QATAR UNIVERSITY

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FRAMEWORK FOR IMPLEMENTING DECISION TECHNIQUES IN CONSTRUCTION INDUSTRY; CONTRACTOR SELECTION GOVERANCE DECISION TECHNIQUES UNDER RISK-SHARING

BY

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ABSTRACT

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PhD Philosophy in Engineering Management

Title: Framework of Implementing Decision Techniques in Construction Industry; Contractor Selection Governance Techniques under Risk Sharing in Qatar

Supervisor of Thesis: Dr. Farayi Mushrifati.

Qatar's construction sector is growing rapidly and building ambitious infrastructure. Contractor selection is crucial to project success, quality, and cost. Effective decision-making is crucial in Qatar's unpredictable and costly building environment. The approach presented in this abstract improves contractor selection governance in Qatar's construction sector by concentrating on risk-sharing measures. This paradigm promises better project performance, less disagreements, and stakeholder participation.

To assesses the current state of knowledge in relation to contractor selection model (Design-Bid Build) and the key factors of particular interest to client organizations in Qatar Contractor selection criteria, decision makers, consultants, clients, and subcontractors are included in the framework development.

To achievement the goal of study many of hypotheses were tested titled as how the planning governance decisions will positively impact on the project planning criteria verification and validation decisions as positive relationship, and positively impact by the project bidding contractors' prequalification's criteria, and positively impact contractors' selection decision framework at the project planning phase, also the project contractor selection criteria will positively impact by the project contractors' prequalification governance decision, and fairly positively impacted by the project execution contractor selection risk agreement.

Self-report questionnaires were used to collect data from public and private sector organization (clients, consultants, contractors, and others familiar with Qatar building project contractor selection). Only 55 completed questionnaires were the base for computing the results. Several questionnaires completed by those who never had the focus discipline answer, and others non-responses, and the some with a lot of missing data were subtracted from the total sample size, all this type were excluded. A Statistical analysis was performed using SPSS Statistics software (version 21.0). Descriptive frequencies, percentage and graphs were calculated for the variables. Reliability and validity were used to evaluate the internal consistency of the questionnaires, and to achievement the hypotheses of study chi-square test, specially, Somers'd and Kendall's tau-c were used. It had been reached many results such as: the planning governance decisions will fairly positively impact on the project planning criteria verification and validation decisions as positive relationship (d=0.167, tau-test=3.854, p-value=0.000), and weak positively impact by the project bidding contractors' prequalification's criteria (d=0.075, tau-test=2.272, p-value=0.023), and fairly positively impact contractors' selection decision framework at the project planning phase (d=0.125, tau-test=0.604, p-value=0.000), also the project contractor selection criteria will moderate positively impact by the project contractors' prequalification governance decision, (d=0.355, tau-test=6.728, p-value=0.000), and fairly positively impacted by the project execution contractor selection risk agreement (d=0.248, tau-test=5.547, p-value=0.000).

***Key Words* :** *Project Validation, Contractor Prequalification, Risk-Sharing, Governance Decision, Contractor Selection, Design-Bid- built, FAHP.*

DEDICATION

The primary aim of this thesis is to investigate, analyze, and provide insight into the intricate dynamics of [Framework for implementing decision techniques in construction Industry; contractor selection Governance decision Techniques under Risk Sharing in Qatar]. Through comprehensive research, data collection, and critical examination, this study will endeavor to identify and assess the key factors, trends, and implications within this field, ultimately contributing to a deeper understanding of [Contractor Selection in Construction Industry]. By employing rigorous research methods and drawing upon a diverse range of data sources, this thesis seeks to advance knowledge, address existing gaps in the literature, and provide a valuable foundation for further inquiry and policy development in this critical domain.

ACKNOWLEDGMENT

I am grateful to my family for their unwavering belief in my abilities and their unwavering support. Your encouragement has been a constant source of strength and motivation.

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CHAPTER ONE: INTRODUCTION

1. Introduction

In the global construction sector, the process of contractor selection typically involves a rigorous prequalification procedure. This procedure may involve a comprehensive evaluation of various aspects of a contractor's qualifications, including their track records, financial capabilities, safety records, and technical skills. In addition, contractors are often required to provide references, demonstrate compliance with national and regional regulations and standards, and showcase their ability to effectively manage subcontractors. The objective in contractor selection is to locate and engage contractors that have a demonstrated history of successfully completing projects, a strong financial position, and a dedication to both quality and safety in their work. The logic behind prequalification lies in that the construction sector may improve project efficiency, mitigate risks, and foster long-term partnerships built on trust and reliability within the construction industry.

Choosing a contractor is critical for every customer or client representative involved in a construction project. Contractor performance is affected by various project construction risks and uncertainties due to the industry's relative complexity and challenges. Deviations by contractors from project specifications or milestones result in issues such as cost overruns, schedule delays, compromised quality, or reduced efficiency. These issues have a direct impact on the goals and objectives of customers, and they also expose customers to potential risks in construction projects.

To minimize the impact of project risks, construction managers use risk-sharing techniques. According to Ahmed and El-Sayegh, risk-sharing techniques have a direct bearing on the accomplishment of a project since they influences key performance metrics such as cost, quality, safety, and schedule (Ahmed and El-Sayegh, 2020). Therefore, choosing the appropriate risk-sharing method is one of the most important management decisions.

The facility coordination process is another important aspect of a construction project. The development and delivery of any project can be influenced greatly by the contracting process used. Coordinating the facility process from start to finish is essential since it is key to producing efficient outcomes and reduction of delays throughout the project.

Tendering bids is one of the most critical components of a construction project, as the right contractor can make or break the job. Open tendering, limited tendering, prequalification, direct order, or negotiation are methods commonly used for contractor selection. Clients often use prequalification as one way to reduce the risks of failures and improve the performance requirements of chosen contractors by internally maintaining project scope, planning, and risks.

To support transparent and fair decision making, as well as foster effective communication, governance is required in construction projects. Governance activities include authorizing, directing, empowering, and overseeing construction project management. Hence, it is necessary to implement an appropriately resourced governance structure. Project governance choices serve to effectively control and direct all facets of a project's life cycle. When these choices are carefully considered, based on knowledge and in accordance with the strategic goals of the organization, they greatly increase the probability of achieving project success.

1.1 Background

A project delivery technique is a framework that is used for the purpose of managing and carrying out a whole project, from beginning to end. It consists of the processes, procedures, and strategies that are used to organize and manage the many different project activities, resources, and stakeholders involved in the process of accomplishing project goals. The manner of delivery will dictate how the project will be planned, developed, obtained, built, and finally presented to the owner or customer of the project.

The delivery of a project may be accomplished through a variety of approaches, each of which comes with its own set of qualities and benefits. Construction management, design-build, design-bid-build, and integrated project delivery are all common delivery methodologies. The degree of cooperation between project participants, the order in which project stages are completed, the distribution of risks and duties, and the total amount of time allotted for the project might vary depending on which approach is used. The selection of a method for the delivery of a project is often determined by considerations such as the complexity of the project, the amount of control that is wanted, budget limitations, and the preferences and priorities of the project owner.

The phrase "delivery method" is used to describe the process through which roles are delegated and responsibilities are established between the many participants in a project's design, procurement, and construction phases (Oyetunji, 2006). Design-bid-build (DBB) is one of the most common construction industry delivery methods. However, others, such as Design-Build (DB) and Construction Management at Risk (CMR), are also viable options. When an owner employs DBB, they will issue two contracts: one with the consultant for the design phase and another with a construction specialist for the actual building to be done (Hale, 2009). In DB, on the other hand, one legal body is responsible for hiring both the consultant and the contractor, and one contract represents both parties' commitments to the project (Tenah, 2001).

Construction Management at Risk (CMR) is a delivery method in which the construction manager is hired during the design phase and is thus given the roles of project coordinator and general contractor (Akpan, 2014). Emerging delivery methods that emphasize collaboration, trust, commitment, and clearing include Integrated Project Delivery, Alliancing, and Partnering (Engebø,2020). These elements are essential in risk-sharing agreements. If the client trusts the contractor's work, they are more likely to understand and accept negative occurrences that may contribute to losses.

The project bidding alternative process discussed in this thesis considers a full spectrum of essential criteria for an effective evaluation and contractor selection that considers all essential processes and their capabilities during the project bidding (selection) stage. The proposed alternative process gives decision-makers a range of valid information to achieve the best decision for the selected prequalified contractor. Criteria provided includes questionnaires or commitment confirmation from the bidding contractors about their position on the tendered project. The contractors must document their current position, i.e., comply or deviate from each criterion during the bidding process.

Owners can select from several project delivery methods, the more common ones being DBB, DB, and CMR. Ideally, the method of delivering a project would be chosen depending on the characteristics with the highest correlation to the project's success. The list of success criteria has frequently been updated over the years due to numerous changes in the construction business, either by adding new variables or giving some factors more priority. Until the 1970s and 1980s, the delivery method was mainly chosen based on price. However, consumer expectations have changed since the 1980s, and they now call for greater cooperation and integration between project participants (Konchar,1998). Owners see a reduction in conflicts and modification orders due to improved communication, which results in fewer schedule delays and lower overall expenditures. Consequently, inclusion of variables such as communication, cost, and schedule growth were added to the selection list, as they facilitate a more practical choice of project delivery (Alhazmi, 2000).

1.2 Research Problem

In the selection of contractors, the DBB delivery process often used in the construction sector creates several challenges. First, this technique often promotes a climate of competitive bidding, in which the only factor that is considered when evaluating contractors is the price they have offered. Higher priority is placed on cost than other critical considerations such as qualifications, experience, and expertise. Therefore, the contract may be given to the contractors who submit the lowest price, even if they do not possess the requisite expertise or resources to effectively perform the project. This can result in lower quality work, delays in the project, and increased costs, negating any original savings. In addition, contractors may use shortcuts to stay within their financial limits. To reduce overall costs, they may resort to utilizing low-quality materials, hiring inexperienced workers, or trying to work at an accelerated pace. The result is poor workmanship, inadequate construction, and significant safety issues, weakening the overall quality and resilience of the project.

