and failed project outcomes.

Normally, the major drivers of construction project scope management are interconnected. Stakeholder management facilitates better planning; communication engenders risk management; external factors demand adaptive leadership. Such inter dependencies underline the necessity to approach scope management more broadly, as not a purely technical problem, but as a multifaceted issue, that requires strategic coherence of different areas. Successful resolution of such inter dependencies are a prerequisite for sound project results in the future.

2.7.1 Case Studies and Empirical Evidence

Various researchers have also studied project scope management in design-build projects. The study by Alemayehu (2024) surveyed Ethiopian infrastructure projects and found that projects with clear goals and well-coordinated teams had fewer delays. Similarly, the study by Ofori (2016) studied projects in Africa and agreed that clear goals are needed but went further to say that involving all stakeholders (like customers, contractors, and communities) at an early stage is key to avoiding issues. However, some research shows other issue. The research conducted by Mengistu and Mahesh (2020) indicated that even in Ethiopia, where goals are clearly outlined, projects are delayed either as a result of ineffective planning or lack of resources.

Other studies are case-based. One such study is the Addis Ababa Light Rail project, which succeeded because the team had good change control mechanisms to handle scope changes (Alemayehu, 2024). The Hawassa Industrial Park project suffered from cost overruns because leaders did not address contractors' grievances against material shortages (Mengistu et al., 2024). These show that while communication and goals are key, planning for resources and leadership are also in action.

There are gaps in the literature. There is limited research into the way that variations in Ethiopian unique construction industry, for instance, hierarchical decision-making, affect scope management. Most studies also examine large cities, but rural projects may face other challenges. So, although global best practices (like precise goals) are a good idea, Ethiopia needs locally derived measures, like training leaders to improve communication and using simple technology to track scope changes.

Generally, case studies suggest that effective scope management relies on good objectives, stakeholders, and leadership. However, the particular problems of Ethiopia like resource limitations and local cultural practices require that these have to be applied cautiously. More research is needed on rural projects and the impact of culture to fill these gaps.

2.8. Importance and Influence of Critical Factors

There is a need to realize the role and contribution of critical factors in scope management if the success of building projects is to be ensured. These critical factors such as scope planning, stakeholder management, change control, and communication do not operate independently but instead engage with one another throughout the life cycle of a project. Studies have determined the overall and relative contributions of these factors and presented differing opinions on which factors are more important at which stage of a project.

For instance, Ika (2009) emphasizes that project success is highly connected with the consolidation of several factors, of which the definition of scope and stakeholder alignment are crucial, especially in the process of planning. Similarly, the finding of Sanvido et al. (1992) finding that clear definition of project scope and strong leadership of project managers were always among the most prevailing success factors. However, contrasting views are expressed by Ogunlana (2010), research, which argue that external conditions such as political and legal climates are likely to dominate internal scope management efforts in developing countries, where uncontrollable changes and stakeholder conflicts are more probable.

Further, Pinto and Slevin (1988b) project lifecycle model predicts "project mission" and "client consultation" as success factors early in a project, which fall under scope definition and stakeholder communication. According to their model, the timing of when each factor has its influence matters. In contrast, the research by Belassi and Tukel (1996) gives a more composite classification system where critical factors are classified based on whether they are project-related, team-related, or external. Their framework deduces that while scope determinants are internally controllable, they are still subject to external influence, i.e., economic fluctuations or regulatory constraints.

Comparative studies like those of Gudienė et al. (2014) and Saqib et al. (2008) confirm that even though there is no single universally valid order of crucial factors, their applicability highly varies with the situation. Competences of the project manager and contractor were identified by Gudienė et al. (2014) o be most crucial in Lithuanian projects, whereas Saqib et al. (2008) placed procurement methods and design team effectiveness as being among the top in Pakistan. This difference emphasizes the need to assess critical factors by project type, delivery system (e.g., design-build), and local conditions.

Furthermore, these critical success factors enjoy causal or reinforcing interdependence. Poor stakeholder involvement can lead to unwell defined scope, which increases the problem of scope creep. Unsuccessful change control processes can result in uncontrolled scope expansion, leading to time delays and cost overruns. Conversely, effective communication practices help to mitigate such risks by aligning team knowledge and furnishing ongoing updates, Fortune and White's (2006) study, which conducted a meta-review of CSFs and concluded communication to be a dominant and the most important.

In general, the determining factors of scope management are interrelated, dynamic, and extremely context-dependent.

2.8.1 Holistic Perspective of How Factors Interact

A holistic view means understanding how different critical factors in scope management work together to influence project success. Many studies show that factors like stakeholder collaboration**,** clear objectives**,** and change control are connected. The study by Alemayehu (2024) found that in Ethiopian projects, when stakeholders like clients, contractors, and communities work together early, projects face fewer delays. Similarly, The study by Ofori

(2016) states that clear goals help teams stay focused, reducing confusion. However, some studies disagree on which factors matter most. The findings of (Chan et al., 2010) argue that technology (like BIM software) is key for reducing errors, but in Ethiopia, the study by Mulugeta (2021) found that poor internet and training limit technology use, making communication more important.

Another one is change control**.** The finding of Ibbs et al. (2001) say formal processes to manage changes prevent cost overruns. However, in Ethiopia, The research conducted by Mengistu and Mahesh (2020) observed that political pressures often force quick changes without proper approval, causing conflicts. This shows that while global studies emphasize strict rules, local practices in Ethiopia sometimes ignore them due to external pressures.

There are also gaps in research. Few studies discuss how cultural practices like informal agreements in Ethiopia affect scope management. For instance, The research conducted by Mengistu and Mahesh (2020)note that hierarchical decision-making slows approvals, but no solutions are offered.

Therefore, the interaction of factors depends on context. In Ethiopia**,** stakeholder collaboration and clear objectives are more important than technology because of limited resources. However, factors like change control and regulatory compliance can clash.

Generally, a holistic view shows that no single factor guarantees success. Instead, projects must balance multiple factors, adapting global best practices to local needs. In Ethiopia, prioritizing collaboration, clear goals, and flexible change management while addressing gaps like cultural barriers can improve scope management.

2.8.2 Relative importance of Each Factor

Research shows that not all critical factors have the same importance in managing project scope. For example, many studies agree that stakeholder collaboration is the most important factor. The findings of Alemayehu et al. (2021) found that projects in Ethiopia with strong teamwork between clients, contractors, and communities had 30% fewer delays. Similarly, The findings of Molenaar et al. (1999) stated that good communication reduces misunderstandings, which helps finish projects on time. However, The findings of Chan et al. (2010) argue that **c**lear project objectives matter more because unclear goals lead to wasted time and money. For instance, the PMI (2017) reported that projects with clear goals had 18% fewer cost overruns.

On the other hand, change control systems are also very important. The findings of Ibbs et al. (2001) showed that projects using formal processes to manage changes saved 15% of their budget. In Ethiopia, projects without these systems, like the Addis Ababa BRT, faced huge cost overruns (Mengistu et al., 2024). Meanwhile, regulatory compliance is less impact but still necessary. The findings of Nurhendi et al. (2022) found that ignoring local laws caused delays in 25% of Ethiopian projects.

However, most studies focus on developed countries, but Ethiopia's challenges, like material shortages, make resource allocation more critical. For example, the Hawassa Industrial Park succeeded by pre-qualifying materials to avoid price changes (Mulugeta, 2021).
Therefore, stakeholder collaboration and clear objectives are the most important factors because they directly prevent delays and conflicts. However, in Ethiopia, factors like resource management and local laws cannot be ignored. To improve projects, managers should focus on teamwork, clear goals, and adapt global strategies to Ethiopia's needs. Generally, while collaboration and clear goals are key globally, Ethiopia must also prioritize resources and regulations to succeed.

2.8.3 Synergies arise when considering multiple critical factors

When critical factors in scope management work together, they create synergies that improve project success. For example, combining stakeholder collaboration and technology adoption helps teams share ideas and fix design errors early. Studies in Ethiopia show that projects using both factors reduced mistakes by 30% (Alemayehu et al., 2021). Similarly, clear objectives and risk management together prevent delays. In Kenya, road projects using these two factors finished 6 months faster (Ofori, 2016).

However, not all studies agree. Some argue cost control conflicts with regulatory compliance .For example, Ethiopian builders faced higher costs when forced to use expensive materials to meet new safety rules (Nurhendi et al., 2022). Other research shows that leadership and communication can balance such conflicts. In the Addis Ababa Light Rail project, good leaders used meetings and digital tools to explain rule changes, reducing complaints (Mulugeta, 2021). Therefore, while existing studies highlight the importance of synergies between critical factors like stakeholder collaboration, technology, and clear objectives, there is limited exploration of how cultural dynamics influence these interactions in specific contexts like Ethiopia

Generally, combining factors like collaboration, technology, and clear goals boosts success. However, conflicts like cost vs. rules need careful management. More research is needed on cultural impacts to help projects in places like Ethiopia.

2.9. Literature Summary and Research Gap

Literature highlights the supreme significance of scope management in the success of Design-Build (DB) projects, particularly in complex area like the construction sector of Ethiopia. It can be seen from the literature analysis that CSFs such as clear definition of scope, stakeholder involvement, communication, and change management have been most commonly identified to be essential for the success of projects. Researchers like Belay et al. (2017) and Gudienė et al. (2014) state that not only are the factors significant individually, but they also interrelate. For instance, poor communication may affect how much changes are controlled and unclear scope planning may cause conflict and delay.

The Studies by Gransberg and Molenaar (2019), Liu et al. (2017), and Zewdu (2021) emphasize effective scope management in the achievement of project goals in time, budget, and quality specifications. The key arguments include scope definition, stakeholder management, risk management, resource allocation, and technology integration. For instance The findings of, Xu et al. (2018) remark on how a well-defined scope minimizes confusion, whereas The findings of Liu et al. (2017) describe how early contractor involvement addresses constructability issues at design, averting costly changes during construction.

Many studies also grouped these factors differently. For example, Pinto and Slevin (1988b) focused on project mission and communication, while Belassi and Tukel (1996) proposed a more detailed framework that includes project-related, organizational, and external factors. These groupings help in prioritizing which areas need more attention. However, most of the existing studies were done in broader contexts, not specifically for DB projects in Ethiopia

In Ethiopia, where resource constraints and bureaucratic inefficiencies are common, these factors are vital to overcoming delays and inefficiencies (Ayele & Derseh, 2020). However, research on scope management in Ethiopia remains limited. Existing studies often generalize findings from developed countries without considering Ethiopia's unique socioeconomic, institutional, and cultural dynamics. For example, the study by Tilahun (2020) point out that hierarchical decision-making and resistance to new methodologies hinder innovation, while The findings of Mekonen et al. (2025) highlight a lack of technical and digital competencies as barriers to advanced scope management practices.

Additionally, while global research explores inter dependencies among Critical Success Factors (CSFs) like scope clarity, stakeholder collaboration, and risk management, their application in Ethiopia is under explored. Synergies, such as those between scope clarity and collaboration or the integration of technologies like Building Information Modeling (BIM), remain untouched due to cultural resistance and resource limitations (Songer & Molenaar, 1996); (Chan et al., 2001)).

Despite the valuable contributions of previous studies, several important gaps still exist. Although many researchers have identified Critical Success Factors (CSFs) that influence project outcomes, there is limited understanding of how these factors interact with and impact one another, especially within the Ethiopian Design-Build (DB) project environment. Most existing studies tend to focus on CSFs in isolation, missing the opportunity to explore their interrelationships and combined effects on project success. Furthermore, there is a noticeable shortage of research specifically focused on scope management practices within DB projects in Ethiopia, even though DB delivery methods are becoming more common in large infrastructure and building initiatives. While advanced multi-criteria decision-making methods such as AHP and ISM have been successfully applied internationally to prioritize and structure CSFs, their use in Ethiopia remains very limited. Therefore, there is a clear need for more focused and methodologically advanced research targeting DB projects in Ethiopia, emphasizing the dynamic interactions among CSFs to provide more practical and actionable insights for enhancing project performance.

Table 2.1 List of identified success factors from the literature review

N0.	Major Theme	Factor	(Institute, 2021)	(Flyvbjerg, 2014)	Kerzner and Saladis (2017)	(Songer & Molenaar, 1996)	(Chan et al., 2016)	(Turner & Müller, 2003)	No.of reputation
1	1. Scope Definition & Planning	Scope and Contractual Clarity	√		√	√	√		4
2		Adequate Plan and Detailed work breakdown structure (WBS)	√	√	√	√	√		5
3		Project type and size	√		√				2
4		Competency of the Consultants Company		√		√	√		3
5		Type of Client (Private vs. Public)		√			√		2
6		Size and Experience of the Client			√	√	√	√	3
7		Early Contractor Involvement (ECI)				√		√	2
8	2. Stakeholder, Communication, and Satisfaction	Effective Communication			√		√	√	3
9		Stakeholder Alignment and Collaboration				√	√		2
10		Trust and Mutual Responsibility Among Stakeholders			√		√	√	3
11		Involvement of All Stakeholders		√		√			2
12		Social Environment				√	√	√	3
13	3. Risk Management & Change Adaptation	Proactive Risk Management	√	√	√	√		√	5
14		Contingency Planning and Client's Preference for Risk Sharing			√		√		2
15		Capability and Competency of Contractors			√	√	√	√	4

N0.	Major Theme	Factor	(Institute, 2021)	(Flyvbjerg, 2014)	Kerzner and Saladis (2017)	(Songer & Molenaar, 1996)	(Chan et al., 2016)	(Turner & Müller, 2003)	No.of reputation
16	3. Risk Managem ent & Change Adaptatio	Flexibility and Compliance with Regulatory system	√				√		2
17		Consultant Experience and Accomplishment		√			√		3
18		Experience and Skills of PM	√		√	√	√	√	5
19	4. Resource Management & Technological Integration	Adequate Resources			√	√		√	3
20		Adequacy of Funds			√		√	√	3
21		Optimal Use of Labor, Materials, and Financial Resources	√		√		√		3
22		Contractor's Technique and Equipment Advancement			√		√		2
23		Technological Environment					√		1
24		Site Organization and Proper Crew Formation			√				1
25		The Economic and Financial Situation of the Contractor		√			√		2
26		Economic and Political Environment				√	√		2
27	**5.** Scope Control & Monitoring	Decision-Making Effectiveness of PM			√				1
28		PM Authority and Involvement	√		√			√	3
29		Single-Source Accountability	√			√		√	3
30		Moderate Change Orders		√	√				2
31		Contractor’s Experience with Similar Projects			√		√		2
32		Use of Project Management Software for Real-Time Tracking				√			1
33		Adequacy of the Planning and Change Control Mechanisms					√		1
34		Consultant's Management Capability					√		1

CHAPTER THREE
METHODOLOGY

3.1 Introduction

In this chapter, the research methodology adopted to investigate critical success factors (CSFs) for effective scope management in Design-Build (DB) projects in the Ethiopian construction sector is outline. The research process aims to map against the research objectives to analyze and prioritize CSFs, and to explore their interrelationships. This chapter presents the study area, research design, population and sampling methods, data sources, data collection tools, data analysis approaches, and procedures taken to ensure the validity and reliability of the data. By systematic effort, this study aims to provide actionable suggestions on how to enhance the practice of scope management in Ethiopian DB projects.

3.2 Study Area

The study focuses on the construction industry in Ethiopia, as given in Figure 3.1 in particular infrastructure projects executed with the Design-Build (DB) method. Target sectors of focus are roads, railways, residential developments and other large-scale public and private infrastructure projects. These sectors are characterized by scarce resources, bureaucratic inefficiencies, cultural resistance, and shifting regulatory regimes, and thus are ideal for testing the applicability of DB methodologies. Geographically, the study encompasses major urban centers such as Adama, Addis Ababa, Sheger city, Bushoftu and Semera city where significant DB projects have been under construction. These locations were choose because they represent different project environments, ranging from federally funded to regional ones.

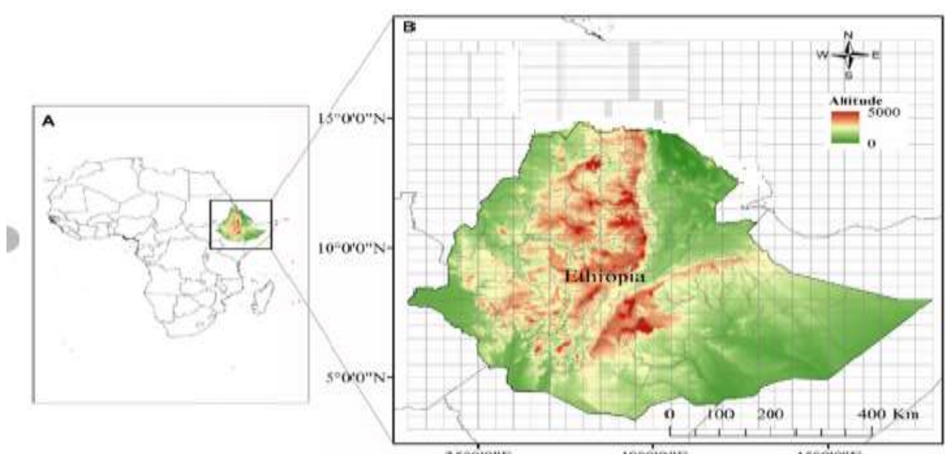

Figure 3.1 Map of Ethiopia

3.3. Study Design

The research adopts a mixed-methods research design that is qualitative and quantitative, mainly descriptive in nature. Comparative analysis and expert judgment are applied in order to achieve a hierarchical structure of critical success factors (CSFs) for effective scope management in Design-Build (DB) projects in the Ethiopian context. The research also combines several significant methodologies, i.e., the Analytic Hierarchy Process (AHP), Interpretive Structural Modeling (ISM) with MICMAC Analysis, and Quadrant Analysis, in a hierarchical fashion to achieve a combined analysis of CSFs.

Determine the Critical Success Factors to Successful Scope Management in Design-Build Projects in Relative Importance by applying Analytic Hierarchy Process (AHP). Analytic Hierarchy Process (AHP) prioritizes and ranks CSFs in a consistent manner by relative importance. AHP breaks down the complex problem of identifying critical factors into a hierarchy of simpler sub-problems so that structured analysis is possible. By making binary comparisons, AHP converts subjective expert opinion into quantifiable weights in a manner that renders judgments logical and consistent. The process additionally provides a ratio of consistency for verifying the consistency of the judgments. The process provides stringent factor prioritization with unambiguous ranking of the most significant CSFs for scope management of DB projects. After that, the Effect of Each CSF Identified on Others to Identify Their Inter-dependencies was ascertained by using ISM and MICMAC Analysis.

Interpretive Structural Modeling (ISM) and MICMAC Analysis are to examine the dynamics of the system and inter-dependencies among the listed Critical Success Factors (CSFs). ISM establishes connections between the factors by organizing them in a hierarchical model of direct and indirect effects, thereby illustrating the interactions as a coherent model graphically. MICMAC is applied along with ISM in order to categorize factors as autonomous, dependent, linkage, or driving according to their dependence and influence levels. Such categorization helps to understand the dynamics of systemic factors in depth without leaving any important relationship behind. MICMAC and ISM both help to have a full view of factor relationships so that an overview of the global impact on scope management by the factors. Lastly, Quadrant Analysis of Integrated Critical Factors with Their Relative Importance and Influence for Effective Scope Management is attained.

Quadrant Analysis is used to integrate AHP and ISM/MICMAC results by plotting factors along two dimensions: their relative importance and influence against scope management. Quadrant Analysis categorizes factors into manageable categories, i.e., high importance/high influence, high importance/low influence that assists in developing successful strategies for effective scope management. By projecting results in the format of a two-dimensional grid, Quadrant Analysis simplifies the interpretation of intricate data to facilitate decision-making. The use of AHP (importance) and ISM/MICMAC (influence) in combination with the quadrant method guarantees exhaustive analysis according to the research goals.

Layered approach offers in-depth examination of CSFs, including their significance, inter-relation, and synergistic effect on scope control. By using primary data in the form of structured questionnaires and expert opinions, supplemented by secondary data in the form of literature reviews. Expert Choice was used for the calculation of the AHP and ISM software was used in the calculation of the interrelationship component. The workflow for the research is illustrated in Figure 3.2. As shown in the figure, the present study starts from the left, that is, the AHP part, and moves towards the right, that is, the ISM (Smith, 2020) part. Finally, Yet Importantly, this methodology will enhance the success of DB projects in Ethiopia through the removal of inefficiencies and resource constraints and facilitating sustainable development of infrastructure.