Another problem with the low bid technique is that it tends to attract contractors that purposely submit bids that are too low to be feasible, just to win the project. After winning the bid, these contractors then create competition between their subcontractors and suppliers, forcing their prices down. This may result in strained relationships with subcontractors, poor workmanship, delays in the procurement process, and the possibility of legal action. In addition, contractors jeopardize their profit margins because of low bid prices and then may find it difficult to keep their companies afloat, which will impact their capacity to finish the project on time and without going over their allotted spending.

1.3 Research Context

While there are many project delivery methods, the DBB method is still very common in developing countries. Observations, literature reviews, and experiences in construction projects show that the DBB project delivery method can be manipulated, thus resulting in sub-optimal performance. The DBB method must be supported by several techniques and practices, such as good governance and risk-sharing. Several studies have examined project risk management, but there is still a lack of understanding of how risk-sharing relates to contractor selection in various settings (Shi, L et al., 2010; Kubba, 2012). As part of a well-planned risk management strategy, precise risk assessment, estimation, and allocation are critical. It is this approach to risk assessment that can be used to improve the safety records of construction projects by allocating relative importance ratings to the many accidents that can occur during construction work. Especially in fast-growing nations, where multiple construction projects are underway simultaneously, the risk of contractors losing responsibility and customers suffering greater costs due to incorrect or insufficient risk-sharing and transfer increases.

A construction project involves many strategies to manage risks, including risk avoidance, risk transfer, risk reduction, and risk acceptance. In contrast, the construction project risk management process has several weak connections, including risk mitigation and risk response development (Subramanyan et al., 2012). With the consent of the contractual parties participating in the project, who must have knowledge of the associated risk responsibilities and the risks included, the completion of a task is dependent upon the assurance that there are sufficient risk management capabilities (Olsen & Osmundsen, 2005).

Various project contexts and scopes of development, as well as time and quality performance standards, have led to a widening differences in the distribution of risk responsibility and duties for contractors. Clients, consultants, suppliers, contractors, and subcontractors are all extensively engaged in building projects, each with its hazards.

One noticeable weakness in the process of selecting contractors is the reliance only on the criteria of inexpensive bid, without a comprehensive assessment of other aspects that might significantly impact both the cost and duration of the project. This fallacy is hypothetically illustrated in Figure 1.

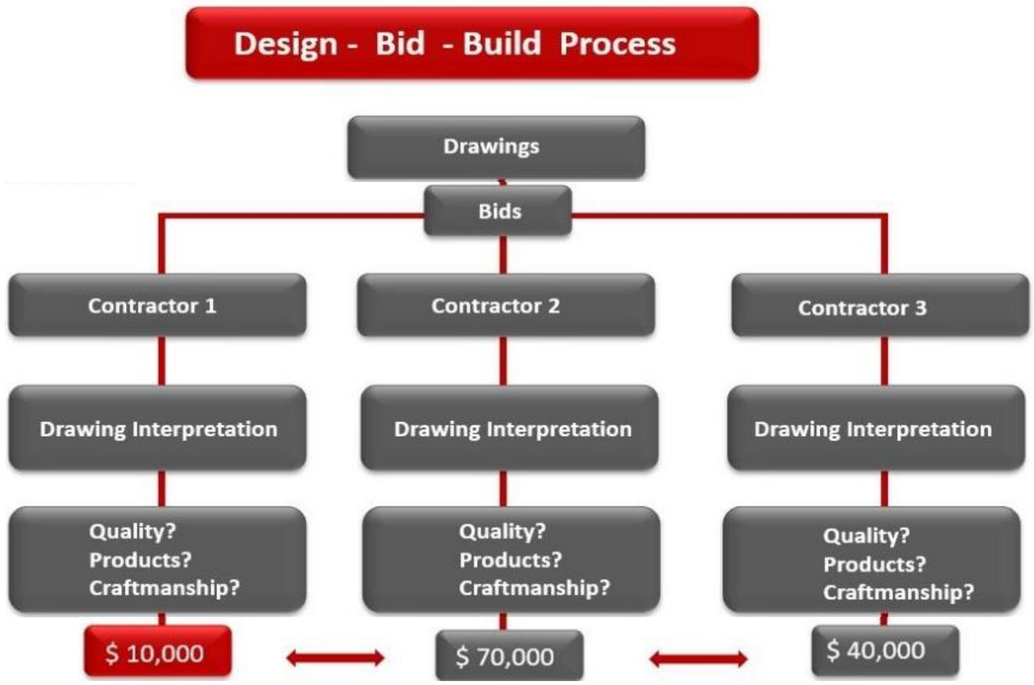


Figure 1. Hypothetical Fallacy in (Design-Bid-Built) Process

To avoid the fallacy in implementing DBB, this thesis argues that a comprehensive analysis of contractors during project planning and prequalification can resolve many issues. In addition to avoiding the selection of a less competent contractor, consequences such as cost overruns, schedule delays, compromised quality, or reduced efficiency can be avoided. In addition to comprehensive analysis of contractors, this thesis argues that the prequalification process be supported by an appropriately resourced governance structure and the contractor selection process should include a risk-sharing agreement. These inclusions are expected to improve project efficiency, reduce risks, and develop long-term partnerships based on trust and dependability.

1.4 Research Motivation

To solve the research problem discussed in section 1.2 and 1.3, a comprehensive framework for the contractor selection process is developed. The framework aims to address the limitations of the traditional contractor selection process in DBB project delivery methods. The traditional selection process often relies on subjective judgments and a less than comprehensive evaluation of contractors' capabilities and qualifications. By incorporating decision techniques, such as multicriteria decision analysis (MCDA), the framework is expected to provide a more objective and systematic approach to evaluate contractors based on predefined criteria and weightings. This motivation aligns with the industry's growing focus on evidence-based decision-making and the need for transparency and accountability in the contractor selection process (Assaf et al., 2020).

Furthermore, the motivation behind integrating risk-sharing into the contractor selection process is to foster a collaborative and mutually beneficial approach between project owners and contractors. Effective risk management and equitable risk allocation are crucial for project success and stakeholder satisfaction. The framework acknowledges the importance of considering risk-sharing mechanisms and contractual provisions during the contractor selection process to ensure that risks are appropriately allocated and managed (Alawneh et al., 2021). This motivation arises from the recognition that effective risk-sharing can lead to improved project outcomes, cost savings, and enhanced relationships between project stakeholders.

The framework for implementing decision techniques in the construction industry, specifically focusing on contractor selection governance decision techniques under risk-sharing, stems from the need to enhance the contractor selection process, promote objective decision-making, and foster effective risk management practices. The rationale behind developing a decision technique framework, with a particular focus on the governance of contractor selection under risk-sharing, arises from the need to improve the contractor selection procedure, facilitate impartial decision-making, and promote efficient risk management strategies. The framework addresses the limitations of traditional methods and aligns with the industry's growing emphasis on evidence-based decision-making, transparency, and collaboration. By incorporating risk-sharing and governance considerations, the framework aims to optimize contractor selection outcomes and improve overall project performance.

1.5 Aims and Objectives

1.5.1 Aims

The goal of construction industries worldwide is to improve efficiency and output indices. All business firms or governmental organizations seek lower costs for construction investments. This approach is usually expected to result in payback to the firm or the organization, such as cost savings or other benefits for their future income. Choosing the appropriate project delivery method is one of the most important management decisions because it directly impacts the project's success and benefits the client.

The aim of this study is to create a decision framework for the contractor selection process, identifying governance and risk-sharing as critical components in selection. The research will investigate how governance can be integrated into project planning verification and validation, as well as how governance can be integrated into contractor prequalification. Additionally, the various alternatives for achieving project cost stability, quality, efficiency, and sustainability will be explored. Finally, the importance of maintaining the defined plan during project execution under the risk-sharing approach will be addressed.

1.5.2 Objectives

To satisfy the aim, the following objectives will be pursued:

1. To identify the impact of governance decisions on the project planning process.
2. To identify the impact of governance decisions on the project contractor prequalification process.
3. To verify and validate the contractor selection decision process under governance and risk-sharing.
4. To analyze the impact of project planning governance decisions at the project planning phase.
5. To analyze the impact of governance on the project contractor's prequalification governance decision in the contractor prequalification phase.
6. To design and develop a framework for contractor selection under governance decisions and risk-sharing, and it impacts on construction projects.

1.6 Research Questions

The following research questions will be answered:

1. What are the impacts of governance decisions on the project planning process?
2. What are the impacts of governance decisions on the project contractor prequalification process?
3. What is the impact on contractor selection decision validation under governance and risk-sharing?
4. What is the impact of the project planning governance decision framework at the project planning phase?
5. What is the impact of governance on the project contractor's prequalification governance decision in the contractor prequalification phase?

6. What is the impact of designing and developing a framework for contractor selection under governance decision and risk-sharing on the project overall?

1.7 Hypothesis

Hypothesis 1: Project planning governance decisions will positively impact by project planning criteria verification and validation decisions.

Hypothesis 2: The project contractors' prequalification governance decision, will positively impact the project contractor selection criteria.

Hypothesis 3: Project bidding contractors' prequalification's criteria will be positively impacted by the project planning governance decision.

Hypothesis 4: project contractors' selection phase criteria will be positively impacted project execution contractor selection risk agreement.

Hypothesis 5: project planning governance decisions will impact contractors' selection decision framework at the project planning phase.

Hypothesis 6: Project planning validation decisions will impact positively by contractors' selection decision framework on contractor prequalification criteria.

1.8 Contribution

The framework for implementing a decision method in the construction industry will result in major contributions to the area. In particular, the emphasis of the framework is on integrating good governance in the contractor selection process under risk-sharing. This structure offers a methodical strategy for the selection of contractors, which ensures objective assessments and decision-making based on accurate information. It is possible for project stakeholders to take into consideration a greater number of elements and criteria when a decision method such as multicriteria decision analysis is included in the project (Gonzalez et al., 2020). The result is a more complete evaluation of the qualifications and capabilities of contractors. Thus, the overall quality, as well as the efficiency of the process of selecting a suitable contractor, is expected to improve.

The framework contributes to governance and monitoring of the contractor selection process in many contexts. It underscores the significance of having a strong objective inventory to guarantee compliance with risk-sharing agreements and to supervise the process of contractor selection. The framework makes it possible to conduct continuing assessments of the performance of chosen contractors and their adherence to risk-sharing agreements (Chauhan et al., 2021). Consistency is made possible by the strategic implementation of monitoring and evaluation procedures. This involvement strengthens commitment to responsibility, accountability, and openness, as well as commitment to ongoing improvement. The framework enhances risk management processes, supports fair risk-sharing, promotes effective governance and monitoring, and provides a methodical approach to the selection of contractors. These contributions make it possible for construction project leaders to improve their decision-making processes, reduce risks more effectively, and provide better results.

1.9 Summary of Research Process

The research started with a study of the literature on project planning and contractor prequalification phases. Data collection was done through a combination of questionnaire and interviews. This was followed by a statistical analysis, calculation of the relative significance index, and ranking of critical success factors. Next, a contractor selection decision-model using fuzzy analytical hierarchy process was developed. A mutual agreement between project owners and selected contractors was then proposed to solve risk-sharing problems and issues during project execution. Finally, discussion of the outcomes, conclusions, and recommendations for the construction industry in Qatar were outlined. A summary of the research process is illustrated in Figure 2. Details of the research methodology are provided in Chapter 3.

1.10 Outline of the Thesis

The study is organized into seven chapters. Chapter one provides the introduction to the thesis. Chapter two presents a literature review. Chapter three provides the research methodology adopted to achieve the research objectives. The development and validation of the proposed framework is presented in chapter four. Chapter five discusses a fuzzy AHP model for implementing the proposed framework. Chapter six presents the overall results and discussion. Chapter seven presents the conclusions and recommendations from this study.

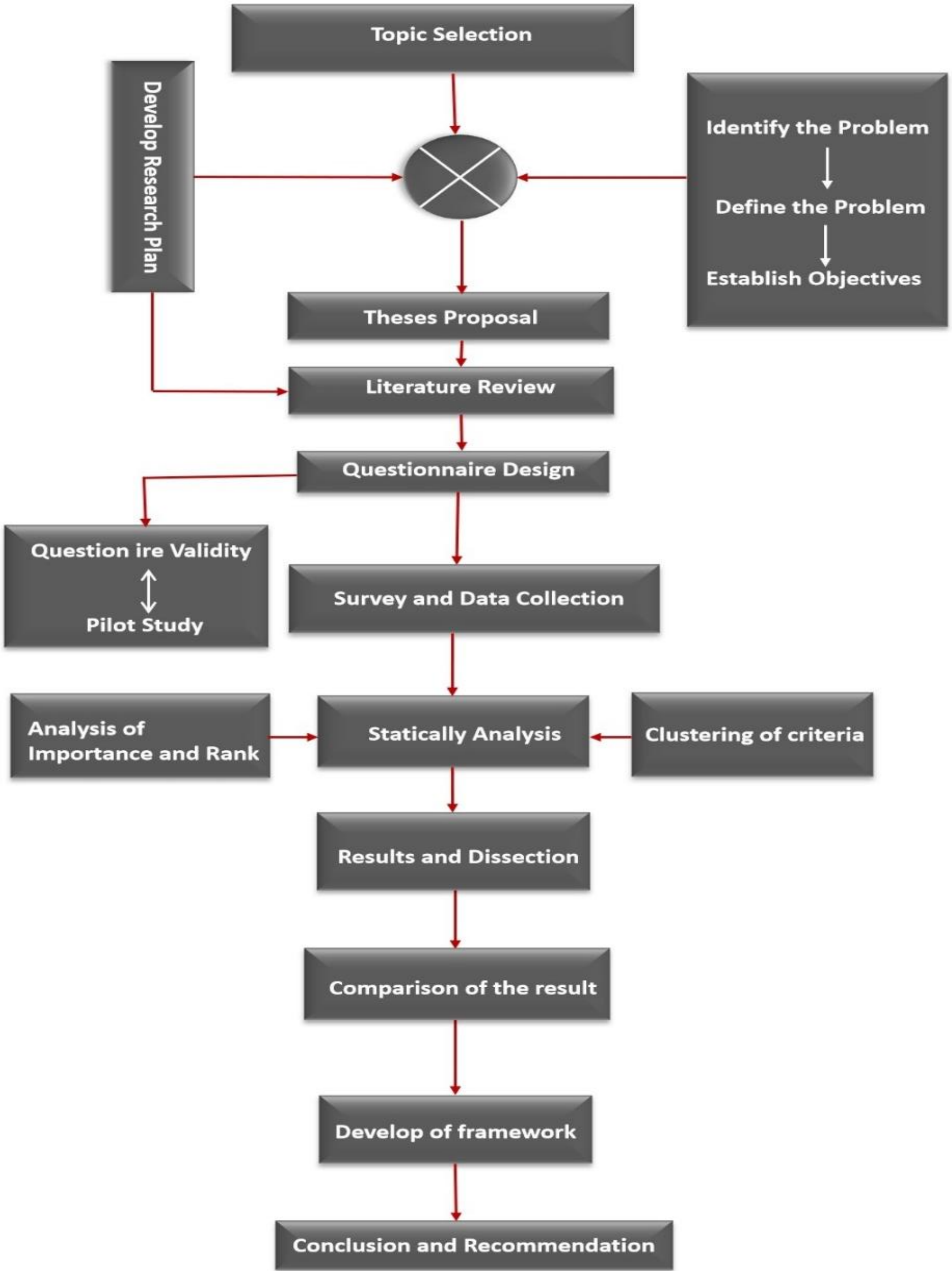


Figure 2. Illustration of the Research Process

Construction in developing countries is frequently beset by many issues, including weak contractor performance due to a lack of expertise, qualifications, and resources. The question is, why is the lowest bid criterion mandatory in public procurement? Evaluating public contracts, especially those characterized by their complexity (such as construction projects and public service contracts), solely based on the lowest bid price criterion is inappropriate. While a public contract may be submitted with the lowest bid price, it doesn't automatically guarantee the best quality in the delivered work or services. Therefore, it is not suitable to heavily rely on the lowest bid price assessment criterion when assessing the quality of work and services.

This thesis is about improving and enhancing the contractor selection process in construction projects. Contractor selection is an important aspect of construction projects. Hence, selecting contractors needs to be done during the initial stages of the project before sourcing the materials for the job. Contractor selection during the initial project stages is performed to maximize the project value and minimize the risk of missing critical components and materials (Shi, He, Onishi, & Kobayashi, 2019).

On the other hand, contractors take advantage of flaws in the bid process management system. This research examines the commonly used rules for bid evaluation and the criteria used by clients and consultants in selecting contractors during the bid review phase of construction projects. Contractor selection is a multicriteria decision-making (MCDM) issue that comprises numerous performance assessment criteria. Choosing the right contractors directly impacts the competitiveness of products and the long-term viability of businesses. Contractor selection has thus been extensively researched, as it is a crucial issue in the supply chain. To solve contractor selection challenges, many researchers have employed various calculation methods (Dotoli, Epicoco & Falagario, 2020).

Contractors are an important aspect of every construction project. Thus, choosing one is a crucial decision for any customer or client representative. The construction industry's relative complexity and difficulties exacerbate the many risks and uncertainties that contractors encounter, thus influencing their eventual performance levels. However, there is a potential for clients to not achieve their intended goals and objectives because of issues related to contractors, including problems with cost, scheduling, and quality. There are several methods available for choosing contractors, including open tendering, selective or restricted tendering, prequalification, and negotiation. Clients employ prequalification of contractors to minimize the risks and challenges described earlier, with the aim of enhancing the performance standards of the chosen contractors. This is done by setting minimum capacities that contractors must meet to be considered for the project.

The construction contract differs from most other forms of contracts in the industry due to several characteristics including the project's complexity, the duration and scale of the project, the price agreed upon, and the amount of work that may be adjusted as the project progresses. "The construction industry makes a significant contribution to the country's economic development" (Adnan et al., 2012). Due to its fragmented and transient character, the construction industry's capacity to manage its projects and contracts has long been difficult (Khuzaimah and Hassan, 2012). As a result, this chapter aims to analyze the associated research on managing the construction sector and its contracts. An introduction to the construction industry, contract management, construction management, and the contracting construction sector are all covered in this chapter. In addition, prior studies in the field will be reviewed and discussed in this chapter, together with the challenges of construction contracting management (Ibrahim, Erdogan et al., 2019).

The term “contract” has many definitions. "A contract is a written agreement that outlines the rights and responsibilities of involved parties, as well as the management of this engagement, all while providing protection against potential risks stemming from various associations, actions, and outcomes," according to one of the most prevalent definitions (Verster, 2006). According to Twort and Rees (2004), the contract binds the contractor to construct the works by establishing a legal agreement between the two parties regarding the obligations and liabilities.