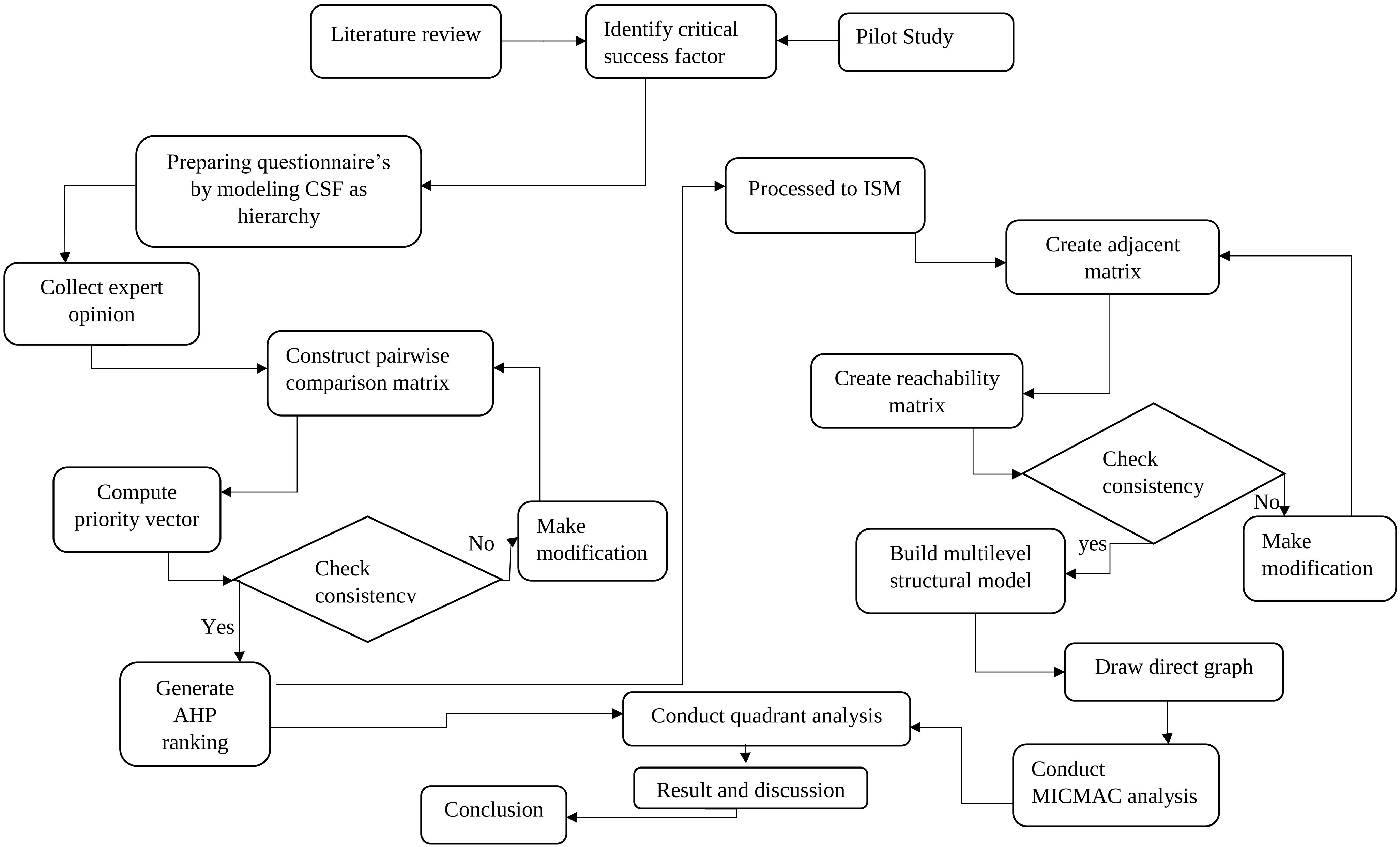

Figure 3.2 work flow chart

3.4. Population and Sampling Technique

3.4.1 Target Population

The population of this study was Design-Build (DB) projects currently being carry out in Ethiopia, According to the Ethiopian Construction Works Corporation (ECWC); there are about 33 Design build projects under construction. Many of these are in fast growing urban areas like Adama, Addis Ababa, Sheger city, Bushoftu and Semera city. These cities were chosen because they are major centers for infrastructure development, including housing projects, roads and hospital. Their active role in Ethiopia's growth makes them ideal for studying how DB projects are planned and managed. The study includes professionals working directly on these projects, such as construction managers, project managers, site engineers, office engineers, Contract Administrator and client representatives. These individuals were selected because they are closely involved in daily project activities, decision-making, and problem solving. The research conducted by Toor and Ofori (2008) suggests that such professionals are in constant liaison with the different stakeholders and engage in such principal activities as the resolution of conflicts and the assurance that projects are back to normal. Similarly, The Studies by Opawole and Jagboro (2017) point out that these stakeholders directly feel issues like delays and cost issues, hence their contribution is beneficial towards informing project success. Additionally, The research conducted by Gunduz and Almuajebh (2020) show that these experts whether working on behalf of contractors, consultants, or project managers have a very similar perception of construction success and the causal factors, and therefore they can be relied upon as credible sources of data for this study.

3.4.2 Sampling Technique

Purposive sampling was the sampling method used in this research. The sample is selected from the population by the judgment of the researcher in this non-probability technique. Case selection in enhancing the quality of a research design should consider appropriateness and adequacy, as advocated for in the research work by Omona (2013). Appropriateness refers to the extent to which the selected cases align with the research aim and the nature of the phenomenon being studied, while adequacy concerns whether the number of selected cases is sufficient to be helpful in giving insights. The most popular way of fulfilling the demand of appropriateness is by employing a purposeful sampling approach using predetermined criteria.

Sampling was conducted based on data gathered from the Ethiopian Construction Works

Corporation (ECWC), which had 33 Design-Build (DB) projects that were under construction in Ethiopia. Among these, 27 projects were found to be located in the major urban centers, i.e., in Addis Ababa, Adama, Sheger City, Bishoftu, and Semera. They were selected because of rapid infrastructure development and having more than one DB project, thus making them viable for studying the current scope management practices.

Of the 27 projects that were in these target cities, 18 were selected for the research and the remaining 9 were left out because they were not operational at the time of data collection. These inactive or semi-active sites lacked the necessary on-going activities and accessible professionals to ensure proper data collection and were therefore not considered for this research. By selecting 18 of the 27 projects, the study covered 66.7% of DB projects in the focus cities, as well as 54.5% of the total 33 active DB projects conducted in Ethiopia. The ratio satisfies the minimum 30% requirement of purposive sampling, as supported by Ogeno (2016) and Mugenda and Mugenda (2003). Out of these 18 projects, professionals such as project managers, construction managers, site engineers, office engineers, and Contract Administrator and client representatives were selected as respondents, as they belong to day-to-day working and are the best available source to give information about scope management problems and practices. The reason for selection of the professional has been described in table 3.2 below

Table 3.2 Roles of respondents

Stakeholder Group	Key Position (Used in Study)	Reason for Selecting
Client (Owner)	Client Representative	Oversees the project from the owner's perspective, ensures that the project scope reflects client needs.
Design-Build Contractor	Project Manager	Coordinates between design and construction; handles scope definition, integration, and change control.
	Construction Engineer	Focuses on implementation and resolving challenges.
	Office Engineer	Supports documentation and coordination of scope details between site and office functions.
	Site Engineer	Supervises field activities to ensure they align with design scope and adjusts for real-time conditions.
	Contract Administrator	Manages scope within contracts, processes scope change requests, and maintains contractual clarity.
	Coordinator	Ensures smooth communication among stakeholders, helping prevent scope creep or misalignment.
Consultant	Consultant Representative	Provides expert advice on scope feasibility, design compliance, and project alignment with regulations.

3.5. Source of Data

The current study uses primary and secondary sources to obtain appropriate data for the research. Primary data were obtained from the key players in the construction industry, including consultants, contractors, and project managers. They were chosen with immense care depending on their experience and involvement in building construction to ascertain data obtained were genuine and aligned with the study objectives. Apart from primary data, secondary data was collected from various available materials to serve as a supporting and complementary material for the study. This included the reading of books, academic papers, journals, conference papers, reputable websites, and other relevant publications. The utilization of primary and secondary data sources allowed for thorough insight into the drivers influencing the extent of the design-build project, along with a clear theoretical foundation to back the practical findings yielded from industry practitioners.

3.6. Method of Data Collection

3.6.1. Pilot Study

34 critical success factors (CSFs) were derived from literature, as seen in Table 2.1 They were selected based on frequent citation in scope management research studies of Design-Build (DB) projects.

For this purpose, three Ethiopian construction professionals were selected to review the draft questionnaire. Among them, two were senior construction management professionals with over 13 years of industry experience at the Ethiopian Construction Institute, and the third was a contract administration expert with more than 10 years of professional experience. These experts evaluated whether the selected CSFs were appropriate for ongoing DB projects in Ethiopia and provided recommendations for refinement.

Based on their feedback, all 34 factors were retained**,** with only minor wording adjustments for better clarity. The finalized factors were then organized into five main categories. These categories are Scope Definition & Planning, Stakeholder, Communication, and Satisfaction, Risk Management & Change Adaptation, Scope Control & Monitoring and Resource Management & Technological Integration. As illustrated in Figure 3.3, this grouping was based on thematic similarities. The number of experts used in this pilot study was considered sufficient, as similar studies have used comparable expert panels to validate research instruments (Zavadskas et al., 2010; Zuo et al., 2018).

3.6.2 Questionnaire

The primary method of data collection for this study was questionnaires. Questionnaires were chosen because they are efficient to administer, can be distributed to large groups at the same time, and allow respondents to share their opinions openly. In the first stage, a questionnaire was designed to facilitate the collection of pairwise comparison data using the AHP. The questionnaire was developed based on a comprehensive literature review and a pilot study that gathered preliminary input on the critical success factors perceived by professionals. The survey focused on evaluating 34 critical success factors related to scope management. Each factor was assessed using a standard nine-point AHP scale. A total of 81 questionnaires were distributed to qualified respondents, including project managers, construction engineers, site engineers, office engineers, contract administrators, coordinators, consultants, and client representatives. The questionnaires were distributed and collected in person. Out of the total, 73 questionnaires were fully completed and successfully returned.

After the first-stage analysis, a second questionnaire was developed. The original 34 factors that had been examined were reduced to 28 critical success factors with relative weights derived from AHP analysis for the second stage. Those 28 factors were most central to sound scope management and were thus selected for further analysis with the support of Interpretive Structural Modeling (ISM). The second-stage questionnaires were then drawn up and posted to the 71 respondents . Out of the above, 70 questionnaires were collected and returned during the second stage. Sample questionnaire is on Appendix D and E.

While the majority of the previous studies, where an integrated AHP-ISM framework has been used, narrowed down critical success factors to 17-21 (Liu et al. (2015) and Song et al. (2017)), the decision to retain 28 factors in this study was based on the distribution of AHP weights. The selected 28 factors accounted for over 90% of the total cumulative weight, indicating that they held the greatest influence on project success. Reducing the number below 28 would have led to the exclusion of factors with significant influence, which could limit the comprehensiveness of the ISM analysis. Furthermore, as supported by Cooper (2008) , the goal of factor reduction is not simply to meet a numerical target but to retain all factors that meaningfully contribute to the outcome. The factor used in first stage is list in figure 3.3

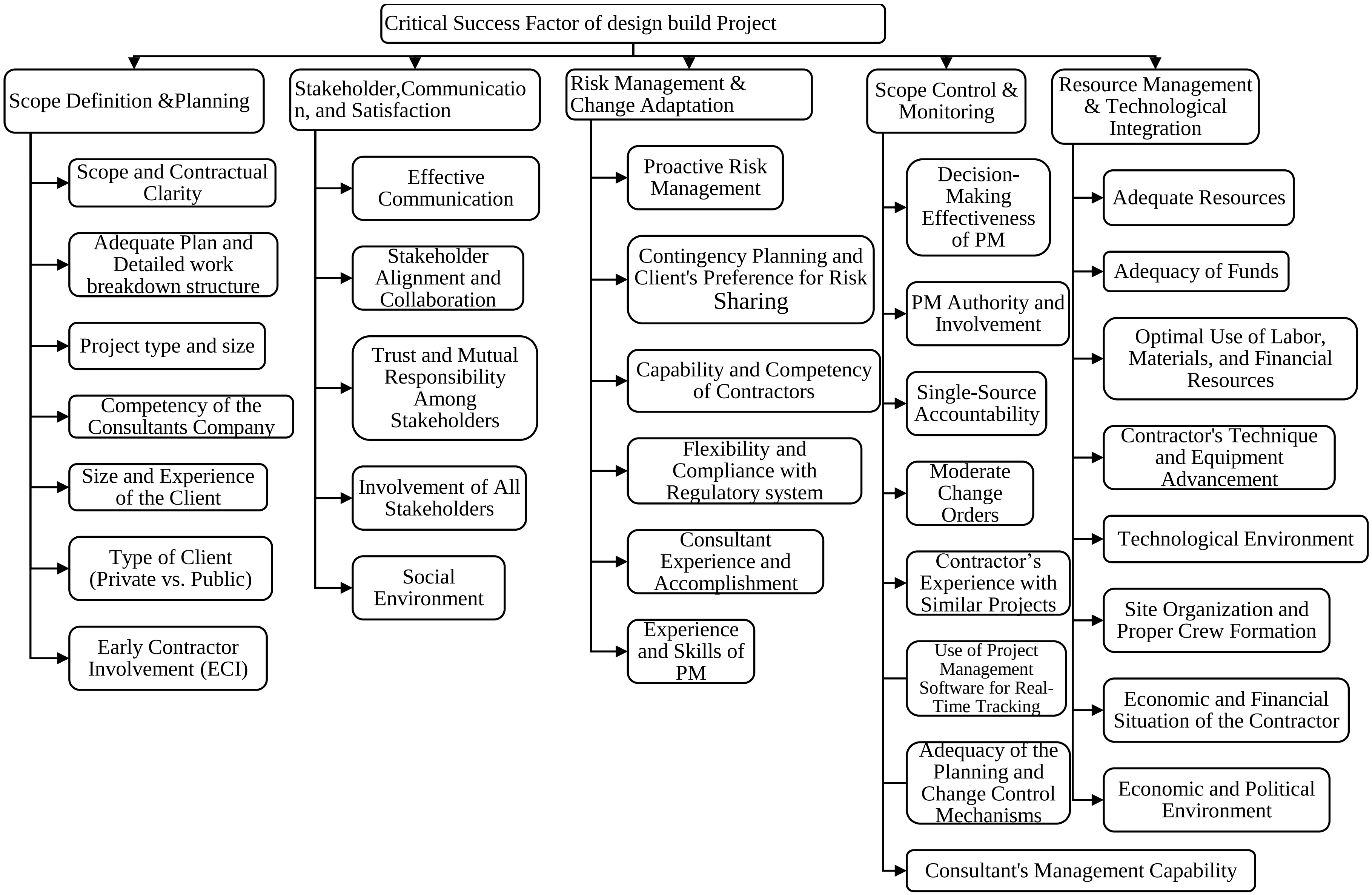

Figure 3.3 Analytical hierarchical structures

3.7. Method of Data Analysis

For this study, four types of data analysis techniques were use. The first one is Analytic Hierarchy Process (AHP) is used to identify and rank factors based on their importance by structuring the problem into a hierarchy of goals, criteria, and sub-criteria. Pairwise comparisons are done on the basis of expert judgment to obtain relative importance of every factor, transforming qualitative information into quantitative weights. Consistency ratio (CR) is discovered to offer logical consistency to the ranking process, making AHP an ideal tool for systematic ranking.

To identify the inter-dependencies among such factors, Interpretive Structural Modeling (ISM) and MICMAC Analysis are used. ISM creates a hierarchical factor model by considering direct and indirect relations, giving a comprehensive idea of how one factor influence another. MICMAC Analysis and ISM by dividing factors based on driving and dependence power. This typology facilitates identification of the linkage factors, driving factors, dependent factors and autonomous factors, providing greater insight into how the system is behaving. Then, through combining the two, the information so collected was processed and provides a basis upon which the factors are ranked based on their relative influence and importance, which was accomplished through quadrant analysis.

3.7.1 Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) of Saaty and Vargas (1980), is a rational process of decision-making that breaks down big complicated problems into simpler ones in levels. It breaks big, complicated problems into smaller parts arranged in levels. Users compare each factor or option against another using a simple number system (1 - 9) to decide which is more important. These comparisons help calculate scores to rank priorities, and a check consistency ratio ≤ 0.10 to ensures the results make sense. AHP combines both numbers and opinions to evaluate choices fairly (Saaty & Vargas, 1980).

The AHP method breaks down complex problems into smaller, organized parts .This makes it easier to analyze and compare options. Below are the steps

Step 1.The first step in the AHP method is to organize the problem into a hierarchy. At the top, clearly state the main goal. Below that, list the main themes (criteria) that influence this goal. These themes can then be broken down into smaller sub-factors to analyze them more thoroughly. This structure helps simplify complex decisions by dividing them into smaller, easier-to-manage parts. As Sample in figure 3.4

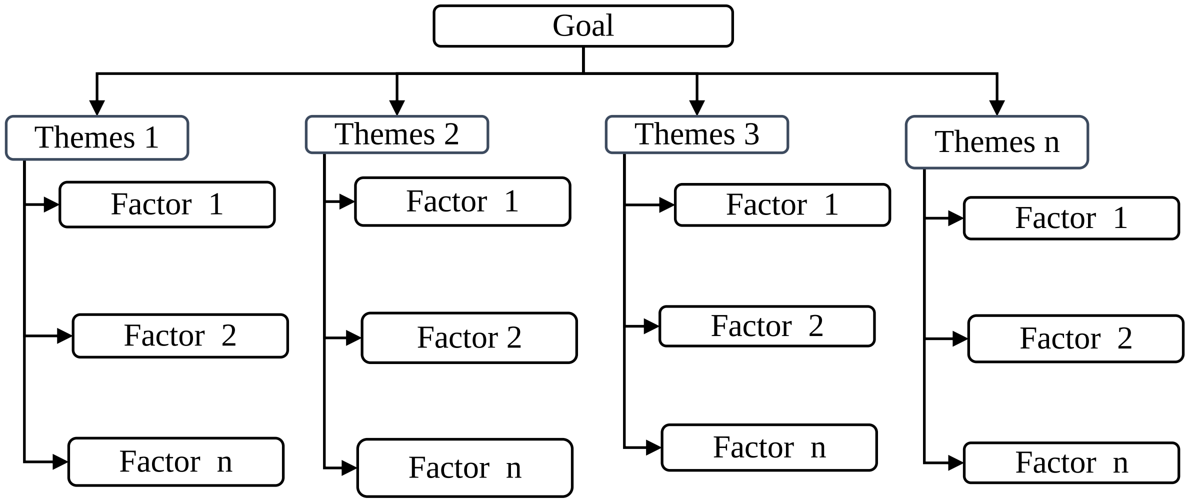

Figure 3.4 Hierarchy structure of AHP

Step 2: Obtain data from experts by questionnaire in the pairwise comparison of options on a qualitative scale, the experts can classify by comparison as show in the table 3.3

Table 3.3 Scale of preference in AHP

Scale	Level of importance	Explanation
9	Extremely important	One option is unquestionably superior, with near-total agreement or proof.
7	Very strictly important	One option is far better or more critical, with strong evidence.
5	Strictly important	One option is clearly better or more critical than the other is.
3	Moderately important	One option is a bit more important than the other based on experience or judgment.
1	Equal important	Both options are equally important for the goal.

Step 3: Create a Comparison Matrix -In this step; a table (matrix) is built to organize the pairwise comparisons of criteria from Step 2. Diagonal entries: Every criteria compared to itself gets a value of one. If the value of the element (i, j) is greater than one, the criterion in the i^{th} row is better than the criterion in the j^{th} column; otherwise, the criteria in the jth column is better than the ith row. The reciprocal of the (i, j) element is the (j, i) element of the matrix.