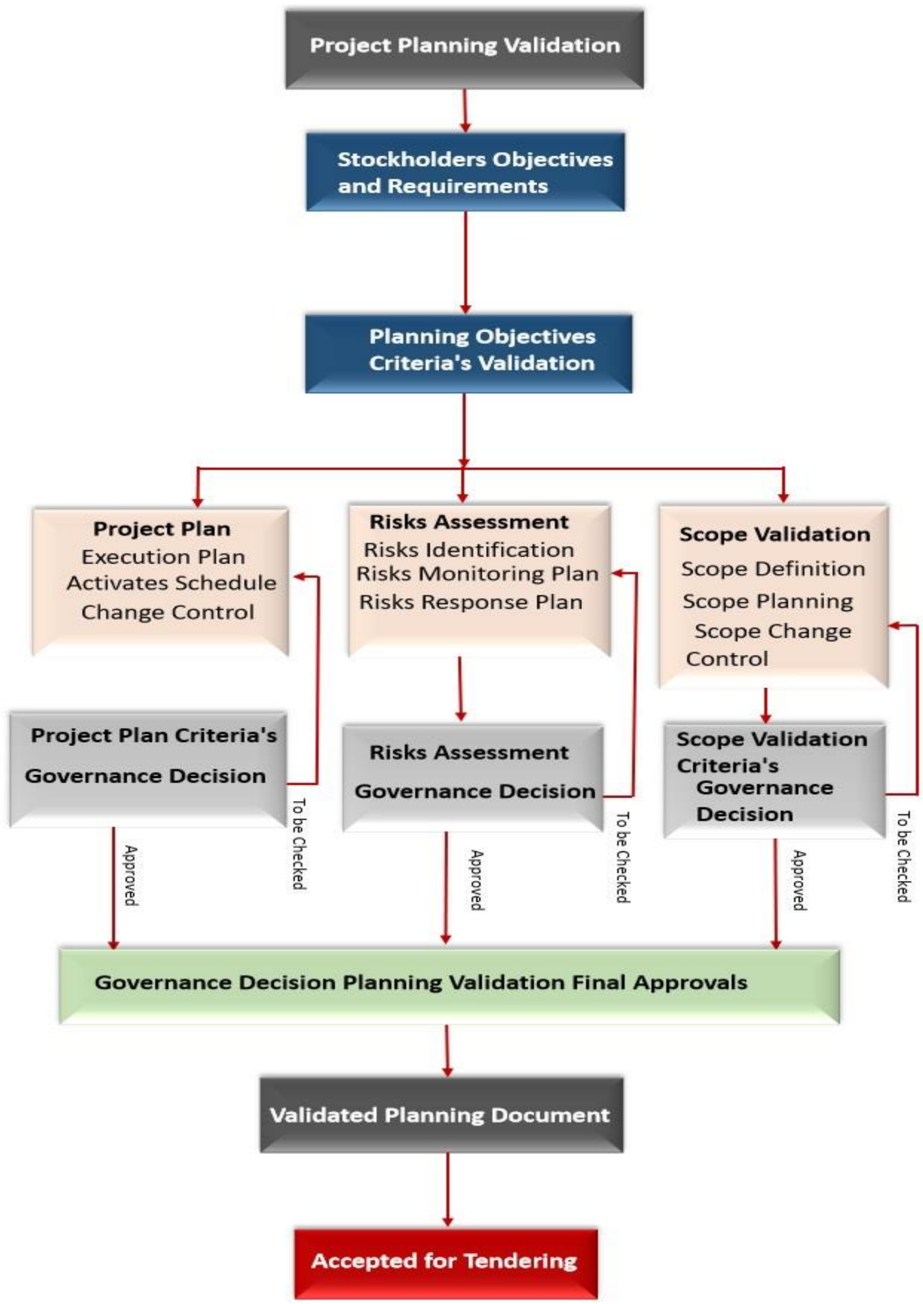
The client (sometimes known as the consultant) and the contractor are the contract parties for any construction project. The owner is the civil consulting works procurer; he usually begins the project and pays the contractor to build it according to the contract's specifications. The contractor is defined as the person whose tender has been accepted by the owner. For the contract, the consultant is appointed by the owner to function as the consultant. Owner, contractor, and consultant constitute a three-party system (Niraula and Kusayanagi, 2011).

2.1 Project Planning Validation

Project planning validation, as shown in Figure 3, implies verifying and validating the plan to ensure that it is complete, accurate, and achievable. It involves checking that the plan is consistent with the project goals and objectives; that all activities required to achieve those goals and objectives are identified; that the resources required to complete the activities are available; and that the plan is realistic and achievable within the constraints of the project. The validation process includes reviewing the project plan with stakeholders, identifying potential risks and issues, and making adjustments to the plan as necessary. It is essential to ensure that the project plan is valid and reliable because it sets the foundation for successful project implementation.

Project planning entails establishing the scope, objectives, and actions required to successfully finish a project with planning and risk. Typically, the process entails selecting project deliverables, developing a work breakdown structure, estimating resources and time, and developing a project timeline. The purpose is to create a plan for finishing the job efficiently and successfully.

Usually, governance processes and structures are put in place to ensure that a project is managed in accordance with the organization's aims and values. This can include establishing project management processes, identifying decision-makers, developing communication methods, and establishing performance measures. The objective is to guarantee that the project is overseen in a manner that optimizes the chances of achieving success while minimizing the potential for failure. Under the validation process, project decisions are reviewed and evaluated to ensure that they are based on accurate and complete information. They are aligned with the project's goals and objectives according to criteria, scope, risks, and plan, and they are consistent with the organization's values and policies. This can include analyzing the data and assumptions involved in each decision-making criterion, considering the potential risks and rewards, and verifying that the conclusion is compatible with the project plan and governance structure. The purpose of the project planning validation process with governance is to guarantee that decisions for project bidding are well informed and aligned with the broader goals of the project and the organization.



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2.2 Contractors Prequalification

The prequalified contractor will be allowed to bid on the project solely based on their responses to the investigated and accepted criteria by the bidders, as well as their standing against each of the following criterion:

- Determining the scope of the project's deliverables and need
- Setting a plan for completion of the project.
- Expertise in contractor management.
- Financial Stability of the Contractor.
- Procurement of contractors.

A prequalification process that is not specific to any particular project is employed to discern qualified contractors from a pool of interested candidates and categorize them according to their technical and financial capabilities, organizational and managerial proficiency, historical performance, adherence to occupational health and safety standards, environmental considerations, and even their approach to handling claims. The following are some of the objectives of this activity (Abdulquadri, Bilau, Witt & Lill, 2018; Ali, Mahdi Mohamed Abdulsamad, 2011) , which is aimed at aiding rather than replacing tender assessment:

1. To disqualify contractors who are not responsive, responsible, or capable.
2. To improve and/or ensure eligible contractors’ bidding possibilities.
3. To promote healthy competition among eligible bidders.
4. To reduce the risk of contractor failure and increase customer satisfaction.

5. To improve contractor selection by establishing a better balance of pricing and performance factors.

Clients would prefer to select bidders who are responsive, responsible, and knowledgeable, in addition to obtaining lower costs.

Contractors can undergo prequalification through two distinct methods: project-specific prequalification and regular prequalification, often referred to as registration. Project-specific prequalification is adaptable and tailors the evaluation to the precise project needs. In contrast, periodic prequalification (registration) remains unchanged throughout the registration or prequalification period. Nevertheless, this registration process can categorize eligible contractors into various capability groups based on their perceived competencies. For individual projects, shortlists may be derived from the pool of registered contractors by considering the latest information on their qualifications and the specific demands of the project. The sections that follow provide an example of some of the more organized prequalification procedures used around the world.

2.2.1 Contractors Prequalification for Bidding

Contractor prequalification, as shown in Figure 4, is a technique used by project owners or general contractors to review and assess the potential contractor’s qualifications before offering them a project or contract.

Typically, this procedure entails collecting evidence on the contractor's expertise, capabilities, financial stability, procurements, and other factors connected with that particular project or contract (similar to a project) and risk sharing involvements. This information is then used to establish whether the contractor is suitable for the project or contract and whether they meet the standards for bidding or participating in the project.

The process through which organizations review and evaluate a potential contractor's capacity to carry out a specific project is known as contractor prequalification. Assessments determine if a contractor has the skills, competence, resources, and ability to complete a project.

Organizations may reduce the risks associated with contractor selection, ensure that contractors fulfil their expectations, and enhance project delivery results by using a well-defined contractor prequalification governance decision process. Additionally, it guarantees that contractors are chosen using measured, objective criteria, preventing any possible moral and legal problems that would result from a subjective selection procedure.

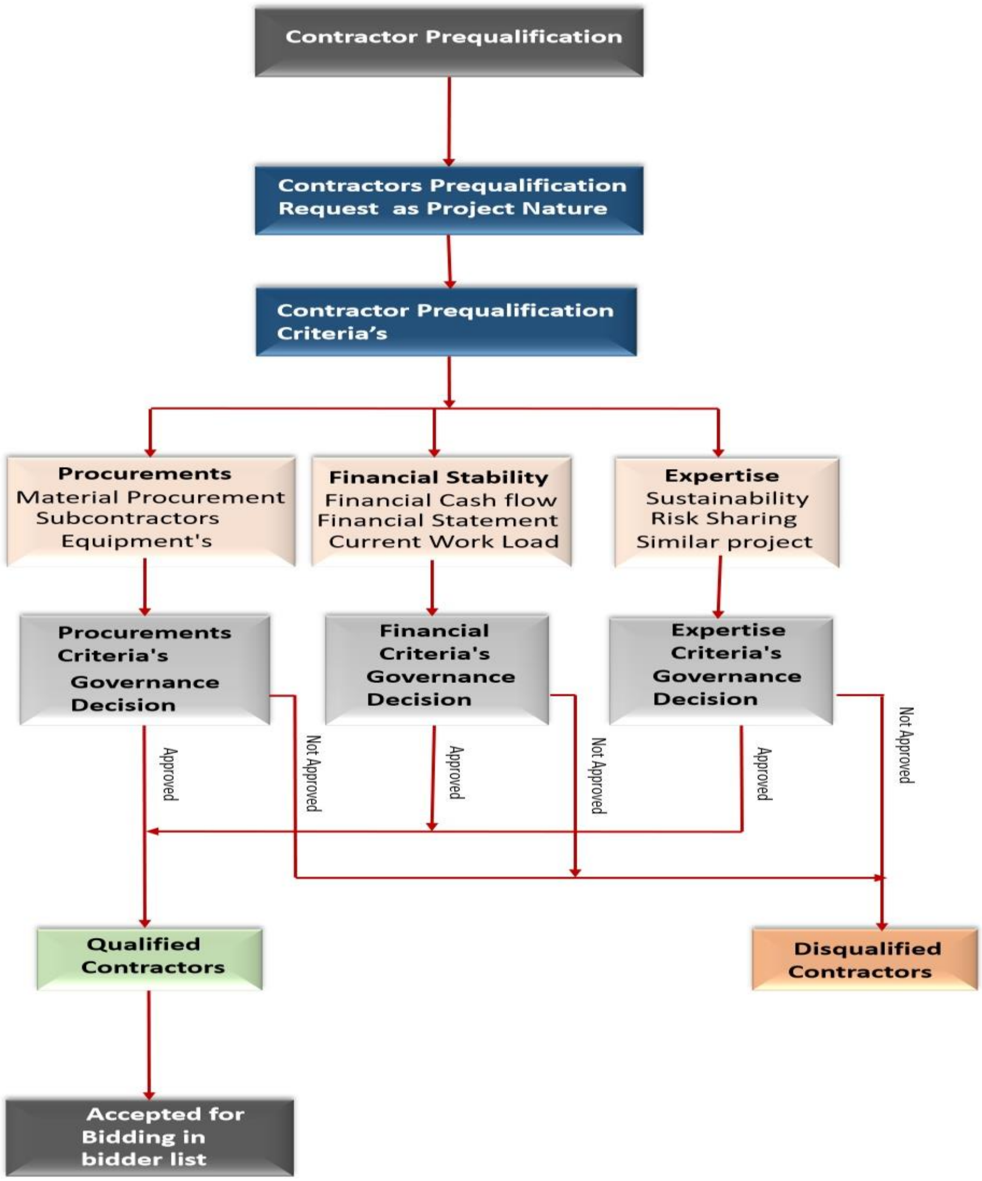

Figure 4. Contractors Prequalification

2.3 Contractor Selection

Contractor selection is the process of selecting the best contractor or supplier for a certain project or service contract (Figure 5). It entails analyzing and comparing various contractors based on several characteristics, such as experience, knowledge, reputation, cost, availability, and compliance with relevant laws and regulations.

Identifying project needs, establishing the scope of work, soliciting bids or proposals, shortlisting possible contractors, conducting interviews or site visits, reviewing proposals or quotes, and negotiating terms and conditions are common processes in the selection process.

The purpose of contractor selection is to choose a contractor who can perform the required quality of work within the stipulated schedule and budget, while avoiding risks, and guaranteeing compliance with relevant standards and regulations, as shown in Figure 5. To ensure the project's success, the selection process should be impartial, open, and based on sound criteria and considerations.

Organizations use a contractor selection delivery model to evaluate and select contractors for construction projects or service contracts. These models often include a set of criteria or factors which are used to evaluate a potential contractors skills and capabilities. A contractor selection model may take into account the following factors:

1. Experience and knowledge: This aspect considers the contractor's prior work experience, especially in related projects or services, as well as their level of skill in the field.
2. Financial stability: This element assesses the contractor's financial health and stability, including a study of their credit score, financial statements, and any outstanding debts.

3. Capacity and resources: This aspect investigates the contractor's ability to handle the project or service, such as availability, personnel size, and equipment resources.
4. Reputation and references: This factor evaluates the contractor's reputation in the business and may include contacting past clients for references.

5. Cost and value: This aspect assesses the contractor's projected cost for the project or service and compares it to the other variables to establish overall value. Based on objective criteria, a contractor selection delivery model can assist companies in making educated judgments about which contractor to hire for their project or service.

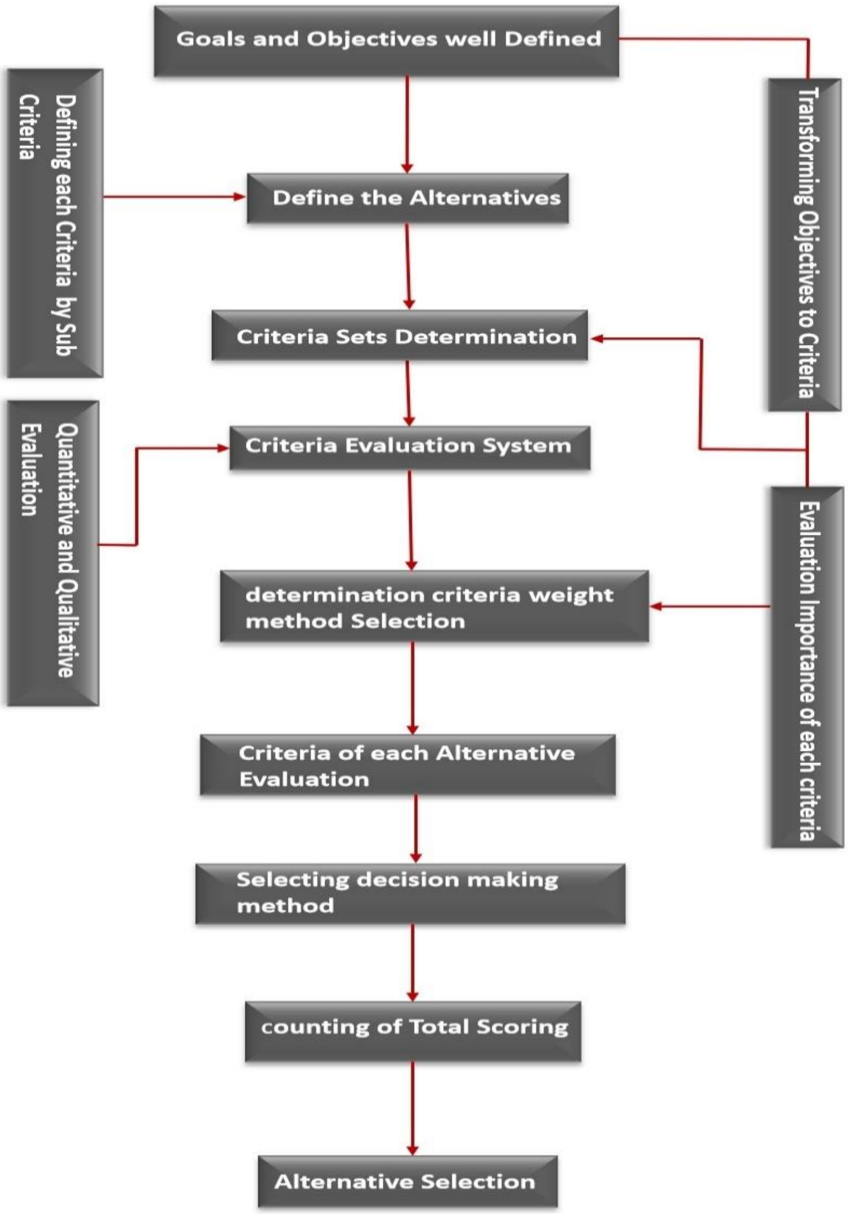

Figure 5.Contractor Selection Decision

2.3.1 Contractor Selection Procedures

A group of possible contractors, who would be invited to submit a proposal on a building project, are chosen through prequalification, a multivariate decision-making process. Prequalification is a preliminary, systematic approach used in the engineering, procurement, and construction sectors to preselect a group of contractors who bid on projects, work, commodities, and services based on criteria established by the client or his/here consultant. Contractors are requested to submit bids on construction projects if they are identified as possible bidders and have the skills necessary to fulfil the project's unique requirements. Decision inputs based on agreements between owners and consultants regarding a certain criterion may have an impact on prequalification choices (Russell, 1996; Hatush & Skitmore, 1997).

2.3.2 Contractor Selection Methods

Contractors are invited to submit a statement which contains information about their qualifications as the first stage in the selection process. Invitations can be extended privately or publicly. In general, contractors making bids for public projects must meet the following requirements:

- They should have the necessary municipal and/or state licenses to be able to execute the project.
- They should be able to provide bid and performance bonds as proof of financial capacity to engage in a contract.

The owner may seek the prequalification data shown below as a general checklist:

- Name, address, and company structure of the builder.

- Financial data, bonding capacity, and bank references as examples of business data.

- Experience in building, including the size, kind, performance on schedule, and budget of completed or ongoing projects.

- The payroll of employees by contractors vs. subcontracting.

Check List for Prequalification Details

The checklist of prequalification details may include the following:

- Rental vs. owned equipment.
- Safety documentation: written plan, practical experience.
- Quality control written software.
- Resumes of the most important executives and managers.
- The workload during bid and bonding capacity status.
- Personnel to be allocated to important managerial and field-supervision jobs.
- Provision of references from finished projects.
- Records of court cases.

Selection Method and Requirements

For use as a proposed general prequalifying statement or a contract-specific qualification statement, the Associated General Contractors of America (AGC) has created a preprinted form titled "Construction Contractor's Qualification Statement for Engineered Construction" (Briggs, Azhar, & Khalfan, 2020). The Associated General Contractors of America AGC is the leading association for the construction industry.

The owner may perform independent investigations into the contractor's credit standing, visit finished projects, speak with owners and operators, look at safety records, and consider additional performance capacity indicators while reviewing and analyzing the information provided.

2.3.3 Contractor Requirements

Private property owners are free to select the contractor they believe to be most qualified. The owner may compile a short list of prequalified contractors with the use of qualifying data, and these contractors will be required to:

- Make a competitive unit price or lump-sum offer for the work.
- Provide cost proposals so that a contract may be negotiated with reasonable conditions.

Public owners may use the qualification data to narrow down the potential bids.

2.3.4 Role of the FAHP in the Contractor Selection Decision Model

As an aid to decision-making, the analytic hierarchy process (AHP) was conceptualized by Thomas L. Saaty (1980). To do so, it uses the decision-own maker's weighted appraisal of the possibilities to determine how much weight to give to each potential course of action. The decision- own maker's judgments and the degree to which they are consistent in their evaluation of the various options are given considerable weight in this method. The AHP is frequently combined with other types of analysis, such as fuzzy logic, mathematical programming, and meta-heuristics (Ho, 2008).

When evaluating bids, the vast majority of decision-makers rely on their own prior knowledge and expertise, leading to a lack of structure and increased uncertainty. However, the AHP fails to accomplish its job because it ignores the fact that people's actual thought processes play a role in decision making. The fuzzy AHP approach has been widely used in the research community as a means of avoiding this difficulty. In the fuzzy AHP (also known as FAHP) model, which is based on fuzzy sets theory, the membership of the specified element is established by the membership function. A fuzzy decision variable's values are described by a membership function with a range from zero to one. In other words, the membership function is what establishes the threshold of ambiguity for the fuzzy decision variable. This tactic is most effective when the language aspects used in reaching a judgment are widely accepted, as is the case with expert opinion. Membership functions can take on a variety of shapes, including trapezoidal , and triangular ones (Chang, 1996).

The aforementioned features of AHP and FAHP have made them common tools for addressing problems of decision-making in numerous facets of construction management. Examples of where they were used include ranking and selecting alternatives in construction project management (Prascevic, 2017); selecting construction projects and conducting risk assessment (Taylana, 2014); assessing the efficiency of territorial units (Çalik, 2018); and creating an integrated discounting strategy in accordance with vendors' expectations (Ucal Sari, 2018).