Step 4: Calculate the normalized Matrix to normalize the matrix to ensure that each column sums to one. Compute the column sums: Sum of column j: sum j = $\sum_{k=1}^{n}$ aij and Divide each element in the matrix by its respective column sum: which is Normalized value bij=aij/sum$j$. The resulting matrix is the normalized pairwise comparison matrix B= [bij]

Step 5: The Priority Vector is compute to determine the priority or weight of each criteria by averaging the rows of the normalized matrix.

Step 6: The Consistency ration is calculate to evaluate the consistency of the pairwise comparisons using equation 3.1 and 3.2:

First, compute the consistency index (CI): $\frac{\lambda\text{max}-\text{n}}{\text{n}-1}$ ……….equation 3.1

Calculate the consistency ratio (CR):$=\frac{\text{CI}}{\text{RI}}$………………. equation 3.2

Where RI is the random index (predefined values for n) and λmax is principal eigenvalue

Step 7: Interpretation of the Consistency Ratio. The value of CR, according to Saaty (1980), should be less than 0.1 if CR≤0.10 the matrix is consistent. In addition, If CR>0.10 adjustment is needed and repeating the process. This step guarantees systematic and rational procedures for criteria and alternative evaluation in decision-making scenarios. This section can elaborate more on section 3.8.

3.7.2 Interpretive Structural Modeling (ISM)

Interpretive Structural Modeling (ISM) is an old-school approach to identifying and structuring complex relationships among parts of a system. It is helpful in decision-making, policy analysis, and system modeling because it simplifies complex systems into a hierarchical framework, making analysis and understanding of interrelationship among elements easy (Warfield, 1976). The process of ISM entails multiple systematic steps. The most important steps are as follows

Step 1:- Elements' Identification: The first step is to define and identify the elements. Determine the success-causing factors. A group of variables that will affect success is identified. The major parameters to be examined are the creation using various research approaches.

Step 2: Compare all items in pairs to determine how they are related based on expert opinions. Create a table called an Adjacent Matrix to show these relationships. The relationships are decided using the idea of "leads to." Follow this rule:

V: If factor Ei has an influence on factor Ej (Ei causes Ej).

A: If factor Ej has an influence on factor Ei (Ej causes Ei).

X: If factor Ei has an effect on factor Ej and factor Ej has an effect on factor Ei (bi-directional effect) and O: There is no effect of factor Ei on factor Ej in the context under consideration.

If the SSIM entry (i, j) is V, then A(i, j) = 1 and A(j, i) = 0.

If the SSIM entry (i, j) is A, then A(i, j) = 0 and A(j, i) = 1.

If the SSIM entry (i, j) is X, then A(i, j) = 1 and A(j, i) = 1.

If the SSIM entry (i, j) is O, then A(i, j) = 0 and A(j, i) = 0.

Step 3: Create the reachability matrix. The Structural Self-Interaction Matrix SSIM is then converting into a reachability matrix, which is a binary matrix that shows the direct and indirect relationships between elements. This matrix helps in determining the transitive relationships among the elements. . For example, if E1 can reach E2 in one-step, and E2 can reach E3 in another step, then E1 can reach E3 in two steps (Warfield, 1976).

Step 4: Divide the reachability matrix into parts and build a multilevel structural model. To do this, identify factors where all the relationships in their rows match the relationships in their columns. These factors are group into levels. Additionally, a factor must have more relationships than the factor below it to be place at a higher level.

Step 5**:** Draw a directed graph (digraph) to show the hierarchy of relationships between variables. In this graph, nodes represent factors, and lines (edges) show connections. The top-level factor is place at the highest point in the hierarchy, with the second-level factor below it. This process is continued until all the factors at the bottom level are positioned at the lower end of the hierarchy (Mandal & Deshmukh, 1994).

Step 6. ISM Model Construction: It is the final step in which the digraph is converted to an ISM model by replacing the nodes with real elements and their relationships. The model presents an accurate and well-arranged picture of the system. It is easy to comprehend and analyze (Warfield, 1976).

Step 7: Perform MICMAC analysis. The factors are further classified after performing the ISM analysis using MICMAC analysis.

3.7.3 Cross-Impact Matrix Multiplication Applied to Classification analysis

After performing the ISM analysis, the results are used further to group the factors by MICMAC analysis. MICMAC, which as Cross-Impact Matrix Multiplication Applied to Classification, is a systematic approach used to investigate and classify variables based on their driving power (influence) and dependence power (dependency) in a system. MICMAC was created during the 1970s by Michel Godet and is often used in association with Interpretive Structural Modeling (ISM) to identify those variables most stabilizing a system (Duperrin & Godet, 1975). This method helps in understanding the hierarchy and dynamics of complex systems by distinguishing between autonomous**,** dependent**,** linkage and independent/driver variables. To Identify critical variables that have the highest influence (driving power) on a system ,Highlight variables that are highly dependent on others ,Classify variables into clusters to prioritize actions in decision-making and Analyze indirect relationships (Ravi & Shankar, 2005).

The MICMAC analysis process begins by creating a Structural Self-Interaction Matrix (SSIM) which is used in ISM before. In this step, relationships between factors are identified and scores are assigning to show how much one factor directly affects another. This matrix helps build a basic understanding of how the factors interact. Next, the SSIM is converting into a Reachability Matrix, which uses simple binary to show whether a relationship exists between factors. This simplifies the data for easier analysis. After this, the driving power to identify how strongly a factor influences others and dependence power to identify how much others of each factor influence it are calculated. Finally, based on these scores, factors are group into four categories: Autonomous factors to identify weak influence and low dependence, often acting independently, Dependent factors to identify heavily influenced by others but with little influence themselves, Linkage factors to identify high influence and dependence and driving factors to identify powerful influence that are rarely affect by others. This classification helps prioritize key factors for decision-making.

3.7.4 Quadrant Analysis

In Quadrant Analysis, factors are evaluated along two key dimensions: their importance and influence. The first step involves assigning scores to each factor for both dimensions, using analysis from AHP and ISM/MICMAC. These scores help quantify the relative positioning of each factor. Next, the factors are plotted on a two-dimensional grid, dividing them into four distinct quadrants: High Importance, High Influence, which is critical and stable; High Importance, Low Influence, which are priority for improvement; Low Importance, High Influence, which should be need monitored closely for potential impact; and Low Importance, Low Influence, which are of lesser priority (Wibowo & Wilhelm Alfen, 2014). This visual representation aids in prioritizing and aligning resources effectively.

The Quadrant Analysis process can be follows

Step 1: Assign Scores to each factor along two dimensions: Importance score (Ii): Represents the significance of factor Fi. Influence Score (INF*i*): Represents the extent to which factor Fi influences other factors.

Step 2: Define the Average Threshold to compute the average scores for importance and influence across all factors.

Step 3: Plot Factors on a 2D Grid each factor Fi is plot on 2D plane, where: The x-axis represents INFi (Influence) and the y-axis represents Ii (Importance).

Step 4: Quadrant Classification, Based on the position relative to $\bar{I}$ and INF classify each factor into one of four quadrants: High Importance, High Influence (HILI): Factors in this quadrant are stable and critical. High Importance, Low Influence (HILI): Factors in this quadrant are priority for improvement. Low Importance, High Influence (LOHI): Factors in this quadrant should need monitored closely. Low Importance, Low Influence (LOLI): Factors in this quadrant are of minimal priority.

3.8. Data Validity and Reliability

Ensuring the precision and reliability of information collected is essential to the validity of any research. These elements in the current research are met using validity and reliability tests. Validity is to what degree the questionnaire is capturing what it was intended to. To assess content validity, from the point of view of the experts. With a construction management and contract administration background, piloted the questionnaire for contextually, clarity, and relevance to the setting of the Ethiopian Design-Build (DB) project. With feedback from them, suitable adjustments were effected to enhance comprehensiveness and consistency with research objectives.

Reliability, nonetheless, was ascertained through specific statistical procedures relevant to analytical methods employed in the research. Reliability for Analytic Hierarchy Process (AHP) was achieved through the calculation of the Consistency Ratio (CR). Respondents concern the measure with confirming the rational consistency of the pairwise comparisons. CR is calculated using equations Equation 3.1 and 3.2 Where n refers to matrix size and RI stands for Random Index, which varies according to matrix size, as shown in Table 3.4 (Saaty, 1980).

Table 3.4 Random Consistency Index

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49	1.52	1.54	1.56	1.58	1.59

A CR value ≤ 0.1 is generally considered acceptable. Once the Consistency ratio is calculated, it is compared with the standard ratio, 0.1 and if it's less or equal to that, then the study will go ahead and if not, rechecking will be required (Rajesh, 2020). Current study was 0.01, which was acceptable. For ISM analysis, the data gathered should be at least 70% consistent (Alawamleh & Popplewell, 2011) . Besides, the ISM analysis data was additionally checked for consistency using Cronbach alpha, where more than 0.7 is acceptable (Levett-Jones et al., 2011). In addition, using SPSS software and the outcome for the current study was 0.906, which is outstanding.

CHAPTER FOUR
RESULT AND DISCUSSION

4.1. Introduction

This chapter explains and interprets the findings of the study. There are four general sections: respondent demographics, results of AHP analysis, results of ISM analysis, and combined interpretation of the AHP and ISM results.

4.2. Respondent Profile

4.2.1. Respondent Profile for Frist Stage

The questionnaire distribution and response process for this study were conducted in two stages. In the first stage, focusing on the Analytic Hierarchy Process (AHP), 81 questionnaires were distributed to selected experts. Of these, two were not returned, three were incomplete, and three were incorrectly filled. Consequently, 73 valid responses were obtained, resulting in a response rate of approximately 90%. These valid responses were utilized for subsequent analysis, as detailed in Table 4.5

Table 4.5 Questionnaire distributed for first stage

Position	Total questionnaires	Properly filled	Not respond	Incomplete	Incorrectly filled
Construction Engineer	4.00	4.00			
Project manager	4.00	4.00			
Contract Administrator	11.00	11.00			
office Engineer	38.00	32.00		2.00	1.00
site Engineer	14.00	12.00	2.00	1.00	2.00
coordinator	2.00	2.00			
Project Manager (Client’s Side)	3.00	3.00			
Client Representative	5.00	5.00			
Total	**81.00**	**73.00**	**2.00**	**3.00**	**3.00**
Percentage	100%	90%	2%	4%	4%

Most of the respondents in this study hold a bachelor's degree. Specifically, 52% have a bachelor's degree, 42% hold a master's degree, and the remaining 5% have a PhD. The detailed breakdown of respondents' educational backgrounds is presented in Figure 4.5.

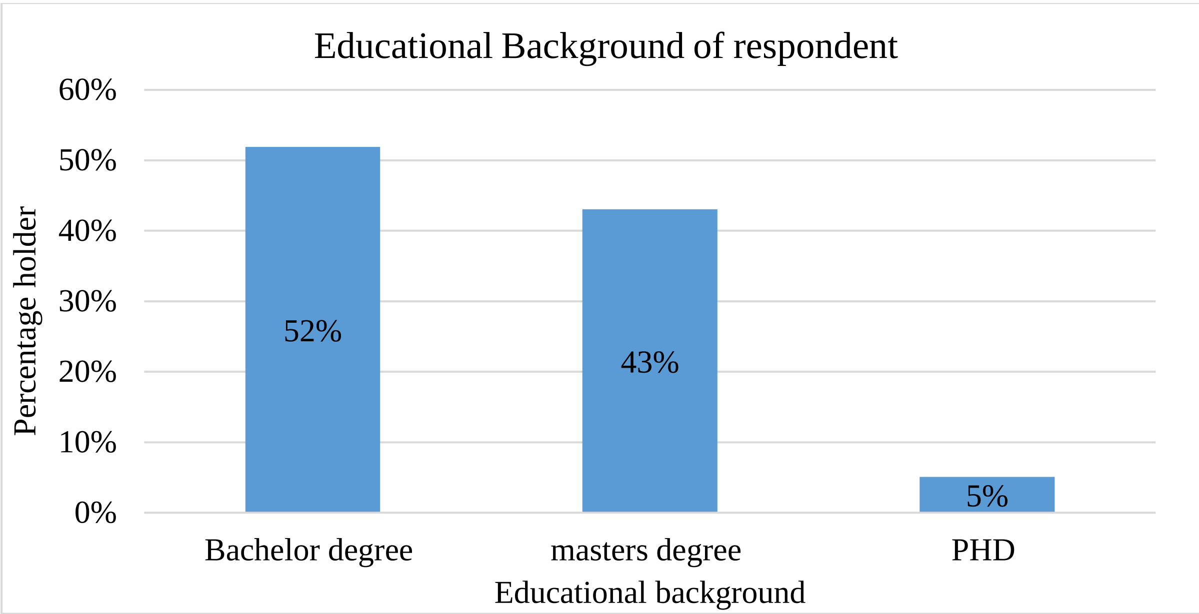

Figure 4. 5 Educational Background of respondent first stage

The respondents' work experience is grouped into four categories: less than 5 years, 5 to 10 years, 11 to 15 years, and more than 15 years. Most respondents (49%) have between 5 to 10 years of experience. About 28% have less than 5 years, 18% have 11 to 15 years, and the remaining 5% have over 15 years of experience. The detailed distribution of respondents' experience as shown in Figure 4.6.

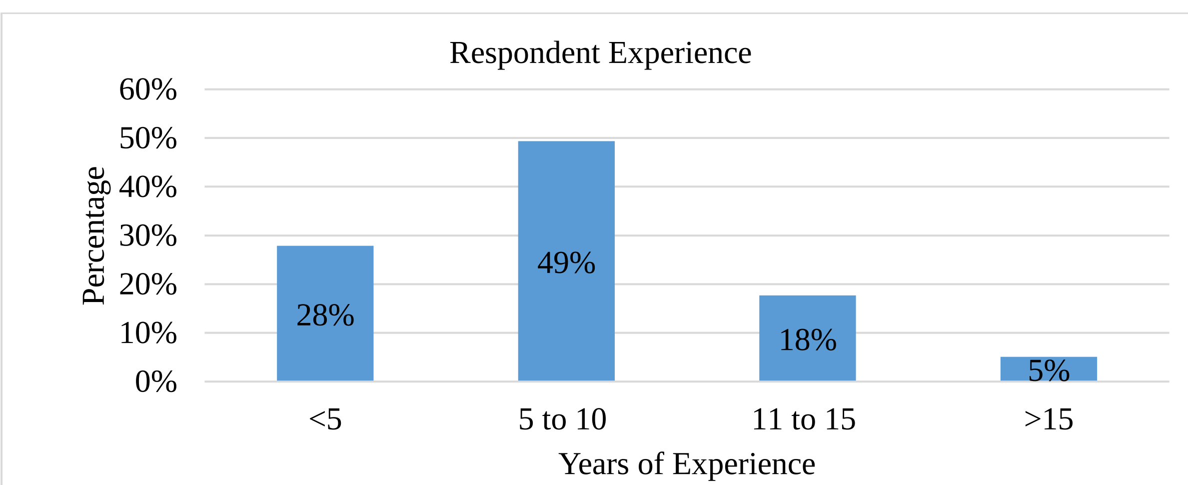

Figure 4.6 Respondent Experience for first stage

4.2.2. Respondent Profile for Second Stage

In the second stage of data collection, 71 questionnaires were distribute to selected experts. Among these, one questionnaire was not return, and four were found to be incomplete. As a result, 66 valid responses were obtain, which accounts for approximately 92.96% of the total distributed questionnaires. This high response rate indicates strong engagement from the participants and enhances the credibility and reliability of the data collected. The details of this response rate are present in Table 4.6.

Questionnaire distributed for second stage

Table 4.6 Questionnaire distributed for second stage

Position	Total questionnaires	Properly filled	Not respond	incomplete
Construction Engineer	4.00	4.00		
Project manager	3.00	3.00		
Contract Administrator	18.00	17.00		1.00
office Engineer	15.00	14.00		1.00
site Engineer	17.00	14.00	1.00	2.00
Site Supervisor	5.00	5.00		
Project Manager	4.00	4.00		
Client Representative	5.00	5.00		
Total	**71.00**	**66.00**	**1.00**	**4.00**
Percentage	100%	92.96%	1%	6%

Most of the respondents in this stage held a bachelor's degree. Specifically, 58% of the participants were bachelor's degree holders, while the remaining 42% had a master's degree. The details of the respondents’ educational background are illustrate in Figure 4.7.

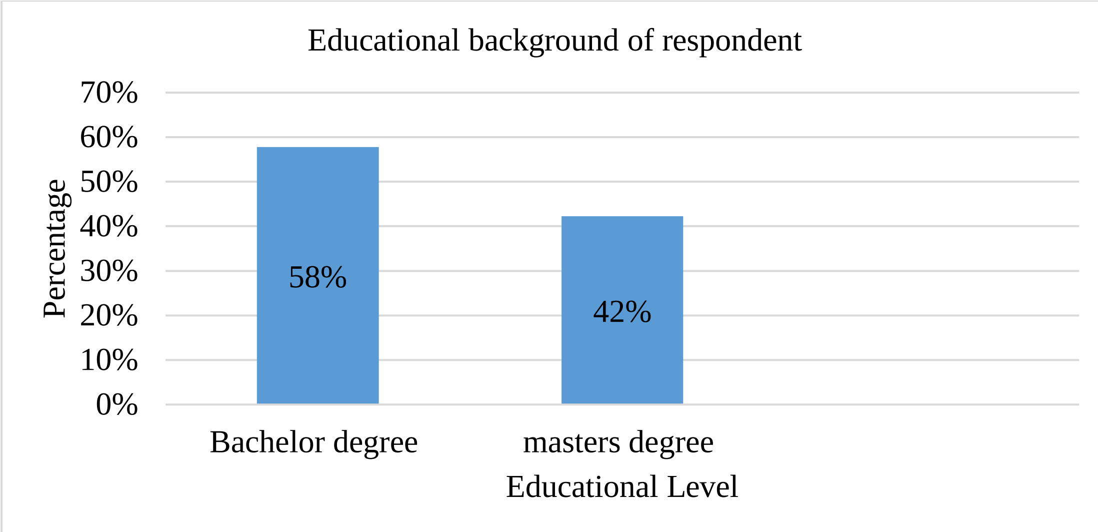

Figure 4.7 Educational background of respondent second stage

The respondents' work experience was group into four categories: less than 5 years, 5 to 10 years, 11 to 15 years, and over 15 years. The majority of participants, making up 46%, had 5 to 10 years of experience. This was follow by 37% of respondents with less than 5 years of experience. Meanwhile, 10% had 11 to 15 years of experience, and 7% had more than 15 years. The detailed distribution of respondents' experience as shown in Figure 4.8.

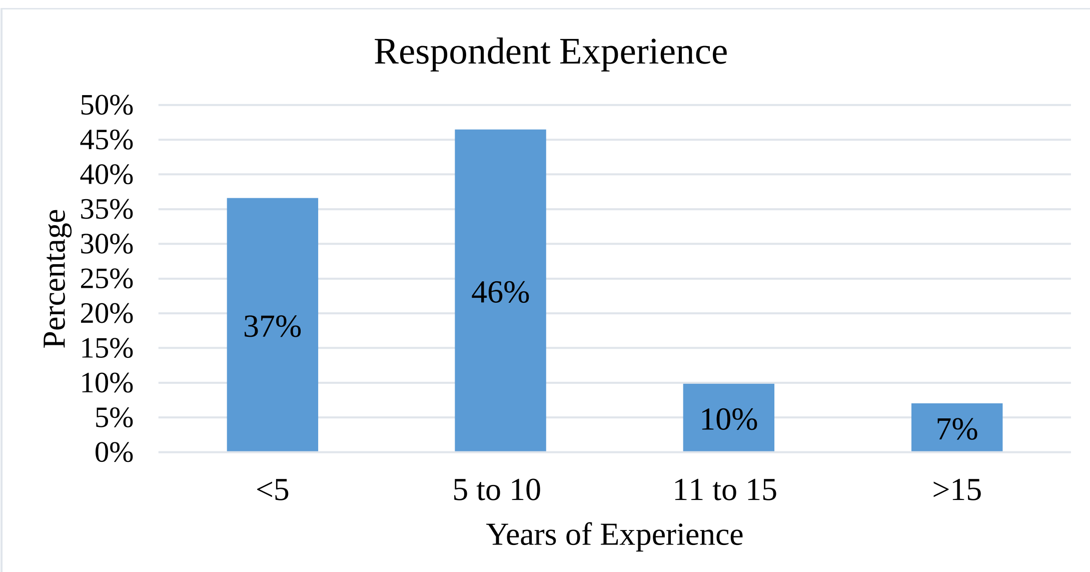

Figure 4.8 Respondent Experience for second stage

4.3 Prioritization of Critical Success Factors based on their level of importance

Prioritization of critical success factors categories; the analysis showed that stakeholder engagement, communication, and satisfaction were the highest-priority critical success factors, with a weight of 0.2345. Resource management and technological integration came in second, with a weight of 0.2224. Risk management and change adaptation ranked third with a weight of 0.214, followed by scope control and monitoring in fourth place, with a weight of 0.185. Finally, scope definition and planning were identified as the least prioritized category, with a weight of 0.143. The inconsistency rate when calculating the weights was 0.01, which is below the maximum allowed inconsistency of 0.1, as calculated using Expert Choice. The details are shown in the table below.