Eligible contractors are chosen from a pool of interested applicants through a general (as opposed to project-specific) prequalification exercise and categorized based on their technical and financial capacity, organizational and managerial expertise, track records for past performance, occupational health and safety, environmental concerns, and occasionally even their attitudes toward claims. The following are some of the goals of this exercise, which are meant to supplement rather than replace the traditional method of evaluating bids:

1. To eliminate contractors who lack responsiveness, accountability, and competence.

2. To improve or guarantee bidding prospects for qualifying contractors.

3. To promote healthy competition among qualified contractors.

4. To avoid/minimize contractor failure risks and enhance client satisfaction.

5. To optimize contractor selection by obtaining a better price-to-performance ratio.

As important as it is to obtain the lowest possible price, customers often place a higher value on working with bidders who are quick to respond, accountable, and knowledgeable. Timely and accurate responses to the prequalification questionnaire are indicative of ‘responsiveness’. One way to test this is with a pass/fail binary decision exercise; another is to use a realistic and thoroughness scale.

The allocation of 'responsibility' to a contractor hinges on several variables, which encompass the contractor's historical performance, quality framework, affiliation with pertinent associations/groups, safety protocols, adherence to governing rules, standards, and regulations, as well as prior experiences with or willingness to participate in collaborative ventures. This means that the bidder’s responsibility can be evaluated based on their track records and reports from previous projects. Competency pertains to a bidder's financial capabilities, technical assets, machinery and facilities, personnel expertise, and organizational and managerial proficiencies, which empower them to undertake contracts typically granted by the specific organization (or a particular contract).

Bidders' abilities can be assessed in light of their resources, past performance, and capacity for handling the project at hand. Assessments of responsiveness, responsibility, and competency are elaborated (Palaneeswaran,1999). It summarizes the main features of this responsiveness, responsibility, and competence (RRC) architecture that might be applied to contractor prequalification. It is possible to prequalify bidders for individual projects or to register them for regular use (often once a year). Project-specific prequalification is characterized by its adaptability as it can cater to the unique criteria of each project, whereas periodic prequalification (registration) remains constant throughout the registration or prequalification period. Contractors with recognized abilities may be categorized into various tiers of labor competency based on their demonstrated skills. Updated information on the registered contractors and any unique project requirements may be utilized to create shortlists from the registered lists which show some of the more formal approaches to prequalifying contractors that are in use around the world .

2.4 Bidding / Tendering Process

2.4.1 Selection Method and Requirements

To serve as either a general prequalification statement or a contract-specific qualification statement, the AGC (American General Contractors), which is the primary organization for the construction sector, has developed a pre-designed document known as the "Construction Contractor's Qualification Statement for Engineered Construction" (Briggs, Azhar, & Khalfan, 2020). The client has the option to conduct separate assessments of the contractor's financial stability, inspect completed projects, communicate with previous project owners and operators, evaluate safety track records, and assess supplementary performance capacity metrics when scrutinizing and assessing the furnished information.

2.4.2 Contractor Requirements

Private property owners are free to select the contractor they believe to be most qualified. The owner may compile a short list of prequalified contractors with the use of qualifying data, and these contractors will be required to:

- Make a competitive unit price or lump-sum offer for the work.
- Provide cost proposals so that a contract may be negotiated with reasonable conditions

The qualification data may be used by public owners to narrow down the potential bids.

2.4.3 Competitive Bidding for Selection

For genuine price-competitive bidding, there are two requirements:

1. A set of building plans, specifications, and other proposed contract papers that are clear and succinct. (The product to be delivered must be specified.)
2. An outlined method for awarding bids (to provide a systematic approach), by offering a methodical strategy to soliciting bids and selecting the winning bidder. The bidding process safeguards both the owner and the bidders.
    - The extent of the designer's involvement in the bidding process is established through the professional services agreement with the client. In a standard arrangement, the architect:
    - Develops plans, specifications, bid materials, and cost estimates for the owner's review and endorsement.
    - Assists the owner in acquiring quotations or pricing proposals for each contract to be awarded.

- Aids the owner in assessing bids or proposals and in making contract selections.

2.4.4 Competitive Public Work Bidding

For projects involving the federal, state, or municipal governments, competitive bidding is frequently required by law or administrative rules. The bundle of documents provided to potential bidders defines various rules and criteria in addition to the broad mission. These documents often consist of the following:

- Documentation must be submitted with bids (e.g., invitation to bid, instruction to bidders, information for bidders, and bid forms).
- The owner/contractor agreement, performance and payment bonds, bid or proposal, general conditions, drawings, specifications, supplemental conditions, addenda, and modification or additional work orders are a few examples of documents detailing the contractor's performance.

2.4.5 Owner's Public Work Bidding Procedures

A competitive bidding system requires particular steps before the bid opening, throughout the bid opening process, and after the bid opening to recruit and notify bidders, receive and analyze bids, and award contracts. The owner conducts these tasks with the designer, a lawyer, and other advisors.

2.4.6 Private Work is Sold Competitively

The owner in the private sector can use broadly the same methods for obtaining competitive bids as those described for the public sector. The owner may limit participation to prequalified bids on a limited list or extend an invitation to a wide range of the construction sector. In most cases, the owner and bidders depend on well-stated bidding and contract agreements, which will be prepared by the designer.

2.4.7 Procedure for Selecting Competitive Negotiated Contractors

In cases where structured price bidding isn't suitable, the owner initially assesses the qualifications presented by interested contractors, selects the contractor who best aligns with the project's criteria based on predefined standards, and subsequently engages in negotiations for a construction contract with that entity or individual. While negotiated lump-sum or unit-price agreements are not excluded, this approach typically leads to a type of reimbursable cost-plus-fee contract. When closer competition related to construction or design-build services is necessary, the owner assembles a list of contractors based on their qualification evaluations. The owner then solicits proposals from these listed contractors to address specific issues specified by the owner, distinct from the earlier contractor prerequisites. With this information in hand, the owner evaluates the project's organizational and financial aspects and engages in contract negotiations with the contractor whose proposal is deemed the most comprehensive in their judgment.

2.4.8 Noncompetitive Negotiated Contractor Selection (Direct Order)

The owner has the option to select a particular contractor and subsequently engage in contract negotiations. The choice of the contractor can be influenced by their past performance on previous projects for the owner.

- The contractor can be uniquely qualified to complete the task.
- The contractor is already at the location doing work.
- Given the seriousness of the issue, quick action is needed.

- When a governmental agency selects a lone source for a contract, the contractor may have distinctive qualities. (For instance, a good rapport with the owner, specialized knowledge, and accessibility to handle an emergency immediately).

This also calls for additional inspections to be made throughout the tender assessment process. The prequalification process seeks to identify organizations that are appropriate for particular types of work, although it is true that the same organization operates differently in various situations. Many clients frequently disregard this axiom, and in such cases, the main worry may be financial qualification alone, regardless of the workload and other possible performance factors.

Some customers combine contractor prequalification and bid awards with contractor performance (by including the evaluation of contractor qualities either using weighted scoring or including it as a contributory component in the prequalification/bid evaluation calculation).

2.5 Bidding Types

Many issues and dilemmas confront contractors in determining profit margins in competitive bidding situations when high-priced offers are submitted to maximize profit margins, which sometimes results in failing to win the contract and experiencing a labor shortage. Alternatively, the executor may offer a low price that wins the contract but leaves a small profit margin. The relationship between the greatest project and the prospect of being the contractor with the lowest tender could turn into a guiding method for selecting the best offer. As a result, it is critical to examine contractor bidding patterns and compare the results to the company's own predicted execution costs over several contracts

(Ashworth, 2008). Tender types are divided into three categories: negotiations, open competition, and closed competition. They will now be discussed in more detail.

2.5.1 Open Tendering

This strategy allows contractors who do not satisfy the basic qualifications to participate and submit a tender (Ashworth, 2008). If the number of offers grows too large, unsuitable contractors are deleted from the list (Ashworth, 2013). Contractors may make proposals for a project via the open tendering system. The customer delivers a short project overview before allowing suitable individuals to submit (Grant, 2003).

2.5.2 Closed Tendering

This is known as the traditional approach and continues to be the most prevalent method for granting construction contracts. The number of organizations requested to tender for the work is normally limited to six under this procedure. The project team invites only a few selected organizations with a high reputation (Ashworth, 2008). Only a predetermined list of organizations receives the invitation to tender. This sort of tender begins with two or more organizations, with the benefit of a closed tender being simple and quick to set up. The public's objection to keeping the tender closed is usually a weakness of closed tenders (Khairy, 2010).

2.5.3 Tender for Negotiation

The construction tender negotiation procedure could be utilized instead of the tendering process. If the client has sufficient construction experience, the client's representative can ask one company to set up a shop and submit a bid, after which the parties will discuss the terms of the deal. If the negotiation is successful, the contract's construction will be completed. If it is not, another executor may be asked to submit a plan, and the process may be repeated (Bennett, 2003). The contracting parties can negotiate all aspects of the tenders as part of the procedure in this type of tender (Euclid Infotech Pvt Ltd, 2012). It usually happens when a client contacts a single contractor based on their requirements.

2.6 Bidding Strategy

Many issues and dilemmas confront contractors in evaluating profit margins in competitive bidding situations when high-priced offers are submitted to maximize profit margins, which sometimes results in failing to win the contract and experiencing a labor shortage. Alternatively, the executor may offer a low price that wins the contract but leaves a small profit margin. The link between the greatest project and the prospect of being the lowest tenderer might turn into a guiding method for picking the best offer. As a result, it is critical to examine contractor bidding patterns and compare the findings to the company's own predicted production costs over several contracts (Ashworth, 2008).

2.7 Risk-sharing Agreement in the DBB Delivery Method

The construction project management literature has recently focused on the concept of risk sharing agreements in the context of the design-bid-build (DBB) delivery method, specifically in relation to the low bid approach, A study by Fong et al. (2017) highlights the importance of risk-sharing methods in DBB projects, showing how they can help reduce disputes and improve project outcomes. In a similar way, Zayed and El-Badry's (2014) piece talks about how important risk-sharing agreements are for a project's success, focusing on how they help align stakeholders' incentives and responsibilities. The DBB approach is commonly associated with a distinct division of design and construction tasks Christopher Ennis, Randall S(2015). Deutsch However, it is acknowledged that such deals are necessary to help people work together and make sure that project risks are shared fairly (Fong et al., 2017; Zayed & El-Badry, 2014), and that risk sharing agreements can be deliberately utilized to distribute risks and responsibilities among the various stakeholders involved in the project. The primary objective of these agreements is to facilitate and strengthen collaboration among stakeholders, minimize the occurrence of possible conflicts, and foster the achievement of project objectives.

Risk sharing agreements in DBB projects have been acknowledged by scholars for their potential advantages. Turner (2016) posits that risk sharing agreements serve to enable the proactive identification and distribution of risks to the parties that possess the most suitable capabilities for their management. These agreements can be especially advantageous in situations involving low bids, as the contractor's primary objective may be to minimize expenses. Through the establishment of clear agreements, stakeholders have the ability to define their respective duties and risks. This technique helps people match their objectives with project goals and prevent conflicting interactions. Risk pooling agreements may foster collaboration, which makes risk management more comprehensive in design and building projects, according to Goh and Love (2015).

The literature highlights the potential benefits associated with risk sharing agreements in DBB projects. However, it is crucial to acknowledge that the actual execution and efficacy of these agreements may exhibit variability. In their study, Aydogan (2005) examines the topic of risk management within various delivery systems. The crucial role of clear contract language, collaborative efforts between parties, and the alignment of incentives in ensuring the effectiveness of risk sharing agreements are emphasized. Furthermore, O'Brien and Fischer (2017) agree that the utilization of the low bid technique may provide difficulties in terms of risk sharing, mostly due to the competitive aspect inherent in the bidding process. However, gaining a comprehensive awareness of the potential advantages and constraints associated with risk sharing agreements in the DBB framework provides useful insights for professionals aiming to enhance project results.

The investigation of risk sharing agreements in the context of the DBB delivery method, specifically in relation to the low bid strategy, has garnered scholarly interest in the field of construction project management. For building projects that use the DBB delivery method, it is important to have effective risk-sharing tools to control how risks are shared among the project's partners. In the past, DBB has been linked to a more hostile way of dividing up risk, with owners usually taking on a large part. Recent trends, on the other hand, show how important joint risk-sharing deals are. Researchers such as Matin et al. (2019) have looked at how well-structured risk distribution methods can lead to better project performance and cost control in DBB. The DBB method is commonly known for its well-defined stages and the division of design and construction responsibilities. However, there is an increasing acknowledgment that risk sharing agreements can have a significant impact in reducing uncertainties and promoting collaborative relationships among stakeholders involved in a project. Such deals try to ensure that risks are shared more fairly among owners, workers, and designers. This encourages better teamwork and makes it less likely that there will be disagreements while the project is being carried out (Winch, 2010) Using information processing to manage building projects. (John Wiley and Sons). As building methods change, risk-sharing deals continue to be an important part of making sure that DBB projects turn out well. The purpose of these agreements is to distribute risks and duties in a way that facilitates efficient risk management and improves project results.

Academic researchers have conducted investigations into the potential suitability and advantages of using risk sharing agreements in DBB projects. A framework for risk management in various project delivery methods, including DBB, was proposed by Nabeel, Sameh and Tarek (2016), . The authors contend that the strategic utilization of risk sharing agreements can effectively distribute risks to the parties most capable of managing them, resulting in enhanced project performance. The aforementioned notion is consistent with Turner's (2016) assertion regarding the importance of well-defined risk allocation procedures to prevent adversarial relationships and foster a collaborative project environment.

The existing body of literature indicates the potential benefits associated with risk sharing agreements while also recognizing the difficulties that may arise during their implementation. In their scholarly work, O'Brien and Fischer (2017) examine the subject of risk management within the bidding process, shedding light on the potential hindrance to effective risk sharing posed by the competitive nature inherent in the low bid strategy. However, the study conducted by Goh and Love (2015) regarding risk management in design and build projects suggests that the utilization of risk sharing agreements can effectively align incentives and improve collaborative risk management endeavors, even in the setting of DBB projects. It is worth noting that although the DBB (low bid) delivery method has historically involved a separation of duties, there is an increasing acknowledgment of the possible advantages associated with risk sharing agreements.

These agreements possess the capacity to facilitate cooperation, bolster risk mitigation endeavors, and harmonize stakeholder motivations, making a valuable contribution to the overall achievement of building projects. Nonetheless, the efficacy of these measures is contingent upon the presence of unambiguous contractual language, a harmonious project setting, and stakeholders' readiness to collectively assume and handle risks.

2.8 Risk-sharing Implementation Assessment under Governance in Construction

2.8.1 Project Risks Definition

Project risks include potential events or circumstances that possess the capacity to exert a negative influence on the achievement of project goals, thereby influencing its objectives, timeline, financial resources, or level of excellence. The risks mentioned previously may originate from a variety of sources, encompassing technical intricacies, shifts in organizational dynamics, environmental influences, market ambiguities, and potential human fallibility. The identification and management of project risks are essential components of effective project management, as they serve to minimize unfavorable outcomes and enhance the probability of project achievement. Risk management encompasses various processes, as outlined by the Project Management Institute (PMI), including the identification, analysis, response planning, and monitoring of risks throughout the entire project lifecycle (PMI, 2017). Through proactive risk management, project managers are able to make well-informed decisions, allocate resources efficiently, and bolster the project's ability to withstand potential setbacks, thereby ultimately contributing to the successful completion of the project.

2.8.2 Risk-sharing Definition

Risk-sharing is a risk management tactic that encompasses the distribution of risks and obligations among various stakeholders engaged in a project or commercial endeavor Peter Jeffrey (2016) Risk-sharing arrangements involve the intentional and mutually agreed-upon distribution of potential risks and rewards among the various stakeholders involved in the business. Through this approach, the responsibility of managing specific risks is distributed among multiple parties, thereby mitigating the risk factor and potential adverse consequences for any individual entity. This approach promotes collaboration and provides incentives for all participants to actively contribute to the mitigation of risks and the success of the project. Risk-sharing provisions are commonly incorporated in contracts and agreements to define the respective risks assumed by each party and the corresponding obligations in their management. The utilization of risk-sharing mechanisms can facilitate a more equitable and enduring strategy for managing risk, promoting collaboration among all stakeholders in pursuit of shared goals.

2.8.3 Risk-sharing Concept in the Construction Industry

Risk sharing is a fundamental principle within the construction industry, which entails the fair distribution of risks and obligations among the diverse stakeholders involved in a construction project. Construction projects are inherently intricate and susceptible to a multitude of uncertainties, encompassing design modifications, meteorological factors, scarcity of labor, delays in material procurement, and unanticipated site circumstances. In order to effectively manage these risks, it is common for project owners, contractors, subcontractors, and other involved parties to engage in contractual agreements that delineate the specific risks that each party assumes and the corresponding measures for risk mitigation. The practice of risk sharing fosters a culture of collaboration, transparency, and accountability among stakeholders, thereby motivating them to collectively engage in the identification, evaluation, and mitigation of potential risks. This methodology aids in the reduction of conflicts, time delays, and budgetary excesses, thereby augmenting the overall achievement of the project. Additionally, it promotes the development of a collective comprehension of risk tolerance and facilitates enhanced decision-making throughout the construction phase.

2.8.4 Importance of Risk-sharing in the Construction Industry

The significance of risk sharing within the construction sector cannot be overstated, as it assumes a crucial role in facilitating project success and growing collaboration among the diverse stakeholders engaged in the process. Construction projects face several variables, including design changes, cost overruns, material shortages, weather, and site conditions. Project owners, contractors, subcontractors, and suppliers use contractual agreements to share risks and profits. This strategy encourages all stakeholders to identify and mitigate risks, improving risk management, conflict resolution, decision-making, and project results. Risk sharing encourages those with a stake in the project to work together to overcome challenges and achieve objectives, improving construction efficiency and effectiveness.

2.9 Risk-sharing Significance in the Context of Contractor Selection Decision-making

The importance of risk-sharing in the context of decision-making for contractor selection lies in its capacity to improve project outcomes and reduce potential risks. When deciding on which contractor to hire for a construction project, it is imperative for owners and project managers to take into account a range of factors, such as the contractor's level of experience, specialized knowledge, and financial viability. The allocation of responsibilities for the management of project risks is achieved through the inclusion of risk-sharing provisions within the contractual agreement between the owner and the contractor. This strategy promotes a joint commitment to minimizing risks and meeting project goals motivates the contractor to work well and anticipate issues. Risk-sharing systems match partners' interests, promote openness, and increase communication throughout the project. This kind of ownership also reduces the owner's risk of financial setbacks and uncertainty. Risk-sharing encourages cooperative and mutually beneficial contractor selection, assuring project success.

2.10 Challenges and Barriers faced in Implementing Risk-sharing in Contractor Selection

The implementation of risk-sharing arrangements in the selection of contractors can present significant challenges attributable to various factors and barriers. A significant obstacle lies in the intricacy of accurately identifying and quantifying risks, given that construction projects encompass a multitude of uncertainties that frequently prove challenging to anticipate. Moreover, the process of negotiating risk-sharing terms can be a time-intensive endeavor, necessitating a substantial degree of trust and transparency among the parties engaged in the negotiation. In addition, the implementation of risk-sharing necessitates a comprehensive comprehension of the distinct roles and obligations assumed by each party involved. However, this process may encounter obstacles due to disparities in organizational cultures and risk tolerance. The absence of experience and knowledge regarding risk-sharing mechanisms among project stakeholders can pose a hindrance to the effective execution of projects. Moreover, certain contractors may exhibit hesitancy in assuming elevated levels of risk owing to apprehensions regarding potential financial obligations and adverse effects on their standing. In order to surmount these challenges and obstacles, it is imperative to prioritize open communication, proactively identify risks at an early stage, engage in collaborative contract drafting, and ensure alignment of interests.

2.11 Risk-sharing Criteria and Governance Decision Role Integration

The correlation between risk-sharing criteria and the significance of governance in the process of contractor selection decision-making is a pivotal element within the realm of project management. Effective governance frameworks evaluate and manage risks when hiring contractors, ensuring that risk-sharing criteria are considered. Odeh and Battaineh (2002) emphasize the importance of prequalification criteria in contractor selection, including risk consideration.