Moving to prioritization of stakeholder, communication, and satisfaction related success factors, based on the respondents' answers; the prioritization of the factors was analyzed. Social Environment ranked first with a weight of 0.293, followed by Effective Communication with a weight of 0.2019. Stakeholder Alignment and Collaboration came third with a weight of 0.1796, while Involvement of All Stakeholders was ranked fourth with a weight of 0.1739. Trust and Mutual Responsibility among Stakeholders ranked fifth, with a weight of 0.151. The inconsistency rate for the weight calculation was 0.02, as calculated using Expert Choice, which is well below the maximum allowable inconsistency of 0.1. The details are shown in the table below.

Next, the prioritization of resource management & technological integration-related success factors was examined. Based on the feedback from respondents, the prioritization of critical factors was analyzed and ranked in the following descending order of priority. Technological Environment (0.1558) received the highest priority, followed by Adequacy of Funds (0.1339) and Adequate Resources (0.1318). Economic and Political Environment (0.1238) ranked next, followed by Optimal Use of Labor, Materials, and Financial Resources (0.1215), Site Organization and Proper Crew Formation (0.1156), Contractor's Technique and Equipment Advancement (0.1097), and Economic and Financial Situation of the Contractor (0.1075). These rankings, along with their respective weightings, were computed with an inconsistency rate of 0.0052, as calculated by Expert Choice, which is well below the maximum permitted inconsistency of 0.1. A summary of these rankings is provided in the table below.

Regarding the Prioritization of Risk Management & Change Adaptation related Success Factors, the results showed the following descending order. Flexibility and Compliance with the Regulatory System (0.2086) emerged as the highest priority, followed by Consultant Experience and Accomplishment (0.1765), Contingency Planning and Client's Preference for Risk Sharing (0.1713), Experience and Skills of the Project Manager (PM) (0.1698), Capability and Competency of Contractors (0.1380), and Proactive Risk Management (0.1355). These rankings, along with their respective weightings, were computed with an inconsistency rate of 0.008, as calculated by Expert Choice, which is well below the maximum permitted inconsistency of 0.1. The detailed rankings are provided in the table 4.7.

Turning to the Prioritization of scope control & monitoring related success factors, the analysis revealed the following prioritization of success factors in descending order of weighting. Single-Source Accountability (0.2171) ranked highest, followed by Moderate Change Orders (0.1912), Project Manager (PM) Authority and Involvement (0.1165), Consultant's Management Capability (0.1019), Use of Project Management Software for Real-Time Tracking (0.1006), Adequacy of the Planning and Change Control Mechanisms (0.0999), Contractor's Experience with Similar Projects (0.0898), and Decision-Making Effectiveness of the Project Manager (PM) (0.0826). The inconsistency rate calculated by Expert Choice was 0.005, which is well below the maximum permitted inconsistency of 0.1. These rankings are summarized in the table below.

In the final category, scope definition and planning related success factors, for scope definition and planning, the prioritization was determined as follows: Type of Client (Private vs. Public) (0.2156) held the highest priority, followed by Early Contractor Involvement (0.1921), Size and Experience of the Client (0.1606), Competency of the Consultant's Company (0.1301), Project Type and Size (0.1282), Scope and Contractual Clarity (0.0978), and Adequate Plan and Detailed Work Breakdown Structure (0.0753). The inconsistency rate as calculated by Expert Choice was 0.012, significantly less than the threshold of 0.1. The values are reported in the table below.

Finally, regarding the Overall prioritization of success factors, in this study, the prioritization of critical success factors (CSFs) was carried out based on the Analytic Hierarchy Process (AHP), both local and global comparisons. The local comparison was first used to prioritize the CSFs within their respective categories by the assignment of weights based on their relative importance. Subsequently, the global comparison was made by multiplying the local weight of each factor by the weight of its category. This procedure determined the global weight of each CSF, which reflected its overall priority across all categories.

The overall results are presented in Table 4.7 and Table 4.8. Table 4.7 shows the local and global weights of the CSFs and their ranks. In this table, the first column contains the group of critical success factors and rank, the second column the group weight, and the third the individual CSFs, with the fourth and fifth columns the local and global weights respectively. The sixth column gives the final global ranking for each factor. Table 4.8 subsequently summarizes the global rankings in a more compact form.

From this analysis, the five highest-ranked CSFs based on global weights were Social Environment (0.0687), Effective Communication (0.0473), Flexibility and Compliance with the Regulatory System (0.0446), Stakeholder Alignment and Collaboration (0.0421), and Involvement of All Stakeholders (0.0408). These results highlight the significance of stakeholder and communication-related factors in the success of design-build construction projects. Additionally, the consistency ratio (CR) of all comparisons across both category and factor levels remained below the acceptable threshold of 0.1, confirming that the weight calculations were reliable and the comparisons consistent.

Table 4.7 Prioritization of Critical Success Factors local and global weight and rank

Groups of CFS	Weights of the group	Critical success factor	Local weights (Rank)	Global weights	Global Rank
1	2	3	4	5	6
1.Stakeholder, Communication, and Satisfaction	0.2345	Social Environment	0.293 (1)	0.068	1
		Effective Communication	0.2019 (2)	0.0473	2
		Stakeholder Alignment and Collaboration	0.1796 (3)	0.042	4
		Involvement of All Stakeholders	0.1739 (4)	0.040	5
		Trust and Mutual Responsibility Among Stakeholders	0.151 (5)	0.035	10
2.Resource Management & Technological Integration	0.2224	Technological Environment	0.1558 (1)	0.0346	12
		Adequacy of Funds	0.1339 (2)	0.0297	14
		Adequate Resources	0.1318 (3)	0.029	16
		Economic and Political Environment	0.12389 (4)	0.0275	18
		Optimal Use of Labor, Materials, and Financial Resources	0.1215 (5)	0.027	20
		Site Organization and Proper Crew Formation	0.1156 (6)	0.0257	21
		Contractor's Technique and Equipment Advancement	0.10979 (6)	0.0244	22
		Economic and Financial Situation of the Contractor	0.1075 (7)	0.024	23
3.Risk Management & Change Adaptation	0.214	Flexibility and Compliance with Regulatory system	0.2086 (1)	0.0446	3
		Consultant Experience and Accomplishment	0.1765 (2)	0.0377	7
		Contingency Planning and Client's Preference for Risk Sharing	0.1713 (3)	0.0366	8
		Experience and Skills of PM	0.1698 (4)	0.036	9
		Capability and Competency of Contractors	0.138 (5)	0.029	15
		Proactive Risk Management	0.1355 (6)	0.029	17

Groups of CFS	Weights of the group	Critical success factor	Local weights (Rank)	Global weights	Global Rank
1	2	3	4	5	6
4.Scope Control & Monitoring	0.185	Single-Source Accountability	0.217194 (1)	0.040	6
		Moderate Change Orders	0.1912 (2)	0.035	11
		PM Authority and Involvement	0.1165 (3)	0.0215	25
		Consultant's Management Capability	0.10198 (4)	0.0188	26
		Use of Project Management Software for Real-Time Tracking	0.1006 (5)	0.018	27
		Adequacy of the Planning and Change Control Mechanisms	0.0999 (6)	0.018	29
		Contractor’s Experience with Similar Projects	0.0898 (7)	0.0166	31
		Decision-Making Effectiveness of PM	0.0826 (8)	0.015	32
5. Scope Definition & Planning	0.143	Type of Client (Private vs. Public)	0.21562 (1)	0.0308	13
		Early Contractor Involvement	0.192151 (2)	0.027	19
		Size and Experience of the Client	0.1606 (3)	0.023	24
		Competency of the Consultants Company	0.13013 (4)	0.0186	28
		Project type and size	0.12824 (5)	0.0183	30
		Scope and Contractual Clarity	0.09781 (6)	0.0139	33
		Adequate Plan and Detailed work breakdown structure	0.07536 (7)	0.0107	34

Table 4.8 Overall Prioritization of Success Factors

	Critical success factor	Global weight	Percentage	Rank
1	Social Environment	0.0687	6.9%	1
2	Effective Communication	0.0473	4.7%	2
3	Flexibility and Compliance with Regulatory system	0.0446	4.5%	3
4	Stakeholder Alignment and Collaboration	0.0421	4.2%	4
5	Involvement of All Stakeholders	0.0408	4.1%	5
6	Single-Source Accountability	0.0402	4.0%	6
7	Consultant Experience and Accomplishment	0.0378	3.8%	7
8	Contingency Planning and Client's Preference for Risk Sharing	0.0367	3.7%	8
9	Experience and Skills of PM	0.0363	3.6%	9
10	Trust and Mutual Responsibility Among Stakeholders	0.0354	3.5%	10
11	Moderate Change Orders	0.0354	3.5%	11
12	Technological Environment	0.0346	3.5%	12
13	Type of Client (Private vs. Public)	0.0308	3.1%	13
14	Adequacy of Funds	0.0298	3.0%	14
15	Capability and Competency of Contractors	0.0295	3.0%	15
16	Adequate Resources	0.0293	2.9%	16
17	Proactive Risk Management	0.0290	2.9%	17
18	Economic and Political Environment	0.0276	2.8%	18
19	Early Contractor Involvement	0.0275	2.7%	19
20	Optimal Use of Labor, Materials, and Financial Resources	0.0270	2.7%	20
21	Site Organization and Proper Crew Formation	0.0257	2.6%	21
22	Contractor's Technique and Equipment Advancement	0.0244	2.4%	22
23	Economic and Financial Situation of the Contractor	0.0239	2.4%	23
24	Size and Experience of the Client	0.0230	2.3%	24
25	PM Authority and Involvement	0.0216	2.2%	25
26	Consultant's Management Capability	0.0189	1.9%	26
27	Use of Project Management Software for Real-Time Tracking	0.0186	1.9%	27
28	Competency of the Consultants Company	0.0186	1.9%	28
29	Adequacy of the Planning and Change Control Mechanisms	0.0185	1.8%	29
30	Project type and size	0.0183	1.8%	30
31	Contractor’s Experience with Similar Projects	0.0166	1.7%	31
32	Decision-Making Effectiveness of PM	0.0153	1.5%	32
33	Scope and Contractual Clarity	0.0140	1.4%	33
34	Adequate Plan and Detailed work breakdown structure	0.0108	1.1%	34

Identifying the critical success factors that affect the management of scope in Ethiopian Design-Build (DB) projects is very important for improving project success. In this study, expert opinions were collect and the Analytic Hierarchy Process (AHP) method was used to carefully explore and prioritize these success factors. The final prioritization of success factors is shown in Table 4.8.

Among the five main categories, Stakeholder Engagement, Communication, and Satisfaction ranked first, with a weight of 0.2345. This result is similar to previous research by Pinto and Slevin (1988a) and Belay et al. (2021), who both found that involving stakeholders and having good communication are the key parts of successful projects. However, other studies like Gudienė et al. (2014) gave less importance to these factors. This difference may be because in Ethiopia, projects often involve many different people with different interests. If these stakeholders are not properly engaged and satisfied, misunderstandings and disagreements can easily happen, which can cause problems for the project.

The second most important category was Resource Management and Technological Integration, with a weight of 0.2224. This is also supported by Ogunlana (2010), who stated that in developing countries, managing people, materials, and technology is very critical. In developed countries, projects often have enough resources, so resource management might not seem as important. However, in Ethiopia, where shortages of cost, skilled labor, and modern tools are common, making good use of available resources becomes a top priority for success.

Third was Risk Management and Change Adaptation, with a weight of 0.214. Similar results were found in studies by Liu et al. (2017) and Chan et al. (2001), who pointed out that handling unexpected problems early helps projects avoid bigger issues later. In Ethiopia, where regulations and political conditions can change suddenly, being flexible and managing risks early is even more important compared to more stable countries (Zou et al., 2007).

Scope Control and monitoring ranked fourth (0.185). This shows that even though it is important to track and control the project's work, it is not as highly prioritized as social and resource factors. The research conducted by Alias et al. (2014) highlighted how important it is to keep projects on track by controlling scope, but in Ethiopia, strong relationships and available resources seem to play a bigger role.

Lastly, Scope Definition and Planning was ranked the least important category (0.143). Other research (Belassi and Tukel (1996); Alias et al. (2014)) showed that clear planning at the beginning is essential for project success. However, in Ethiopia, sometimes projects start even when the planning is not complete, mainly because of the need to move quickly or the challenges in organizing many parties.

This highlights a gap that needs to be improved better and more complete planning before starting would help many DB projects succeed.
In general, this study shows that in Ethiopian DB projects, human-centered factors such as stakeholder involvement and communication are considered more important than technical and administrative ones. This is different from some other countries where planning and monitoring are more heavily emphasized.

Looking at the individual success factors, the most important one was Social Environment, with a global weight of 0.0687 (6.9%). This agrees with Pinto and Slevin (1988a) and Belay et al. (2021), and Nguyen and Ogunlana (2004), who also found that trust, teamwork, and good relationships are essential for project success. In Ethiopia, many projects rely heavily on relationships between the client, contractor, and consultant, so building a strong social environment becomes even more important.

The second-ranked factor was Effective Communication, with a weight of 0.0473 (4.7%). This matches the findings of Gudienė et al. (2014) and Nguyen and Ogunlana (2004) who showed that clear and regular communication helps avoid misunderstandings, solve problems quickly, and improve project performance. Especially in DB projects where responsibilities are shared between designers and builders, communication becomes even more critical for scope management.
The third most important factor was Flexibility and Compliance with Regulatory Systems, with a weight of 0.0446 (4.5%). This matches Chan et al. (2001) and Zou et al. (2007), who found that projects succeed better, when they can adjust to changing laws and client needs. In Ethiopia, where regulations and political decisions can change quickly, being flexible and staying compliant with the law is necessary for keeping projects on schedule and within budget.
Other important factors such as Stakeholder Alignment and Collaboration (rank 4) and Involvement of All Stakeholders (rank 5) also support the idea that human and relationship management plays a large role in DB project success. These findings are similar to Belay et al. (2021) and Nguyen and Ogunlana (2004), who both emphasized the need for early and strong collaboration among all parties involved in construction projects.

Interestingly, technical and resource-related factors like Single-Source Accountability, Consultant Experience and Accomplishment, and Contingency Planning ranked slightly lower but were still important. These findings are close to what previous studies by Alias et al. (2014) and Liu et al. (2017) found, where both human and technical factors work together for project success.

However, factors related to detailed scope planning, such as Scope and Contractual Clarity and Adequate Work Breakdown Structure, ranked much lower in the current study. This is different from findings in countries like the UK and USA (White & Fortune, 2002). Where detailed planning is often seen as a top priority. This difference again shows that in Ethiopia, where projects often face resource and administrative challenges, social and relationship-based factors take the lead. The detail Final analytical hierarchy structure is shown in figure 4.9.

Overall, this study shows that for Ethiopian DB projects, focusing on social relationships, clear communication, and flexibility in handling risks and regulations are the most critical areas for improving scope management. This insight can help project managers, clients, and contractors focus their efforts where it matters most to achieve project success.

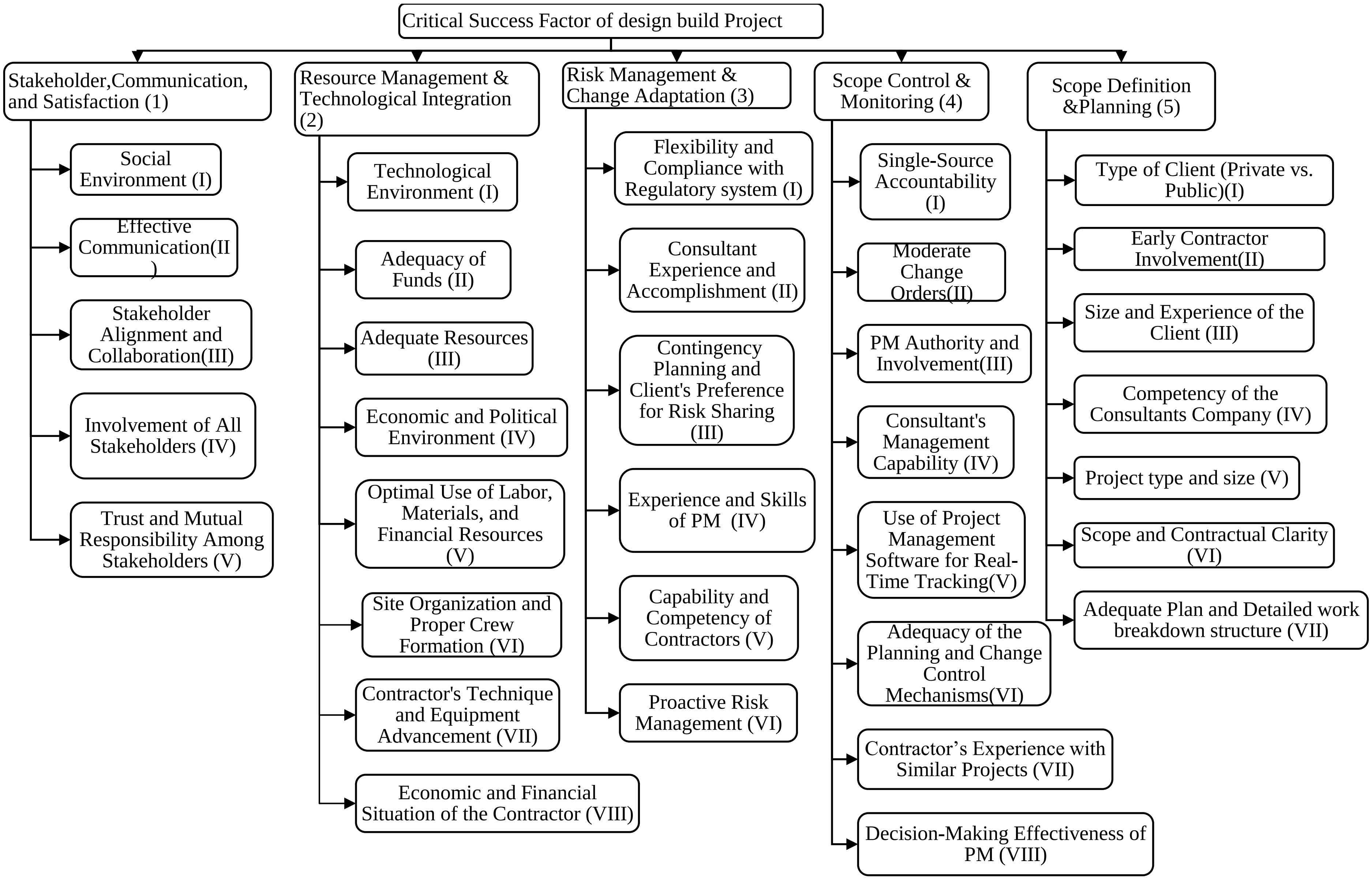

Figure 4.9 Final analytical hierarchy structure

4.4 Examining Interrelationships among Critical Success Factors

After the prioritization of critical success factors using AHP, the top 28 factors selected which representing 90% of the total weight for further analysis. These factors, shown in Table 4.9, were analyzed using Interpretive Structural Modeling (ISM) to examine how each factor influences the others and to understand their interrelationships. ISM helps identify the driving and dependent factors among the selected success factors. This method provides a clear structural hierarchy of influence among factors. Understanding these relationships supports better decision-making in managing project scope effectively.

Table 4.9 Top 28 critical success factor based on the relative importance

	Critical success factor	Symbol	Rank
1	Social Environment	E1	1
2	Effective Communication	E2	2
3	Flexibility and Compliance with Regulatory system	E3	3
4	Stakeholder Alignment and Collaboration	E4	4
5	Involvement of All Stakeholders	E5	5
6	Single-Source Accountability	E6	6
7	Consultant Experience and Accomplishment	E7	7
8	Contingency Planning and Client's Preference for Risk Sharing	E8	8
9	Experience and Skills of PM	E9	9
10	Trust and Mutual Responsibility Among Stakeholders	E10	10
11	Moderate Change Orders	E11	11
12	Technological Environment	E12	12
13	Type of Client (Private vs. Public)	E13	13
14	Adequacy of Funds	E14	14
15	Capability and Competency of Contractors	E15	15
16	Adequate Resources	E16	16
17	Proactive Risk Management	E17	17
18	Economic and Political Environment	E18	18
19	Early Contractor Involvement	E19	19
20	Optimal Use of Labor, Materials, and Financial Resources	E20	20
21	Site Organization and Proper Crew Formation	E21	21
22	Contractor's Technique and Equipment Advancement	E22	22
23	Economic and Financial Situation of the Contractor	E23	23
24	Size and Experience of the Client	E24	24
25	PM Authority and Involvement	E25	25
26	Consultant's Management Capability	E26	26
27	Use of Project Management Software for Real-Time Tracking	E27	27
28	Competency of the Consultants Company	E28	28

Based on expert's opinion, there are influences and directional relationships among the factors identified. These insights helped to create a 28-by-28 Adjacency Matrix, which highlights only the direct connections between these factors. Detailed in Appendix A. Final a Reachability Matrix is created by considering both direct and indirect relation among factors. This change follows the principle of transitivity, a key assumption in Interpretive Structural Modeling (ISM). The final reachability matrix, which outlines the driving and dependent powers of each factor, is available in Appendix B. where "Dri.P" stands for driving power, while "Dep.P" indicates dependency power. Using this reachability matrix, the factors is dived into different hierarchical levels, as shown in Appendix C. These levels show how the elements are structured, ranging from the most influential at the base of the hierarchy to the most dependent at the top. In this visual model, each node represents a factor, and the arrows between them indicate the nature and direction of their influence. As shown in Figure 4.10.

Regarding data quality, the inconsistency rate from the responses was 10.61%, which is comfortably below the acceptable limit of 30%, as noted by (Alawamleh & Popplewell, 2011). To further evaluate the internal reliability of the ISM questionnaire, before go to data collection sample question can distributed to same respondent and the Cronbach's alpha coefficient is calculated by using SPSS software, which came out to be 0.906, indicating excellent internal consistency.

From the analysis, the factors related to the Optimal Use of Labor, Materials, and Financial Resources, along with the Consultant's Management Capability and the Consulting Company Competency, were all rated at Level 10. This means they have the highest influence and are prioritized first. Following closely behind, factors like Flexibility and Regulatory Compliance, Stakeholder Collaboration, Consultant Experience, and Adequate Resource Availability, which were grouped at Level 9, making them the second most important. On the other side, factors such as the Type of Client (Public vs. Private) and the economic and political Environment were placed at Level 1, showing they are highly dependent and have the least influence, thus ranked tenth. Just above them, the Economic and Financial Situation of the Contractor was rated at Level 2, coming in at ninth place. However, Most of the factors is at center, which is around 18 factor in total, fell between Levels three to eight, indicating a mid-range influence and significance. From this Level 7 had the highest number of factors. Once established the structural model, MICMAC analysis is conducted.

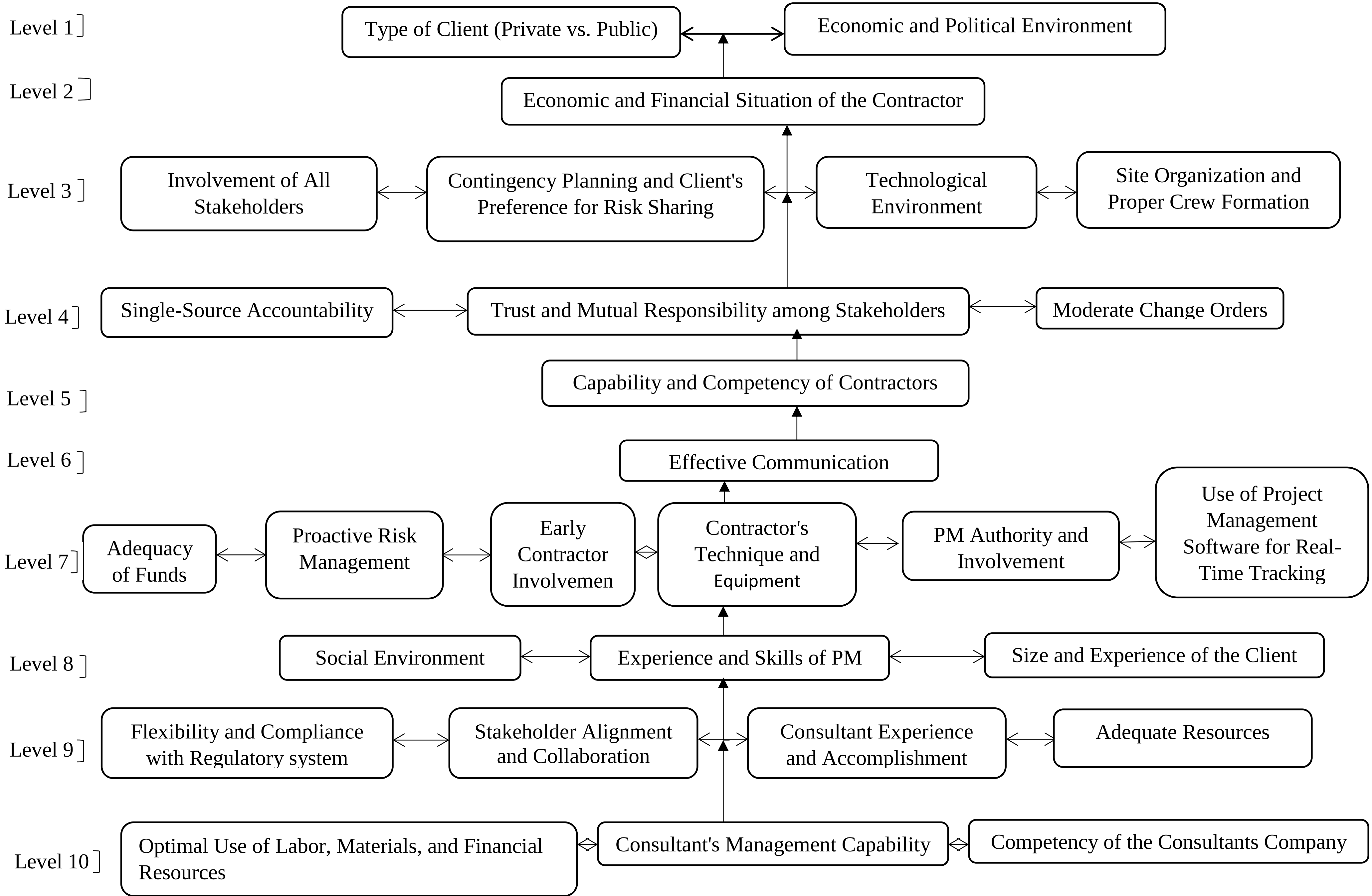

Figure 4.10 Interpretive structural modeling diagram

The MICMAC analysis (Cross-impact Matrix Multiplication Applied to Classification) places according to their respective levels of system influence and dependence, factors in the autonomous quadrant, the dependent quadrant, the linkage quadrant and the independent quadrant. The MICMAC analysis places the following factors in the independent quadrant because they have strong system influence but are little influenced by other factors: Stakeholders' trust and mutual responsibility (E10), Adequacy of funds (E14), Proper use of labor, materials and money (E20), Ability of the consultant's manager (E26), Competence of the consultants company (E28).The other factors exist in the linkage quadrant because they have both high influence and dependence levels and as a consequence are essential components of the system. As shown in Figure 4.11

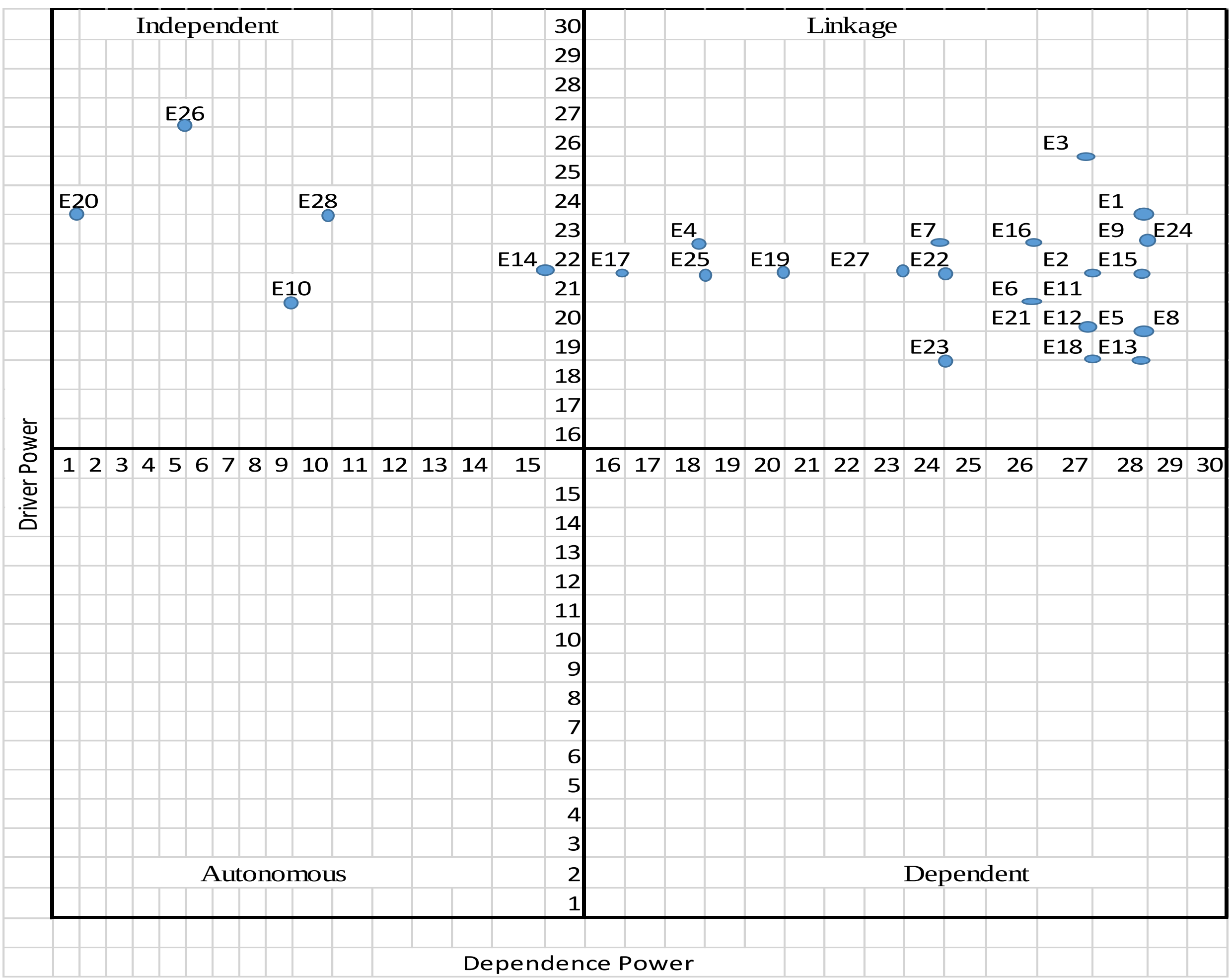

Figure 4.11 MICMAC Analysis result

A hierarchical framework of critical success factors (CSFs) applicable to effective management of project scope in design-build construction projects is illustrated in Figure 4.11. From the model, it is evident that all 28 CSFs are inter connected with factors at the earlier stages in the hierarchy exerting direct and indirect influences over subsequent factors. At the top level are success factors like Optimal Use of Labor, Materials, and Financial Resources, Consultant's Management Capability, and Competency of the Consultant's Company can high influence on the other factor.

These underlying factors have direct impacts on Flexibility and Compliance with Regulatory Systems, Stakeholder Alignment and Collaboration, Consultant Experience and Accomplishment, and Sufficient Resources. This is because when resources are used in an optimal manner and consultants have high abilities, it provides a sound basis for managing regulatory demands, enhancing collaboration among stakeholders, and facilitating the presence of required inputs for project implementation. Study conducted by Low and Hou (2019) describe that effective utilization of resources coupled with sound technical management practices greatly improves project responsiveness and regulatory compliance.

Although Optimal Use of Labor, Materials, and Financial Resources, Consultant's Management Capability and Competency of the Consultants Company is indirect influence on Social Environment, Experience and Skills of PM and Size and Experience of the Client. For instance, greater collaboration between stakeholders and flexibility to regulations system is directly influence the Social Environment, Experience and Skills of PM, Size and Experience of the Client. The study by Akanni et al. (2015) emphasized the significance of a supportive environment and good quality leadership in facilitating successful project results, thereby validating this relationship.

The size and experience of the client, skill level of the project manager, and social environment, in turn, have a direct influence upon several operational factors, including Adequacy of Funds, Proactive Risk Management, Early Contractor Involvement, Contractor's Techniques and Equipment, Project Manager Authority and Involvement, and Utilization of Project Management Software for Real-Time Tracking. This is because mature clients and experienced project managers have higher chances of securing funding, engaging contractors early during planning, and incorporating contemporary technology into project controls. Research conducted by Njama (2015) state that these practices are crucial to improve monitoring effectiveness, financial planning, and risk readiness.

Additionally, the influence from previous phases is also indirect because initial collaborative and regulatory competencies influence project leadership, which in turn promotes proactive risk management, Adequacy of Funds, Early Contractor Involvement, Contractor's Technique and Equipment, PM Authority and Involvement and Use of Project Management Software for Real-Time Tracking. For example, stakeholders who are aligned at the beginning are likely to be in consensus with risk-sharing approaches and the utilization of computer programs for monitoring scope performance (Ghanbaripour et al., 2020).

These enablers then directly influence Effective Communication at all levels of the project. When financial resources are assured, risk is managed early, contractors are brought in from the very beginning, and project managers are provided with authority and electronic tools, communication flows easier. This increase transparency and reduces scope uncertainty. The study by Musarat et al. (2021) argue that effective communication systems are usually the outcome of deliberate strategic planning, effective project leadership, and technological facilitation.

Effective Communication is directly influences the capabilities and competencies of contractors. The provision of clear, timely, and consistent information guarantees that contractors remain aligned with both the scope requirements and the expectations of the project. Consequently, this alignment enhances their capacity to execute tasks within established parameters and deadlines. The research conducted by Patel et al. (2002) indicates that the clarity of project communication significantly improves contractor performance, thereby minimizing instances of rework and disputes concerning scope.

Competent and efficient contractors are central to enabling Single-Source Accountability, Trust and Mutual Responsibility among Stakeholders, and guaranteeing Moderate Change Orders. These are influence directly when contractors are familiar with their work and possess the technical and managerial competence to undertake them. Trust is fostered when contractors carry out work consistently, and this reduces the need for excessive change orders. The cumulative effect of core enablers on these outcomes illustrates that planning and capability-development early on lead to stronger project governance and scope stability.

It should be noted that the causes of successful utilization of resources and consultants' professionalism affect not just the subsequent immediate stage but also indirectly influence all the future outcomes at greater levels. Successful consultant management indirectly facilitates trust and accountability mechanisms through fostering a stable, well-structured project environment. This cause-and-effect interdependence supports the point of view that gains in critical success factors in the early stages yield cumulative rewards during the overall scope management process. The detail hierarchy is shown in figure 4.11

In addition, the factors were grouped in two of the four quadrants from the MICMAC analysis. The factors Stakeholders' trust and mutual responsibility, Adequacy of funds, Proper utilization of labor, materials, and financial resources, Consultant's Management Capability, and Competence of the consultants' company are in the independent quadrant. These factors possess high driving power but exhibit low dependency power. These variables are at the lowest two levels of the ISM-based directed graph, which suggests that they are the fundamental drivers of influence for the overall success of design-build construction projects. As conceptualized in the "law of the vital few and trivial many," it is submitted that 80% of the outcomes are the result of just 20% of the causal variables (Liu et al., 2015). Accordingly, the effective handling of these root causes is expected to have the most effect on the implementation of design-build projects.

Among them, Competence of the consultants company show especially strong driving power. The Competence of the consultants company and Consultant's Management Capability are critical drivers, as they influence design integrity and construction supervision from early stages. Stakeholders' trust and mutual responsibility supports collaborative working environments, which are vital in design-build settings where contractors and designers are jointly responsible for project outcomes.

The remaining 23 factors fall in the linkage quadrant, i.e., they have high driving power and high dependency power. These factors are highly interrelated among themselves. Any change in one of the factors in this set is likely to influence several others. These are Effective Communication, Stakeholder Alignment and Collaboration, Project Manager Experience and Skills, Proactive Risk Management, Economic and Political Environment, Early Contractor Involvement, and others. Their positioning in the linkage group points to the interactive, mutually influencing character of design-build project environments, where developments and decisions in one part of the project frequently have direct influence in other parts.

Comparison of MICMAC results with AHP ranking as well as the results deduced from literature in consideration shows differences in ranking the factors. While MICMAC analysis had singled out Adequacy of funds and Proper use of labor, materials, and Financial Resources as underlying causes with high driving power, these factors have not been ranked as most critical in the literature before. The research conducted by Gudienė et al. (2014) and Belay et al. (2021) also pointed out the significance of contractors' technical expertise and stakeholders' involvement, which might be more crucial in varied delivery modes. Moreover, existing AHP results indicate Adequacy of funds ranked 14th and Proper use of labor, materials and financial resource ranked 20th; also, Consultant's Management Capability did not get a high ranking.

This disparity can be accounted for by the distinctive criteria that were used in the analysis. AHP and other analyses used importance as a measure of criticality from what appeared to have direct relevance, while the MICMAC method utilizes influence, which captures more structural influences that are not necessarily so clear but are systemically important. Study by Gudienė et al. (2014) state, the use of the notion of importance alone is troublesome for decision-makers in the determination and tackling of the underlying causes of success or failure. Influence-based methods such as MICMAC, on the contrary, enable strategic comprehension of how project success can be established at the fundamental level, particularly in complicated and interdependent delivery systems such as design-build. This idea is also supported by Iyer and Sagheer (2010) , who emphasize that managing root drivers is a more efficient approach than simply reacting to immediate issues. The detail of the result is shown in figure 4.11

4.5. Prioritization Based on combined Hierarchical Structure

The main goal of this paper is to organize the critical success factors for design-build construction projects based on both their importance and their influence. These two rankings were done separately, and to understand the relationship between them, Spearman’s rank correlation was used. The result show that a correlation coefficient of 0.121, which means there is a very weak positive relationship between importance and influence when one increases, the other might slightly increase too, but the connection is not strong or consistent. To make the results easier to interpret and understand to combine the two rankings, quadrant analysis was used. The results, shown in Figure 4.12, grouped the factors into different categories. Seven critical success factors were found in the "priority to improvement” quadrant. These are also important but of less effect, therefore stress must be put on their strengthening. These include Type of Client (Private vs. Public), Technological Environment, Moderate Change Orders, Stakeholders' trust and mutual responsibility, Competence of the Consultants Company, Involvement of All Stakeholders, and Single-Source Accountability. Another group of factors, including Experience and Skills of PM, Consultant Experience and Accomplishment , Social Environment, Effective Communication, Stakeholder Alignment and Collaboration, and Flexibility and Compliance with Regulatory system , fall into the "critical and stable" quadrant. These are very important and high influential, so they should be maintained carefully to ensure the project performs well. Other else there are certain ones, which appear to have more than they need as resources and of less concern. These are Economic and Financial Situation of the Contractor, Site Organization and Proper Crew Formation, Economic and Political Environment, and Capability and Competency of Contractors which is at low priority quadrant. Indicating that they do not need immediate attention, the remaining eleven critical success factors are listed as need monitoring and possible over killer. This analysis helps in focusing on the most critical areas for increasing the performance of design-build construction projects.

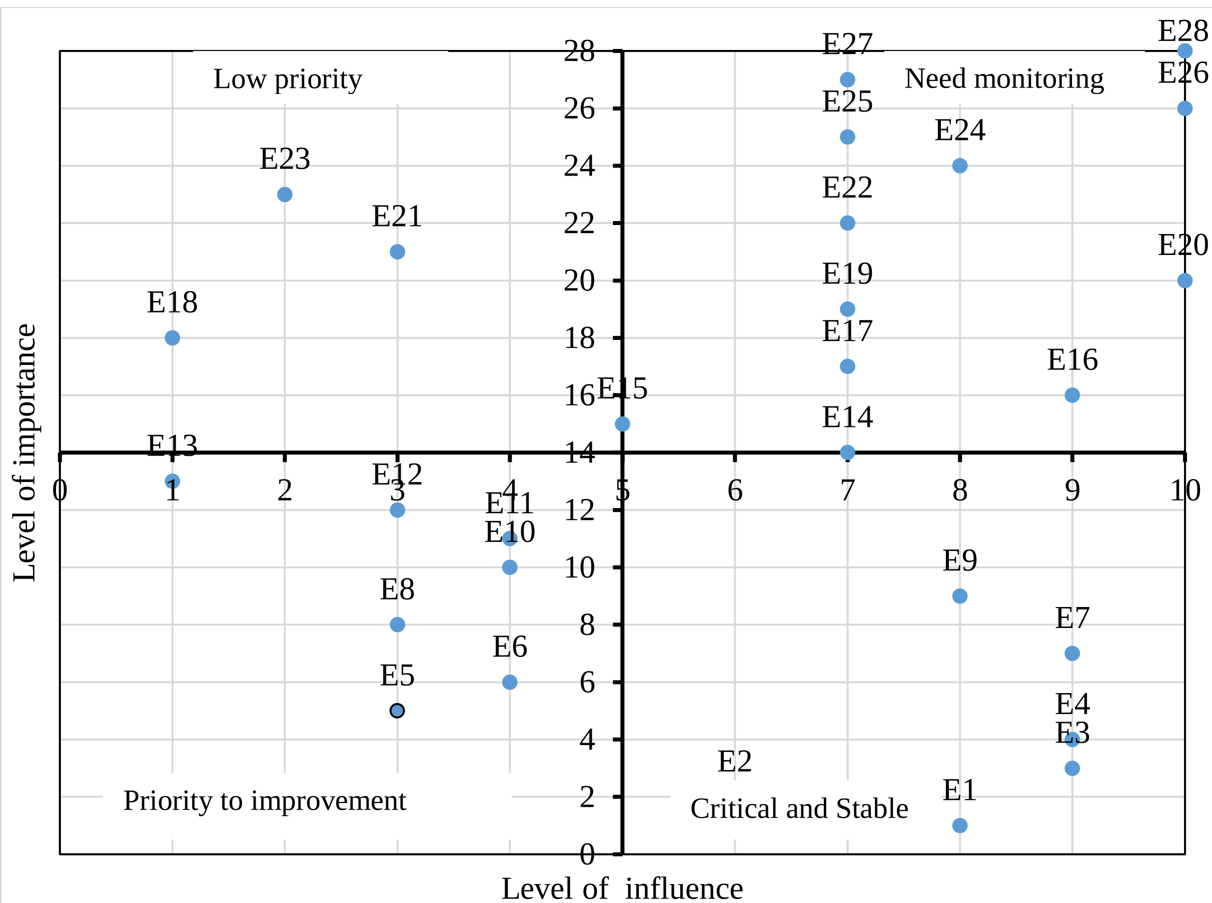

Figure 4.12 Quadrant Analysis Result

Project success not only serves as a requirement for managing current projects, but also for planning and directing upcoming projects. Such success is what can be achieved by being carefully in considering critical success factors and managing them. Without considering the factors or their poor management, the project is highly likely to fail (Sinesilassie et al., 2018).The previous discussion is focus on were both on the impact of these factors, but not at the same time. Nevertheless, significant and impactful factors have to be identified in order to have a complete picture of what truly leads to successful projects. For this purpose, quadrant analysis is needed. It was capable of identifying the prevalent factors that are high on importance as well as influence. Six of the most significant ones were located in the "critical and stable" quadrant, as shown in Figure 4.12. These are Social Environment, Effective Communication, Flexibility and Compliance with Regulatory system, Stakeholder Alignment and Collaboration, Consultant Experience and Accomplishment and Experience and Skills of PM. These are crucial in the realization of the successful completion of design-build construction projects as also reflected by Ika (2009), who also suppose that project performance should be guaranteed through an emphasis on both strategic and operating success factors.

Among all the factors, Social Environment was found to be the most influential for project success in the quadrant analysis. It was ranked third in influence and first in importance in the AHP analysis. This shows that the social setting that exists around the project such as people relationships, teamwork, respect for one another, and social norms have a very significant role to play in ensuring the success of a design-build construction project. Where there is good and healthy social setting, communication improves, conflicts reduce, and cooperation among all players increases. The same findings were reported in previous studies. For instance, according to Belay et al. (2021), Olander and Landin (2005), social factors and stakeholder relations have a significant role in deciding the level to which a project runs smoothly. Therefore, giving proper heed to the social environment can lead to better performance as well as enhanced success rates of design-build construction projects.

Effective Communication is another most consistent and significant determinants of success. In this study, it was placed at 2nd position of importance (AHP analysis) and 5th of influence, meaning that it not only exerts a high degree of effect on project success but also significantly contributes towards driving other success factors. Effective communication ensures all parties to the project which is client, contractors, consultants, and other stakeholder are well informed and on time, minimizing conflict and delays. Communication ranks as one of the top ten critical success factors, Pinto and Slevin (1987), as poor communication can lead to coordination failures. In the same opinion, Chung and Kua (2016) pointed out that communication quality directly affects stakeholder relationships and project performance. The research by Belassi and Tukel (1996) also noted that communication is among the managerial considerations that are key to success, especially in complex project environments like design-build. In using integrated delivery systems, where roles have a tendency to overlap, and clear communication is even more imperative to manage expectations and coordinate change. The research by Nguyen and Ogunlana (2004) also corroborated the same by identifying communication as one of the drivers of project performance in developing countries. Therefore, strengthening communication channels should receive the utmost priority for performance improvement in design-build construction projects.

Flexibility and Compliance with Regulatory System is another important critical success factor in the critical and stable quadrant. It was ranked 3rd in terms of importance using AHP analysis and 2nd in terms of its influence using ISM analysis, thereby proving its dual significance as a factor influencing and being influenced by other project success factors. Design-build construction project regulations are prone to alter throughout the duration of the project lifecycle. Therefore, remaining flexible and compliant with such regulatory changes guarantees project continuity and avoids costly legal and administrative delays. According to Ika (2009), regulatory compliance is a critical key to successful project delivery, particularly in public-private projects where the governance structures are more complex. Similarly the study by, Ofori (2016) explained that project environments in developing countries are faced with regulatory uncertainty, and therefore flexibility is even more critical. In addition, the research by Garbharran et al. (2012) noted that awareness of and adaptation to local legislation, building codes, and procurement procedures is among the secrets of reducing delays and pleasing stakeholders. Under design-build delivery, where design and construction are integrated, early adherence to regulatory issues can make the approval process streamlined and avoid late changes. Thus, regulatory knowledge and flexibility in responding to change are important for the development of performance and providing assurance for the success of projects

In In each analysis quadrant, critical success factors that share similar features are grouped. The first quadrant, the so-called Critical and Stable, contains the most significant factors that are also most powerful. They are the most crucial success factors. For a project to succeed, these factors' performance should be given most priority. The second quadrant is referred to as Priority for Improvement. It holds factors that are very significant but of lesser influence. These play a vital role in achievement and must be enhanced at the earliest to upgrade the functioning of design-build construction projects. The third quadrant, Needs Monitoring, comprises items that are high influence and low importance. These tend to be root causes that do not necessarily appear important but affect many other items. They tend to require more effort and resources to address but are still crucial for ultimate success. Finally, the fourth quadrant contains the Low Priority group of factors. They are of lesser impact and influence, and therefore their overall influence on project success is limited compared to the other quadrants. The final hierarchical model combining the result of ISM, AHP, and quadrant analysis is shown in Figure 4.13.

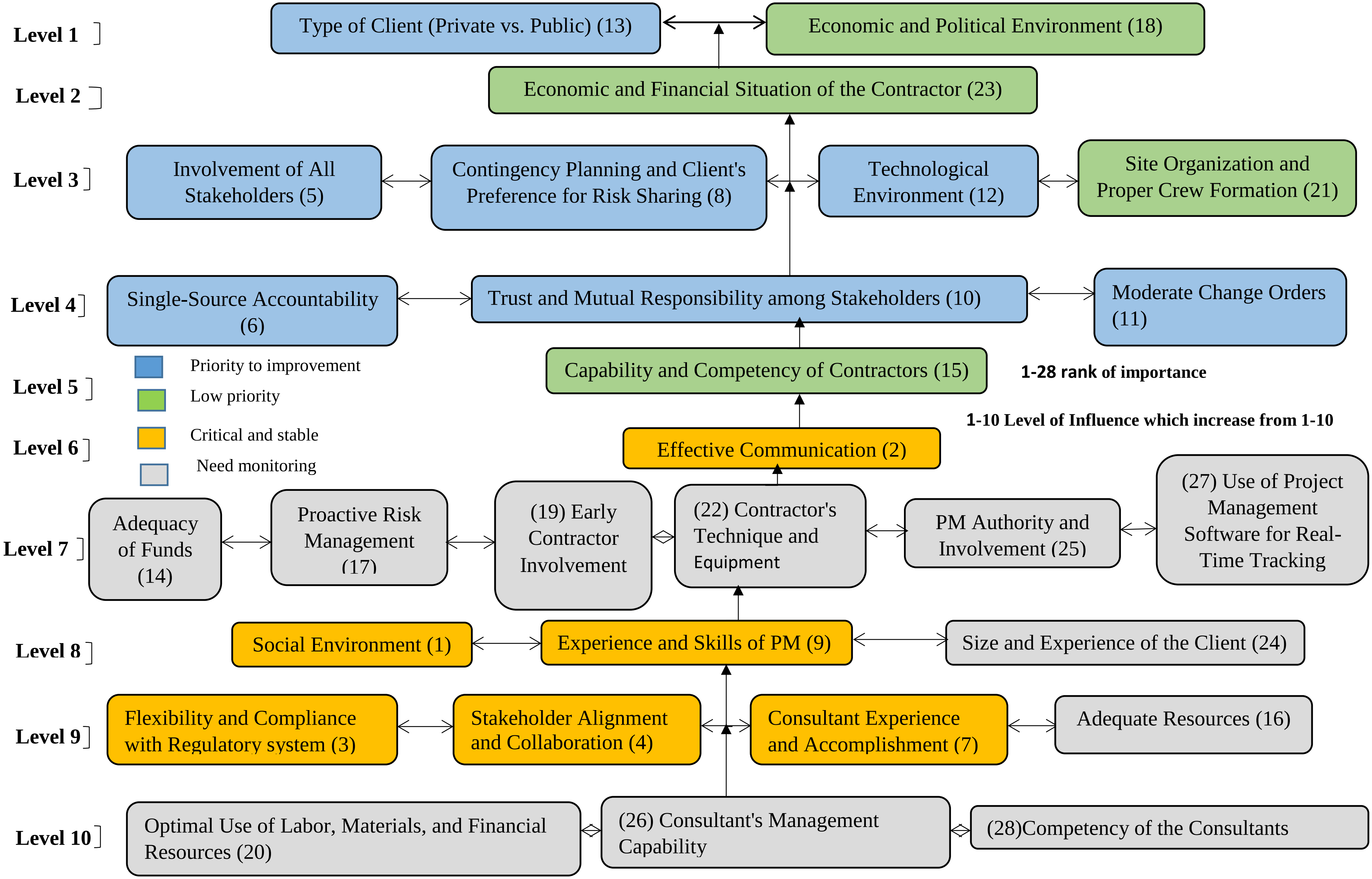

Figure 4.13 Hierarchy structural model based on influence and importance

CONCLUSION AND RECOMMENDATION

Conclusions

Understanding the critical success factors (CSFs) of design-build construction projects is pivotal to project success. This research utilized a holistic and interconnected approach based on AHP, ISM, and MICMAC methods to identify, rank, and examine the interdependencies of the CSFs. Based on the input from the literature review and opinion from the professionals, Out of the categories Stakeholder engagement, communication, and satisfaction, Resource management and technological integration, and Risk management and change adaptation is the top three most important critical success factor which determining project success. Moreover, most of the critical success factors observed have strong interrelationships. Furthermore, From the AHP analysis the overall top three critical success factor is Social Environment, Effective Communication, Flexibility and Compliance with Regulatory System. In addition, the ISM result show that Optimal Use of Labor, Materials, and Financial Resources, Consultant's Management Capability and Competency of the Consultants Company Is the top three influencer.

Furthermore, quadrant analysis allowed the factors to be categorized according to their impact and priority. Notably, the top AHP-ranked CSFs Social Environment, Effective Communication, Flexibility and Compliance with Regulatory System, and Stakeholder Alignment and Collaboration were all is the most important and influence critical success factor. It demonstrates their crucial position in influencing other factors and directly contributing to project success.

In brief, this research provides decision-makers, project managers, and design-build stakeholders with tangible guidance on how to tackle design-build projects. The research underscores the value of adopting a strategic approach that balances influence and significance, prioritizes stakeholder collaboration, and enables adaptive project management. The integrated model utilized in this research can serve as an effective tool for designing, monitoring, and optimizing the success of future design-build construction projects.

Recommendation

Professionals engaged in design-build construction projects are strongly encouraged to apply the findings of this study to improve the likelihood of project success by concentrating on the most critical success factors identified through the integrated AHP, ISM, and MICMAC methodologies. The research identifies Social Environment, Effective Communication, Flexibility and Compliance with Regulatory System, and Stakeholder Alignment and Collaboration as being both very important and influential. As these factors play a central position in influencing project results, practitioners ought to give them high priority during the project life cycle. The structure, as developed through the research, also can be used on a practical basis for predicting project performance and guide decision-making to take appropriate timely corrective actions.

For future researcher while the current study employed the AHP method to determine the importance of success factors, future studies are recommended to use Fuzzy AHP to account for uncertainty and subjectivity in judgments by experts. In the same way, Fuzzy ISM can provide more reliable relationship analysis among factors by including confidence levels in the responses of experts. Applying this integrated approach across different types of construction project delivery methods.

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APPENDEX

Appendix A: Adjacency Matrix

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24	E25	E26	E27	E28
E1	1	0	1	0	1	0	1	1	0	0	1	1	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0
E2	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0
E3	1	1	1	1	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0
E4	1	0	0	1	0	1	0	1	0	0	0	1	1	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0
E5	0	1	0	0	1	0	0	0	1	0	0	1	1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0
E6	1	1	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
E7	1	0	1	1	0	0	1	1	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
E8	0	1	0	0	0	0	0	1	1	0	0	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0
E9	1	1	0	0	1	1	0	1	1	0	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
E10	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0
E11	1	0	1	1	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
E12	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
E13	0	0	1	0	1	0	1	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0
E14	1	0	0	0	0	0	1	0	0	1	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0
E15	0	1	1	0	0	0	0	0	1	0	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
E16	1	0	1	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
E17	1	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	1	0
E18	0	1	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0
E19	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	1	0	0
E20	0	0	1	1	1	1	0	0	0	0	1	1	1	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0
E21	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
E22	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0
E23	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0
E24	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0
E25	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1
E26	1	0	1	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	1	1
E27	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1	1
E28	0	1	0	0	1	1	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	1	0	1	0	0	0	1

Appendix B: Reachability Matrix

factor	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24	E25	E26	E27	E28	Dri.P	Rank
E1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	0	24	3
E2	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	0	0	1	1	1	1	0	22	5
E3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	26	2
E4	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	0	23	4
E5	1	1	1	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	0	1	1	0	0	1	0	20	7
E6	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	1	0	0	1	0	21	6
E7	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	23	4
E8	1	1	1	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	0	1	1	0	0	1	0	20	7
E9	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	0	23	4
E10	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	0	0	1	0	21	6
E11	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	0	1	0	21	6
E12	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	1	0	0	1	1	1	1	0	0	1	0	20	7
E13	1	1	1	1	1	0	1	1	1	0	0	1	1	0	1	1	0	1	0	0	1	1	0	1	1	0	1	1	19	8
E14	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	0	1	0	0	22	5
E15	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	0	1	0	22	5
E16	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0	23	4
E17	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	0	1	1	22	5
E18	1	1	1	0	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	0	1	1	1	1	1	0	0	0	19	8
E19	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	1	0	1	1	1	1	0	1	1	1	22	5
E20	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	24	3
E21	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0	1	0	20	7
E22	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	0	0	1	1	0	1	1	0	1	1	22	5
E23	1	1	1	0	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	0	1	1	1	1	1	0	0	0	19	8
E24	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	1	1	0	1	1	1	1	1	0	1	1	23	4
E25	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1	0	1	1	22	5
E26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	27	1
E27	1	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	0	1	1	22	5
E28	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	24	3
Dep.p	28	27	27	18	28	26	24	28	28	9	26	27	28	15	28	26	16	27	20	1	27	24	24	28	18	5	23	10		
Level	1	2	2	7	1	3	4	1	1	11	3	2	1	9	1	3	8	2	6	13	2	4	4	1	7	12	5	10		

Appendix C: Partition of Critical Success Factor

	Reachability Set	Antecedent Set	Intersection	Dr.P	De.P	Level
	Level I					
E1	1-16,18,19,21-25,27	1.-28	1-16,18,19,21-25,27	24	28	
E2	1-9,11-13,15-19,21,24-27	1-20,22-28	1-9,11-13,15-19,24-27	22	27	
E3	2-19,21-25,27-28	1-10,12-28	2-10,12-19,21-25,27-28	26	27	
E4	1-9,11-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	
E5	1-3,5-9,11-13,15-19,21,23-24,27	1.-28	1-3,5-9,11-13,15-19,21,23-24,27	20	28	
E6	1-3,5-9,11-16,18-19,21-24,27	1-12,15-28	1-3,5-9,11-12,15-16,18-19,21-24,27	21	26	
E7	1-9,11-19,21-25	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	
E8	1-3,5-9,11-13,15-19,21,23-24,27	1.-28	1-3,5-9,11-13,15-19,21,23-24,27	20	28	
E9	1-9,11-19,21-24,27	1.-28	1-9,11-19,21-24,27	23	28	
E10	1-3,5-16,19,21-24,27	1,3,10,14,22,25-28	1,3,10,14,22,27	21	9	
E11	1-2,4-9,11-16,18,21-25,27	1-12,14-27	1-2,4-9,11-12,14-16,18,21-25,27	21	26	
E12	1-9,11-13,15-16,18,21-24,27	1-24,26-28	1-9,11-13,15-16,18,21-24,27	20	27	
E13	1-5,8-9,12-13,15-16,18,21-22,24-25,27-28	1.-28	1-5,8-9,12-13,15-16,18,21-22,24-25,27-28	19	28	I
E14	1-5,7-16,18-19,21-24,26	1,3-4,6-7,9-11,14,16-17,21,25-26,28	1,3-4,7,9-11,14,16,21,26	22	15	
E15	1-9,11-13,15-19,21,23-25,27	1.-28	1-9,11-13,15-19,21,23-25,27	22	28	
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	
E17	1-3,5-9,11-18,21-22,24-25,27-28	2-5,7-9,15,17,20-22,25-28	2-3,5,7-9,15,17,21-22,25,27-28	22	16	
E18	1-3,5-6,8-9,11-13,15-16,18-19,21-25	1-9,11-28	1-3,5-6,8-9,11-13,15-16,18-19,21-25	19	27	I
E19	1-9,11-13,15,18-19,21-24,26-28	1-10,14-16,18-20,23-24,26,28	1-9,15,18-19,23-24,26,28	22	20	
E20	1-9,11-13,15-25,27	20	20	24	1	
E21	1,3,5-9,11-18,21-24,27	1-24,26,28	1,3,5-9,11-18,21-24,	20	27	
E22	1-13,15,17-18,21-22,24-25,27-28	1,3-4,6-7,9-14,16-28	1,3-4,6-7,9-13,17-18,21-22,24-25,27-28	22	24	
E23	1-3,5-6,8-9,11-13,15-16,18-19,21-25	1,3-12,14-16,18-21,23-28	1,3,5-6,8-9,11-12,15-16,18-19,21,23-25	19	24	
E24	1-9.11-13,15-16,18-19,21-25,27-28	1.-28	1-9.11-13,15-16,18-19,21-25,27-28	23	28	
E25	1-6,8-11,13-18,22-25,27-28	1-3,7,11,13,15-18,20,22-28	1-3,11,13,15-18,22-25,27-28	22	18	

E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E27	1-3,5-6,8-13,15-18,21-25,27-28	1-6,8-13,15,17,19-22,24-28	1-3,5-6,8-13,15,17,19,21-22,24-25,27-28	22	23	
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level II						
E1	1-16,18,19,21-25,27	1.-28	1-16,18,19,21-25,27	24	28	
E2	1-9,11-13,15-19,21,24-27	1-20,22-28	1-9,11-13,15-19,24-27	22	27	
E3	2-19,21-25,27-28	1-10,12-28	2-10,12-19,21-25,27-28	26	27	
E4	1-9,11-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	
E5	1-3,5-9,11-13,15-19,21,23-24,27	1.-28	1-3,5-9,11-13,15-19,21,23-24,27	20	28	
E6	1-3,5-9,11-16,18-19,21-24,27	1-12,15-28	1-3,5-9,11-12,15-16,18-19,21-24,27	21	26	
E7	1-9,11-19,21-25	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	
E8	1-3,5-9,11-13,15-19,21,23-24,27	1.-28	1-3,5-9,11-13,15-19,21,23-24,27	20	28	
E9	1-9,11-19,21-24,27	1.-28	1-9,11-19,21-24,27	23	28	
E10	1-3,5-16,19,21-24,27	1,3,10,14,22,25-28	1,3,10,14,22,27	21	9	
E11	1-2,4-9,11-16,18,21-25,27	1-12,14-27	1-2,4-9,11-12,14-16,18,21-25,27	21	26	
E12	1-9,11-13,15-16,18,21-24,27	1-24,26-28	1-9,11-13,15-16,18,21-24,27	20	27	
E14	1-5,7-16,18-19,21-24,26	1,3-4,6-7,9-11,14,16-17,21,25-26,28	1,3-4,7,9-11,14,16,21,26	22	15	
E15	1-9,11-13,15-19,21,23-25,27	1.-28	1-9,11-13,15-19,21,23-25,27	22	28	
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	
E17	1-3,5-9,11-18,21-22,24-25,27-28	2-5,7-9,15,17,20-22,25-28	2-3,5,7-9,15,17,21-22,25,27-28	22	16	
E19	1-9,11-13,15,18-19,21-24,26-28	1-10,14-16,18-20,23-24,26,28	1-9,15,18-19,23-24,26,28	22	20	
E20	1-9,11-13,15-25,27	20	20	24	1	
E21	1,3,5-9,11-18,21-24,27	1-24,26,28	1,3,5-9,11-18,21-24,	20	27	
E22	1-13,15,17-18,21-22,24-25,27-28	1,3-4,6-7,9-14,16-28	1,3-4,6-7,9-13,17-18,21-22,24-25,27-28	22	24	
E23	1-3,5-6,8-9,11-13,15-16,18-19,21-25	1,3-12,14-16,18-21,23-28	1,3,5-6,8-9,11-12,15-16,18-19,21,23-25	19	24	II
E24	1-9.11-13,15-16,18-19,21-25,27-28	1.-28	1-9.11-13,15-16,18-19,21-25,27-28	23	28	
E25	1-6,8-11,13-18,22-25,27-28	1-3,7,11,13,15-18,20,22-28	1-3,11,13,15-18,22-25,27-28	22	18	
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E27	1-3,5-6,8-13,15-18,21-25,27-28	1-6,8-13,15,17,19-22,24-28	1-3,5-6,8-13,15,17,19,21-22,24-25,27-28	22	23	

E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level III						
E1	1-16,18,19,21-25,27	1.-28	1-16,18,19,21-25,27	24	28	
E2	1-9,11-13,15-19,21,24-27	1-20,22-28	1-9,11-13,15-19,24-27	22	27	
E3	2-19,21-25,27-28	1-10,12-28	2-10,12-19,21-25,27-28	26	27	
E4	1-9,11-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	
E5	1-3,5-9,11-13,15-19,21,23-24,27	1.-28	1-3,5-9,11-13,15-19,21,23-24,27	20	28	III
E6	1-3,5-9,11-16,18-19,21-24,27	1-12,15-28	1-3,5-9,11-12,15-16,18-19,21-24,27	21	26	
E7	1-9,11-19,21-25	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	
E8	1-3,5-9,11-13,15-19,21,23-24,27	1.-28	1-3,5-9,11-13,15-19,21,23-24,27	20	28	III
E9	1-9,11-19,21-24,27	1.-28	1-9,11-19,21-24,27	23	28	
E10	1-3,5-16,19,21-24,27	1,3,10,14,22,25-28	1,3,10,14,22,27	21	9	
E11	1-2,4-9,11-16,18,21-25,27	1-12,14-27	1-2,4-9,11-12,14-16,18,21-25,27	21	26	
E12	1-9,11-13,15-16,18,21-24,27	1-24,26-28	1-9,11-13,15-16,18,21-24,27	20	27	III
E14	1-5,7-16,18-19,21-24,26	1,3-4,6-7,9-11,14,16-17,21,25-26,28	1,3-4,7,9-11,14,16,21,26	22	15	
E15	1-9,11-13,15-19,21,23-25,27	1.-28	1-9,11-13,15-19,21,23-25,27	22	28	
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	
E17	1-3,5-9,11-18,21-22,24-25,27-28	2-5,7-9,15,17,20-22,25-28	2-3,5,7-9,15,17,21-22,25,27-28	22	16	
E19	1-9,11-13,15,18-19,21-24,26-28	1-10,14-16,18-20,23-24,26,28	1-9,15,18-19,23-24,26,28	22	20	
E20	1-9,11-13,15-25,27	20	20	24	1	
E21	1,3,5-9,11-18,21-24,27	1-24,26,28	1,3,5-9,11-18,21-24,	20	27	III
E22	1-13,15,17-18,21-22,24-25,27-28	1,3-4,6-7,9-14,16-28	1,3-4,6-7,9-13,17-18,21-22,24-25,27-28	22	24	
E24	1-9.11-13,15-16,18-19,21-25,27-28	1.-28	1-9.11-13,15-16,18-19,21-25,27-28	23	28	
E25	1-6,8-11,13-18,22-25,27-28	1-3,7,11,13,15-18,20,22-28	1-3,11,13,15-18,22-25,27-28	22	18	
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E27	1-3,5-6,8-13,15-18,21-25,27-28	1-6,8-13,15,17,19-22,24-28	1-3,5-6,8-13,15,17,19,21-22,24-25,27-28	22	23	
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level IV						
E1	1-16,18,19,21-25,27	1.-28	1-16,18,19,21-25,27	24	28	
E2	1-9,11-13,15-19,21,24-27	1-20,22-28	1-9,11-13,15-19,24-27	22	27	

E3	2-19,21-25,27-28	1-10,12-28	2-10,12-19,21-25,27-28	26	27	
E4	1-9,11-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	
E6	1-3,5-9,11-16,18-19,21-24,27	1-12,15-28	1-3,5-9,11-12,15-16,18-19,21-24,27	21	26	IV
E7	1-9,11-19,21-25	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	
E9	1-9,11-19,21-24,27	1.-28	1-9,11-19,21-24,27	23	28	
E10	1-3,5-16,19,21-24,27	1,3,10,14,22,25-28	1,3,10,14,22,27	21	9	IV
E11	1-2,4-9,11-16,18,21-25,27	1-12,14-27	1-2,4-9,11-12,14-16,18,21-25,27	21	26	IV
E14	1-5,7-16,18-19,21-24,26	1,3-4,6-7,9-11,14,16-17,21,25-26,28	1,3-4,7,9-11,14,16,21,26	22	15	
E15	1-9,11-13,15-19,21,23-25,27	1.-28	1-9,11-13,15-19,21,23-25,27	22	28	
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	
E17	1-3,5-9,11-18,21-22,24-25,27-28	2-5,7-9,15,17,20-22,25-28	2-3,5,7-9,15,17,21-22,25,27-28	22	16	
E19	1-9,11-13,15,18-19,21-24,26-28	1-10,14-16,18-20,23-24,26,28	1-9,15,18-19,23-24,26,28	22	20	
E20	1-9,11-13,15-25,27	20	20	24	1	
E22	1-13,15,17-18,21-22,24-25,27-28	1,3-4,6-7,9-14,16-28	1,3-4,6-7,9-13,17-18,21-22,24-25,27-28	22	24	
E24	1-9.11-13,15-16,18-19,21-25,27-28	1.-28	1-9.11-13,15-16,18-19,21-25,27-28	23	28	
E25	1-6,8-11,13-18,22-25,27-28	1-3,7,11,13,15-18,20,22-28	1-3,11,13,15-18,22-25,27-28	22	18	
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E27	1-3,5-6,8-13,15-18,21-25,27-28	1-6,8-13,15,17,19-22,24-28	1-3,5-6,8-13,15,17,19,21-22,24-25,27-28	22	23	
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level v						
E1	1-16,18,19,21-25,27	1-2,4-28	1-16,18,19,21-25,27	24	28	
E2	1-9,11-13,15-19,21,24-27	1-20,22-28	1-9,11-13,15-19,24-27	22	27	
E3	2-19,21-25,27-28	1-10,12-28	2-10,12-19,21-25,27-28	26	27	
E4	1-9,11-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	
E7	1-9,11-19,21-25	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	
E9	1-9,11-19,21-24,27	1.-28	1-9,11-19,21-24,27	23	28	
E14	1-5,7-16,18-19,21-24,26	1,3-4,6-7,9-11,14,16-17,21,25-26,28	1,3-4,7,9-11,14,16,21,26	22	15	
E15	1-9,11-13,15-19,21,23-25,27	1.-28	1-9,11-13,15-19,21,23-25,27	22	28	V
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	

E17	1-3,5-9,11-18,21-22,24-25,27-28	2-5,7-9,15,17,20-22,25-28	2-3,5,7-9,15,17,21-22,25,27-28	22	16	
E19	1-9,11-13,15,18-19,21-24,26-28	1-10,14-16,18-20,23-24,26,28	1-9,15,18-19,23-24,26,28	22	20	
E20	1-9,11-13,15-25,27	20	20	24	1	
E22	1-13,15,17-18,21-22,24-25,27-28	1,3-4,6-7,9-14,16-28	1,3-4,6-7,9-13,17-18,21-22,24-25,27-28	22	24	
E24	1-9.11-13,15-16,18-19,21-25,27-28	1.-28	1-9.11-13,15-16,18-19,21-25,27-28	23	28	
E25	1-6,8-11,13-18,22-25,27-28	1-3,7,11,13,15-18,20,22-28	1-3,11,13,15-18,22-25,27-28	22	18	
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E27	1-3,5-6,8-13,15-18,21-25,27-28	1-6,8-13,15,17,19-22,24-28	1-3,5-6,8-13,15,17,19,21-22,24-25,27-28	22	23	
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level VI						
E1	1-16,18,19,21-25,27	1.-28	1-16,18,19,21-25,27	24	28	
E2	1-9,11-13,15-19,21,24-27	1-20,22-28	1-9,11-13,15-19,24-27	22	27	VI
E3	2-19,21-25,27-28	1-10,12-28	2-10,12-19,21-25,27-28	26	27	
E4	1-9,11-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	
E7	1-9,11-19,21-25	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	
E9	1-9,11-19,21-24,27	1.-28	1-9,11-19,21-24,27	23	28	
E14	1-5,7-16,18-19,21-24,26	1,3-4,6-7,9-11,14,16-17,21,25-26,28	1,3-4,7,9-11,14,16,21,26	22	15	
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	
E17	1-3,5-9,11-18,21-22,24-25,27-28	2-5,7-9,15,17,20-22,25-28	2-3,5,7-9,15,17,21-22,25,27-28	22	16	
E19	1-9,11-13,15,18-19,21-24,26-28	1-10,14-16,18-20,23-24,26,28	1-9,15,18-1923-24,26,28,	22	20	
E20	1-9,11-13,15-25,27	20	20	24	1	
E22	1-13,15,17-18,21-22,24-25,27-28	1,3-4,6-7,9-14,16-28	1,3-4,6-7,9-13,17-18,21-22,24-25,27-28	22	24	
E24	1-9.11-13,15-16,18-19,21-25,27-28	1.-28	1-9.11-13,15-16,18-19,21-25,27-28	23	28	
E25	1-6,8-11,13-18,22-25,27-28	1-3,7,11,13,15-18,20,22-28	1-3,11,13,15-18,22-25,27-28	22	18	
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E27	1-3,5-6,8-13,15-18,21-25,27-28	1-6,8-13,15,17,19-22,24-28	1-3,5-6,8-13,15,17,21-22,24-25,27-28	22	23	
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level VII						
E1	1-16,18,19,21-25,27	1.-28	1-16,18,19,21-25,27	24	28	

E3	2-19,21-25,27-28	1-10,12-28	2-10,12-19,21-25,27-28	26	27	
E4	1-9,11-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	
E7	1-9,11-19,21-25	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	
E9	1-9,11-19,21-24,27	1.-28	1-9,11-19,21-24,27	23	28	
E14	1-5,7-16,18-19,21-24,26	1,3-4,6-7,9-11,14,16-17,21,25-26,28	1,3-4,7,9-11,14,16,21,26	22	15	VII
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	
E17	1-3,5-9,11-18,21-22,24-25,27-28	2-5,7-9,15,17,20-22,25-28	2-3,5,7-9,15,17,21-22,25,27-28	22	16	VII
E19	1-9,11-13,15,18-19,21-24,26-28	1-10,14-16,18-20,23-24,26,28	1-9,15,18-1923-24,26,28,	22	20	VII
E20	1-9,11-13,15-25,27	20	20	24	1	
E22	1-13,15,17-18,21-22,24-25,27-28	1,3-4,6-7,9-14,16-28	1,3-4,6-7,9-13,17-18,21-22,24-25,27-28	22	24	VII
E24	1-9.11-13,15-16,18-19,21-25,27-28	1.-28	1-9.11-13,15-16,18-19,21-25,27-28	23	28	
E25	1-6,8-11,13-18,22-25,27-28	1-3,7,11,13,15-18,20,22-28	1-3,11,13,15-18,22-25,27-28	22	18	VII
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E27	1-3,5-6,8-13,15-18,21-25,27-28	1-6,8-13,15,17,19-22,24-28	1-3,5-6,8-13,15,17,21-22,24-25,27-28	22	23	VII
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level VIII						
E1	1-16,18,19,21-25,27	1.-28	1-16,18,19,21-25,27	24	28	VIII
E3	2-19,21-25,27-28	1-10,12-28	2-10,12-19,21-25,27-28	26	27	
E4	1-9,1-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	
E7	1-9,11-19,21-25	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	
E9	1-9,11-19,21-24,27	1.-28	1-9,11-19,21-24,27	23	28	VIII
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	
E20	1-9,11-13,15-25,27	20	20	24	1	
E24	1-9.11-13,15-16,18-19,21-25,27-28	1.-28	1-9.11-13,15-16,18-19,21-25,27-28	23	28	VIII
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level IX						
E3	1-16,18,19,21-25,27	1-10,12-28	2-10,12-19,21-25,27-28	26	27	IX
E4	1-9,1-19,21-24,27	1-4,7,9,11-16,19-20,22,24-26	1-4,7,9,11-16,19,22,24	23	18	IX

E7	1-9,1-19,21-24,27	1-17,19-22,24,26,28	1-9,11-17,19,21-22,24	23	24	IX
E16	1-9,11-16,18-19,21-26	1-18,20-21,23-28	1-9,11-16,18,21,23-26	23	26	IX
E20	1-9,11-13,15-25,27	20	20	24	1	
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	
Level X						
E20	1-9,11-13,15-25,27	20	20	24	1	X
E26	1-19,21-28	2,14,16,19,26	2,14,16,19,26	27	5	X
E28	1-3,5-10,12-19,21-25,27-28	3,13,17,19,22,24-28	3,13,17,19,22,24-25,27-28	24	10	X

Appendix D: Sample AHP Questionaries'

Section 1: Demographic Information

General Profile of Respondents

1. Please, choose & circle the multiple-choice questions

No.	Demographic Factor	Response Options
1	Name of Organization	
2	Project Name	
3	Organization Type	☐ Government ☐ Private ☐ Both ☐ Other (Specify: ______)
4	Years of Experience in Construction	☐ <5 Years ☐ 5-10 Years ☐ 11-15 Years ☐ >15 Years
5	Position in the Organization	☐ Project Manager ☐ office Engineer ☐ Contractor ☐ Legal Advisor ☐ client/ owner ☐ consultant ☐ Contract Administrator ☐ site engineer ☐ Other (Specify: ______)
6	Higher Educational Qualification	☐ Diploma ☐ Bachelor's Degree ☐ Master's Degree ☐ PhD ☐ Other (Specify: ______)

Objective of the study: The general objective of this study is to identify and prioritize critical factors influencing Successful Scope management in design build construction project in Ethiopia

Method: Conduct a pair-wise comparison to identify the weight of several success factor, which are important to successful of Scope management in design build construction project in Ethiopia and to calculate an overall score of the factors using the Analytic Hierarchy Process (AHP).

Instruction: The respondent is required to compare these factors based on their importance to the successful Scope management in design build construction project in Ethiopia

Example

CASE 1: If you think, factor **"A"** is very important, than factor **"B"** circle or mark the numbers **"9"** **<u>to the left of the center</u>**

CASE 2: If you think factor **"B"** is very important, than factor **"A"** circle or mark the numbers **"9"** to **<u>the right of the center</u>**

A	Very important	Important	Moderate important	Slightly Important	Equal important	Slightly Important	Moderate important	Important	very important	**B**
	9	7	5	3	1	3	5	7	9	

CASE 1: If you think, factor **"A"** is very important, than factor **"B"**

CASE 2: If you think factor **"B"** is very important, than factor **"A"**

Categories	Success factor
1. Scope Definition & Planning	Scope and Contractual Clarity
	Adequate Plan and Detailed work breakdown structure (WBS)
	Project type and size
	Competency of the Consultants Company
	Type of Client (Private vs. Public)
	Size and Experience of the Client
	Early Contractor Involvement (ECI)

2. Stakeholder, Communication, and Satisfaction	Effective Communication
	Stakeholder Alignment and Collaboration
	Trust and Mutual Responsibility Among Stakeholders
	Involvement of All Stakeholders
	Social Environment
3. Risk Management & Change Adaptation	Proactive Risk Management
	Contingency Planning and Client's Preference for Risk Sharing
	Capability and Competency of Contractors
	Flexibility and Compliance with Regulatory system
	Consultant Experience and Accomplishment
	Experience and Skills of PM
4. Resource Management & Technological Integration	Adequate Resources
	Adequacy of Funds
	Optimal Use of Labor, Materials, and Financial Resources
	Contractor's Technique and Equipment Advancement
	Technological Environment
	Site Organization and Proper Crew Formation
	The Economic and Financial Situation of the Contractor
	Economic and Political Environment
5. Scope Control & Monitoring	Decision-Making Effectiveness of PM
	PM Authority and Involvement
	Single-Source Accountability
	Moderate Change Orders
	Contractor’s Experience with Similar Projects
	Use of Project Management Software for Real-Time Tracking
	Adequacy of the Planning and Change Control Mechanisms
	Consultant's Management Capability

1. Comparison of Categories of Critical Success Factors According to Their Impact on Success

	A	Very important	Important	Moderate important	Slightly Important	Equal important	Slightly Important	Moderate important	Important	very important	B
1	Scope Definition & Planning	9	7	5	3	1	3	5	7	9	Stakeholder, Communication, and Satisfaction
2	Scope Definition & Planning	9	7	5	3	1	3	5	7	9	Risk Management & Change Adaptation
3	Scope Definition & Planning	9	7	5	3	1	3	5	7	9	Resource Management & Technological Integration
4	Scope Definition & Planning	9	7	5	3	1	3	5	7	9	Scope Control & Monitoring
5	Stakeholder, Communication, and Satisfaction	9	7	5	3	1	3	5	7	9	Risk Management & Change Adaptation
6	Stakeholder, Communication, and Satisfaction	9	7	5	3	1	3	5	7	9	Resource Management & Technological Integration
7	Stakeholder, Communication, and Satisfaction	9	7	5	3	1	3	5	7	9	Scope Control & Monitoring
8	Risk Management & Change Adaptation	9	7	5	3	1	3	5	7	9	Resource Management & Technological Integration
9	Risk Management & Change Adaptation	9	7	5	3	1	3	5	7	9	Scope Control & Monitoring
10	Resource Management & Technological Integration	9	7	5	3	1	3	5	7	9	Scope Control & Monitoring

2. Comparison of Scope Definition & Planning Factors According to Their Impact on Success

	A	Very important	Important	Moderate important	Slightly Important	Equal important	Slightly Important	Moderate important	Important	very important	B
1	Scope and Contractual Clarity	9	7	5	3	1	3	5	7	9	Adequate Plan and Detailed work breakdown structure (WBS)
2	Scope and Contractual Clarity	9	7	5	3	1	3	5	7	9	Project type and size
3	Scope and Contractual Clarity	9	7	5	3	1	3	5	7	9	Competency of the Consultants Company
4	Scope and Contractual Clarity	9	7	5	3	1	3	5	7	9	Type of Client (Private vs. Public)
5	Scope and Contractual Clarity	9	7	5	3	1	3	5	7	9	Size and Experience of the Client
6	Scope and Contractual Clarity	9	7	5	3	1	3	5	7	9	Early Contractor Involvement (ECI)
7	Adequate Plan and Detailed work breakdown structure (WBS)	9	7	5	3	1	3	5	7	9	Project type and size
8	Adequate Plan and Detailed work breakdown structure (WBS)	9	7	5	3	1	3	5	7	9	Competency of the Consultants Company
9	Adequate Plan and **Detailed** work breakdown structure (WBS)	9	7	5	3	1	3	5	7	9	Type of Client (Private vs. Public)
10	Adequate Plan and Detailed work breakdown structure (WBS)	9	7	5	3	1	3	5	7	9	Size and Experience of the Client
11	Adequate Plan and Detailed work breakdown structure (WBS)	9	7	5	3	1	3	5	7	9	Early Contractor Involvement (ECI)
12	Project type and size	9	7	5	3	1	3	5	7	9	Competency of the Consultants Company

13	Project type and size	9	7	5	3	1	3	5	7	9	Type of Client (Private vs. Public)
14	Project type and size	9	7	5	3	1	3	5	7	9	Size and Experience of the Client
15	Project type and size	9	7	5	3	1	3	5	7	9	Early Contractor Involvement (ECI)
16	Competency of the Consultants Company	9	7	5	3	1	3	5	7	9	Type of Client (Private vs. Public)
17	Competency of the Consultants Company	9	7	5	3	1	3	5	7	9	Size and Experience of the Client
18	Competency of the Consultants Company	9	7	5	3	1	3	5	7	9	Early Contractor Involvement (ECI)
19	Type of Client (Private vs. Public)	9	7	5	3	1	3	5	7	9	Size and Experience of the Client
20	Type of Client (Private vs. Public)	9	7	5	3	1	3	5	7	9	Early Contractor Involvement (ECI)
21	Size and Experience of the Client	9	7	5	3	1	3	5	7	9	Early Contractor Involvement (ECI)

Appendix E: Sample ISM Questionaries'

Section 1: Demographic Information

General Profile of Respondents

1. Please, choose & circle the multiple-choice questions

No.	Demographic Factor	Response Options
1	Name of Organization	
2	Project Name	
3	Organization Type	☐ Government ☐ Private ☐ Both ☐ Other (Specify: ______)
4	Years of Experience in Construction	☐ <5 Years ☐ 5-10 Years ☐ 11-15 Years ☐ >15 Years

5	Position in the Organization	☐ Project Manager ☐ office Engineer ☐ Contractor ☐ Legal Advisor ☐ client⁄ owner ☐ consultant ☐ Contract Administrator ☐ site engineer ☐ Other (Specify: ______)
6	Higher Educational Qualification	☐ Diploma ☐ Bachelor's Degree ☐ Master's Degree ☐ PhD ☐ Other (Specify: ______)

Section II: interrelation between critical success factors

Objective of the study: The general objective of this study is to identify and find the interrelation between critical Successful factors in Design-Build Construction Project in Ethiopia

Instruction: The respondent is required to identify only the direct interrelationship between these factors based on which factor influence the occurrence of the other factor

CASE 1: If you think factor **"A"** influence "**B"** Mark the relation column by **"→"**

CASE 2: If you think factor **"B"** influence **"A"** mark the relation column by **"←"**

CASE 3: if you think, **both** factors influence **one another** mark the relation column by **"↔"**

CASE 4: If you think **both** factors, **do not** influence **one another** mark the relation column by "**X**"

	Relationship	
Case 1 "A"	→	**"B"**
Case 2 "A"	←	**"B"**
Case 3 "A"	↔	**"B"**
Case 4 "A"	×	**"B"**
A	Relationship	B
Social Environment		Effective Communication
Social Environment		Flexibility and Compliance with Regulatory system
Social Environment		Stakeholder Alignment and Collaboration
Social Environment		Involvement of All Stakeholders
Social Environment		Single-Source Accountability
Social Environment		Consultant Experience and Accomplishment
Social Environment		Contingency Planning and Client's Preference for Risk Sharing
Social Environment		Experience and Skills of PM
Social Environment		Trust and Mutual Responsibility Among Stakeholders
Social Environment		Moderate Change Orders
Social Environment		Technological Environment
Social Environment		Type of Client (Private vs. Public)
Social Environment		Adequacy of Funds
Social Environment		Capability and Competency of Contractors
Social Environment		Adequate Resources
Social Environment		Proactive Risk Management
Social Environment		Economic and Political Environment
Social Environment		Early Contractor Involvement
Social Environment		Optimal Use of Labor, Materials, and Financial Resources
Social Environment		Site Organization and Proper Crew Formation
Social Environment		Contractor's Technique and Equipment Advancement
Social Environment		Economic and Financial Situation of the Contractor
Social Environment		Size and Experience of the Client
Social Environment		PM Authority and Involvement
Social Environment		Consultant's Management Capability
Social Environment		Use of Project Management Software for Real-Time Tracking

Social Environment		Competency of the Consultants Company
Effective Communication		Flexibility and Compliance with Regulatory system
Effective Communication		Stakeholder Alignment and Collaboration
Effective Communication		Involvement of All Stakeholders
Effective Communication		Single-Source Accountability
Effective Communication		Consultant Experience and Accomplishment
Effective Communication		Contingency Planning and Client's Preference for Risk Sharing
Effective Communication		Experience and Skills of PM
Effective Communication		Trust and Mutual Responsibility Among Stakeholders
Effective Communication		Moderate Change Orders
Effective Communication		Technological Environment
Effective Communication		Type of Client (Private vs. Public)
Effective Communication		Adequacy of Funds
Effective Communication		Capability and Competency of Contractors
Effective Communication		Adequate Resources
Effective Communication		Proactive Risk Management
Effective Communication		Economic and Political Environment
Effective Communication		Early Contractor Involvement
Effective Communication		Optimal Use of Labor, Materials, and Financial Resources
Effective Communication		Site Organization and Proper Crew Formation
Effective Communication		Contractor's Technique and Equipment Advancement
Effective Communication		Economic and Financial Situation of the Contractor
Effective Communication		Size and Experience of the Client
Effective Communication		PM Authority and Involvement
Effective Communication		Consultant's Management Capability
Effective Communication		Use of Project Management Software for Real-Time Tracking
Effective Communication		Competency of the Consultants Company
Flexibility and Compliance with Regulatory system		Stakeholder Alignment and Collaboration

Appendix F: SPSS Software output

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DATASET ACTIVATE DataSet1.
DATASET CLOSE DataSet0.

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  /COMPRESSED.
NONPAR CORR
  /VARIABLES=Importance Influence
  /PRINT=SPEARMAN TWOTAIL NOSIG
  /MISSING=PAIRWISE.
```

Nonparametric Correlations

```
[DataSet1] F:\correlation 3.sav
```

Correlations

			Importance	Influence
Spearman's rho	Importance	Correlation Coefficient	1.000	.121
		Sig. (2-tailed)	.	.541
		N	28	28
	Influence	Correlation Coefficient	.121	1.000
		Sig. (2-tailed)	.541	.
		N	28	28

Correlations

			Importance	Influence
Spearman's rho	Importance	Correlation Coefficient	1.000	.121
		Sig. (1-tailed)	.	.270
		N	28	28
	Influence	Correlation Coefficient	.121	1.000
		Sig. (1-tailed)	.270	.
		N	28	28

```
SAVE OUTFILE='F:\cronbach alpha.sav'
  /COMPRESSED.
RELIABILITY
  /VARIABLES
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA
  /STATISTICS=SCALE CORR.
```

Reliability

```
[DataSet0] F:\cronbach alpha.sav
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	11	100.0
	Excluded[a]	0	.0
	Total	11	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.906	.913	114

Appendix G: Implications of each factor related to the design-build project scope

Major Theme	Factor	Justification for DB Construction Project Scope	Ref 1	Ref 2	Ref 3	Ref 4	Ref 5	Ref 6
1. Scope Definition & Planning	Scope and Contractual Clarity	Clear scope definition and Well-defined roles ensures that the design and construction teams are aligned from the start, reducing miscommunication and scope creep.	(Cho & Gibson Jr, 2001)	(Institute, 2021)	(El Wardani et al., 2006)	(Chan et al., 2016)	(Xu et al., 2018)	(Gransberg & Molenaar, 2019)
	Adequate Plan and Detailed work breakdown structure (WBS)	Detailed plans and specifications in DB projects clarify scope, prevent ambiguity, and align team's .A good WBS breaks the project into manageable tasks, reducing scope creep risks.	(Institute, 2021)	Kerzner and Saladis (2017)	(Flyvbjerg, 2014)	(Müller & Jugdev, 2012)	(Liu et al., 2017)	
	Project type and size	A project's type and size affect how complex its scope is and what resources are needed. Setting the scope based on these factors, helps match goals and ensures the project succeeds.	(Kerzner & Saladis, 2017)	(Guide, 2017)				
	Competency of the Consultants Company	Competent consultants ensure that the project scope is defined accurately and that potential issues are addressed early on.	(Liu et al., 2017)	(Chan et al., 2016)	(Flyvbjer g, 2014)			
	Type of Client (Private vs. Public)	The type of client (private or public) can affect the scope, as public projects may face more regulatory constraints or political considerations.	(Flyvbjer g, 2014)	(Ayele & Derseh, 2020)	(Tilahun, 2020)			

Major Theme	Factor	Justification for DB Construction Project Scope	Ref 1	Ref 2	Ref 3	Ref 4	Ref 5	Ref 6
1. Scope Definition & Planning	Size and Experience of the Client	Larger clients often have more complicated needs, so detailed scope planning is key to meet their goals. Experienced clients usually know exactly what they want, which helps avoid changes and keeps the project on track.	(Turner & Müller, 2003)	(Liu et al., 2017)	(Chan et al., 2016)			
	Early Contractor Involvement (ECI)	Integrating contractors early in the DB process reduces scope-related issues by leveraging construction expertise during the design phase, resulting in fewer scope changes and better alignment with client expectations.	(Müller & Jugdev, 2012)	(Ballard, 2000)	(Nahapiet & Ghoshal, 1998)	(Morris & Pinto, 2004)		
2. Stakeholder, Communication, and Satisfaction	Effective Communication	Communication across the design and construction teams is vital in DB projects to ensure alignment and address issues before they affect the scope.	(Cleland & Ireland, 2006)	(Turner & Müller, 2003)	(Crawford, 2014)	(Zwikael & Smyrk, 2015)	(Touran et al., 2010)	(Lee et al., 2022)
	Stakeholder Alignment and Collaboration	In Design-Build (DB) projects, keeping all stakeholders (like clients, designers, contractors) on the same page is key. Misaligned expectations can lead to costly delays or budget issues. Working closely together ensures the scope stays clear and everyone's goals are met.	(Chan et al., 2010)	(Touran et al., 2010)	(Gransberg, 2016)	(Molenaar et al., 2009)	(Osei-Kyei & Chan, 2015)	
	Trust and Mutual Responsibility Among Stakeholders	Building trust and mutual responsibility ensures stakeholders work together to adhere to the project scope, minimizing conflicts and scope changes.	(Crawford, 2014)	(Agistin et al., 2021)	(Tilahun, 2020)			

Major Theme	Factor	Justification for DB Construction Project Scope	Ref 1	Ref 2	Ref 3	Ref 4	Ref 5	Ref 6
2. Stakeholder, Communication, and Satisfaction	Involvement of All Stakeholders	Including all relevant stakeholders in decision-making processes ensures their needs are considered, and scope changes are minimized.	(Zewdu, 2021)	(Songer & Molenaar, 1996)	(Agistin et al., 2021)			
	Social Environment	Social factors shape stakeholder expectations, influencing the project scope and requiring alignment of interests.	(Shen et al., 2022)	(Hooshmand, 2020)	(Songer & Molenaar, 1996)	(Ayele & Derseh, 2020)		
3. Risk Management & Change Adaptation	Proactive Risk Management	Proactively identifying risks early in DB projects helps prevent unplanned scope changes, especially given the integrated nature of design and construction work.	(Kerzner & Saladis, 2017)	(Institute, 2021)	(Geraldi et al., 2011)	(Winch, 2010)	(Baccarini, 1999)	
	Contingency Planning and Client's Preference for Risk Sharing	Contingency plans address unexpected resource shortages to safeguard the project scope from disruptions caused by unforeseen challenges. Clients who collaborate with contractors through shared risk agreements minimize scope deviations by ensuring roles and responsibilities are clearly defined and upheld across the project lifecycle.	(Kerzner & Saladis, 2017)	(Liu et al., 2017)				
	Capability and Competency of Contractors	Skilled contractors are vital in DB projects, as their expertise ensures complex scopes are managed effectively while reducing risks of quality issues or deviations.	(Chan et al., 2001)	(Olawale & Sun, 2015)	(Morris & Pinto, 2004)	(Turner et al., 2009)	(El Wardani et al., 2006)	(Jugdev & Müller, 2005)

Major Theme	Factor	Justification for DB Construction Project Scope	Ref 1	Ref 2	Ref 3	Ref 4	Ref 5	Ref 6
3. Risk Management & Change Adaptation	Flexibility and Compliance with Regulatory system	A flexible regulatory system makes it easier to use approaches like Design-Build, keeping the scope on track without rigid rules. At the same time, following regulations avoids legal problems and scope changes that could cause delays or extra costs.	(Guide, 2017)	(Zewdu, 2021)	(Cooke-Davies, 2002)	(Ayele et al., 2021)		
	Consultant Experience and Accomplishment	Experienced consultants offer better guidance on managing scope, helping set realistic goals and reducing the risk of changes. Their record of accomplishment shows how well they can handle scope challenges and keep the project on track.	(Liu et al., 2017)	(Gransberg, 2016)	(Flyvbjerg, 2014)	(Hashem M. Mehany et al., 2018)		
	Experience and Skills of PM	Experienced project managers (PMs) handle complex Design-Build projects better by spotting and solving scope issues early, preventing risks or delays. A PM who inspires the team keeps everyone focused on the project's goals, reducing the chance of scope changes or distractions.	(Crawford, 2014)	(Turner & Müller, 2003)	(Müller & Jugdev, 2012)	(Toor & Ogunlana, 2008)	(Institute, 2021)	
4. Resource Management & Technological Integration	Adequate Resources	Ensuring that the necessary materials, labor, and equipment are available and aligned with scope requirements is essential for DB projects to avoid delays and cost overruns.	(Müller & Jugdev, 2012)	(Morris & Pinto, 2004)	(Turner et al., 2009)			
Major Theme	Factor	Justification for DB Construction Project Scope	Ref 1	Ref 2	Ref 3	Ref 4	Ref 5	Ref 6

4. Resource Management & Technological Integration	Adequacy of Funds	In DB projects, sufficient funding ensures that the defined scope can be executed without cutting corners, thus preventing scope reductions or project delays due to budget constraints.	(Olawale & Sun, 2015)	(Morris & Pinto, 2004)	(Turner et al., 2009)	(Baiden et al., 2006)	(Jugdev & Müller, 2005)	
	Optimal Use of Labor, Materials, and Financial Resources	Properly allocating resources, helps meet the project scope on time and within budget. Having skilled workers ensures the scope is executed as planned, preventing delays or quality problems caused by a lack of qualified labor.	(Kerzner & Saladis, 2017)	(Zewdu, 2021)	(Chan et al., 2016)	(Cooke-Davies, 2002)		
	Contractor's Technique and Equipment Advancement	The use of advanced techniques and equipment ensures that the project scope is completed efficiently and to a high standard.	(Kerzner & Saladis, 2017)	(Eriksson et al., 2017)				
	Technological Environment	The technological landscape influences the scope by offering tools and solutions that improve scope management, efficiency, and execution.	(Martínez-Aires et al., 2018)	(Lee et al., 2022)				
	Site Organization and Proper Crew Formation	Efficient site organization and skilled crew management ensures that the project scope is executed effectively, minimizing scope deviations.	(Koskela, 2000)	(Kerzner & Saladis, 2017)				

Major Theme	Factor	Justification for DB Construction Project Scope	Ref 1	Ref 2	Ref 3	Ref 4	Ref 5	Ref 6
4. Resource Management & Technological Integration	The Economic and Financial Situation of the Contractor	The financial stability of the contractor ensures they can allocate the necessary resources to meet the defined scope without risk of scope reductions or delays.	(Flyvbjerg, 2014)	(Hooshmand, 2020)	(Ayele & Derseh,			
	Economic and Political Environment	Economic conditions affect funding, costs, and scope, demanding flexibility to meet project goals. Political changes can influence regulations, resources, and funding, potentially altering the scope.	(Shen et al., 2022)	(Hooshmand, 2020)	(Songer & Molenaar,	(Ayele & Derseh, 2020)		
5. Scope Control & Monitoring	Decision-Making Effectiveness of PM	Effective and timely decision-making by the PM helps avoid scope deviations, keeping the project moving forward in alignment with the original scope.	(Zwikael & Smyrk, 2015)	(Eriksson et al., 2017)	(Kerzner & Saladis,	(Cleland & Ireland, 2006)		
	PM Authority and Involvement	A PM with authority can enforce scope control effectively in DB projects, ensuring that both design and construction teams stay on track and that the scope is adhered to throughout the project lifecycle.	(Turner & Müller, 2003)	(Touran et al., 2010)	(Institute, 2021)	(Zwikael & Smyrk, 2015)	(Bonke & Winch, 2002)	
	Single-Source Accountability	Design-Build projects benefit from having a single point of accountability, ensuring scope adherence and reducing confusion between designers and contractors.	(Gransberg & Molenaar, 2008)	(Liu et al., 2017)	(Guide, 2017)			

Major Theme	Factor	Justification for DB Construction Project Scope	Ref 1	Ref 2	Ref 3	Ref 4	Ref 5	Ref 6
5. Scope Control & Monitoring	Moderate Change Orders	DB projects benefit from controlled and predictable change orders to minimize scope creep and cost overruns. These changes should be reviewed carefully to avoid disrupting the overall project scope.	(Flyvbjerg, 2014)	(Cleland & Ireland, 2006)	(Walker, 2015)	(Koskela & Howell, 2002)		
	Contractor's Experience with Similar Projects	Contractors with experience in DB projects are better equipped to manage scope effectively and anticipate challenges that may arise during both design and construction phases.	(Crawford, 2014)	(Walker, 2015)	(Koskela & Howell, 2002)	(Ballard, 2000)	(Nahapiet & Ghoshal, 1998)	
	Use of Project Management Software for Real-Time Tracking	Real-time project management tools allow for better tracking of progress against the defined scope, helping to mitigate scope creep or deviations early on.	(Baiden et al., 2006)	(Cleland & Ireland, 2006)				
	Adequacy of the Planning and Change Control Mechanisms	Strong planning and control methods manage scope effectively, preventing creep or delays. In DB projects, evolving client needs require solid change control to handle scope changes systematically, avoiding cost overruns and delays.	(El Wardani et al., 2006)	(El Wardani et al., 2006)	(Olawale & Sun, 2015)	(Eriksson et al., 2017)		
	Consultant's Management Capability	A consultant's ability to manage the project ensures that scope is maintained, and issues are addressed without causing delays or scope creep.	(Liu et al., 2017)	(Crawford, 2014)				