2.12 Project Risk Assessment and Identifying Project Risks (From Owner/Client Side)

The utilization of project risk assessment criteria offers a systematic methodology for the identification and effective management of potential risks within a project. According to Liu (2018), significant risk assessment criteria from the perspective of the owner/client encompasses factors such as the clarity of project scope, availability of resources, engagement of stakeholders, and the complexity of the project. According to Zhao et al. (2020), the owner/client's viewpoint on project-specific risks encompasses various factors such as delays in acquiring permits and conflicting expectations among stakeholders. Moreover, the project owner may encounter substantial challenges due to external risks, including alterations in market conditions or legal/regulatory matters. By taking into account the risks specific to a project and utilizing suitable risk assessment criteria, owners or clients can actively mitigate potential problems, improve their decision-making process, and guarantee the successful completion of their projects.

During the process of project risk assessment, project owners are able to identify a range of project risks and subsequently classify them into distinct categories, thereby enhancing the efficiency of risk management practices. The following is a compilation of prevalent project risks and their respective categorizations, as discerned by the project owner.

1. Scope Risks

- Ambiguous project scope or requirements.
- Potential changes in project scope during execution (for example, change of order).
- Incomplete or unclear project documentation.

2.Financial Risks

- Overrunning budget.
- Fluctuating material and labor costs.
- Funding or financing issues.

3.Schedule Risks

- Delays in obtaining permits or approvals.
- Unforeseen project interruptions.
- Tight project timelines.

4. Contractual Risks

- Unclear contract terms and conditions.
- Contractual disputes and legal liabilities.
- Non-compliance with contractual obligations.

Through the process of categorizing project risks, project owners can enhance their ability to prioritize risk management endeavors, allocate resources in an efficient manner, and formulate suitable strategies for responding to risks. This systematic approach ultimately contributes to the achievement of successful project delivery.

2.13 Project Risks, Specific and Category Risks (From Contractor Side)

The assessment criteria for project risks are of great importance to contractors and bidders as they evaluate the potential risks and uncertainties associated with a project. According to Eskerod and Huemann (2013), important factors to consider in risk assessment from the perspective of the contractor or bidder include the level of clarity in the contract, the complexity of the project, the financial stability of the client, and the adequacy of project information. According to Yu et al. (2017), the contractor/bidder's viewpoint on project-specific risks may encompass concerns such as insufficient project specifications, fluctuating material prices, stringent project timelines, and ambiguous project objectives. Moreover, the contractor's capacity to successfully execute the project can be significantly influenced by risks associated with subcontractor performance and the availability of skilled labor. Contractors and bidders can enhance their ability to evaluate project feasibility, prepare competitive bids, and implement effective risk management strategies by considering project-specific risks and utilizing appropriate risk assessment criteria. This will increase their likelihood of successfully securing and executing the project.

During the process of project bidding, contractors engage in the identification of diverse project risks in order to evaluate the viability of the project and ascertain the extent of risk they are prepared to undertake. The following is a compilation of prevalent project risks and their corresponding categories that contractors may discern during the process of project bidding:

1. Scope Risks

- Ambiguous project scope or requirements.
- Potential changes in project scope during execution (project divagations).
- Incomplete or unclear project bidding documentation.

2. Financial Risks

- Cost estimation inaccuracies.
- Fluctuating material and labor prices.
- Unforeseen project expenses.

3.Schedule Risks

- Challenging project timelines.
- Potential delays due to external factors.
- Conflicting project schedules (with other commitments).

4. Contractual Risks

- Unclear contract terms and conditions.
- Contractual disputes and legal liabilities.
- Non-compliance with contractual obligations.

5. Technical Risks

- Complexity of project design and implementation.
- Technological limitations or unfamiliarity.
- Potential technical challenges in execution.

6. Safety Risks

- Project site safety hazards and requirements.
- Compliance with safety Regulations and standards.
- Potential safety incidents and liabilities.

The process of identifying and assessing potential risks associated with a project during the bidding phase enables contractors to make well-informed decisions, accurately estimate costs and timelines, and formulate effective risk management strategies. This, in turn, enhances their ability to compete for bids and successfully execute projects.

2.14 Project Risks between the Owners and the Contractors as Common Risks Metrics

According to Zhang et al. (2016), there are several project risks that can be mutually shared by both the client/owners and the contractors/bidders in a construction project. These risks encompass design changes, weather impacts, material availability, and unforeseen site conditions. These risks are generally outside the direct control of any individual entity and have the potential to have a substantial impact on the project's timeline, budget, and overall quality. By effectively communicating and discussing these potential risks, both the client/owner and the contractors/bidders can work together to identify and analyze uncertainties, as well as devise appropriate risk management strategies to minimize the negative impacts associated with these risks. Zhang and Hu (2019) emphasize the significance of risk-sharing in the effective management of cost-related risks, as it promotes a collaborative approach in the estimation of costs and development of contingency plans. Moreover, the practice of risk-sharing can foster a culture of transparent communication and a proactive stance towards the identification and mitigation of risks, ultimately resulting in enhanced project resilience and successful project execution.

The identification of project risks that are commonly shared between owners and contractors typically centers on critical project elements that are of mutual concern to both parties. Presented below is a compilation of common project risks and their respective categories:

1. **Design Risks**
   - Design changes and modifications during the project.
   - Potential discrepancies between design specifications and practical implementation.
2. **Schedule Risks**
   - Delays in project completion.
   - Unforeseen interruptions impacting project timelines.
3. **Cost Risks**
   - Budget overruns and cost escalations.

- Variations in material and labor prices affecting project costs.

4. **Scope Risks**
   - Changes in project scope impacting project deliverables.
   - Scope creep leading to additional work requirements.
5. **Environmental Risks**
   - Environmental impact and compliance issues.
   - Pollution and waste management challenges.
6. **Contractual Risks**
   - Contractual disputes and disagreements.
   - Non-compliance with contract terms and conditions.
7. **Stakeholder Risks**
   - Stakeholder expectations and demands affecting project decisions.
   - Stakeholder resistance or opposition impacting project progress.

The presence of project risks that are shared between owners and contractors underscores the need for collaborative efforts in order to collectively identify, assess, and effectively handle potential challenges. By implementing efficient risk-sharing mechanisms and establishing effective communication channels, both entities can formulate strategies to mitigate risks, assign obligations, and cultivate a collaborative approach to tackle uncertainties, thereby facilitating the successful execution of the project

2.15 The Effective of Developed Governance Risk-sharing Framework

The alignment of risk-sharing criteria with the overarching objectives and strategic goals of a project is contingent upon the presence of a robust governance framework. The governance framework ought to encompass well-defined policies, procedures, and decision-making mechanisms that incorporate risk-sharing considerations throughout all phases of the project's lifespan. Geraldi et al. (2011) highlight the significance of a project governance board in supervising risk-sharing agreements, thereby ensuring the allocation of risks aligns with the project's strategic priorities and risk tolerance levels. The implementation of routine risk assessments and evaluations, as recommended by Pinto and Slevin (2017), enables project stakeholders to recognize variations in risk exposure and subsequently modify risk-sharing criteria. Furthermore, the establishment of effective communication and collaboration among stakeholders, as emphasized by Atkinson (2015), plays a crucial role in fostering a collective comprehension of risk-sharing objectives and obligations. A comprehensive governance framework that effectively harmonizes risk-sharing criteria with the overarching objectives of a project enables project managers to make well-informed decisions, improve risk management practices, and ultimately attain successful project outcomes.

2.16 The Governance Role

2.16.1 Governance Role in the Projects

Projects can fail or succeed based on the quality of their governance. It is a high-level structure that lays out methods and organizational structures for keeping track of multiple projects and overseeing broad, overarching objectives (Nielsen, 2010). The most basic advantages of successful project governance lie in its ability to help an organization achieve strategic alignment between project objectives, see the project through to a successful conclusion, and monitor its progress. Project governance is the primary business function, providing a framework for the policies, procedures, and decision-making processes that boosts easy management of projects, programs, and portfolios. Resultantly, it is fundamental to PBOs across an organization, especially for complex projects, and it correlates strongly with success (Garland, 2009).

2.16.2 Governance Role in Construction Projects

Corporate governance encompasses a wide range of elements, including the frameworks, protocols, interactions with stakeholders, and regulations that oversee the utilization and execution of authority within organizations. Corporate governance, by encouraging self-regulation within a broader framework, impacts both the formulation and achievement of an organization's objectives (ASX, 2007; OECD, 2004). Nonetheless, it does not have a monopoly on the actions of people within an organization (Clegg et al., 2002). In light of this, "governance is ultimately concerned with providing the structure for ordered rule and team effort" (Stoker, 1998). Project governance is the process by which a project is managed so that it is carried out in accordance with the norms of a particular PBO and its owning organization. It offers many advantages, including fostering transparency at all organizational levels and throughout the project lifecycle. Specifically, project reporting systems that clearly define the roles and responsibilities of all project stakeholders are frequently installed as part of project governance. A sound governance framework aids in project managers' ability to prioritize their work while not limiting their ability to respond quickly to unforeseen changes.

2.16.2.1 Governance Role in Project Planning

Project managers are better able to establish and prioritize the goals that must be achieved to bring in a successful project when they have a solid understanding of the governance and overarching objectives of a PBO (Too, 2014). It is possible to modify or change goals if they do not fit with the PBO's overall strategic objectives. Additionally, a sound governance framework guarantees that every project continues to be in line with the PBO's overarching organizational objective. Higher boards (such as working groups) inside an organization can play a supportive role in resolving disputes or ambiguities and upholding institutional standards without losing sight of the organization's overarching strategic objectives. Therefore, we might infer that project governance, which involves more than just routine organizational monitoring and planning, is an essential tool for completing projects successfully. As a result, it should be used as a facilitator of collaboration and reflection (Kerzner, 2017).

The application of corporate governance theories in a project context can be discerned through the presence of common themes and concepts, including cost (e.g., transaction cost economics or TCE), trust (e.g., stewardship theory), and control (e.g., principal-agent theory). Project governance, facilitated by the project sponsor, the project team, and the organization's structures and methodologies, aims to align project objectives with the overarching organizational strategy. The use of terms like "strategic," "contracts," and "roles" is appropriate in this context.

Within organizations, there are two key parties, the principal and the agent, engaged in an agency relationship as per agency theory. Both parties are viewed as rational economic actors motivated by self-interest. Governance structures may prioritize immediate results, focusing on cost and control (Mitnick, 1973; Ross, 1973).

Transaction cost economics (TCE) suggests that businesses adapt their governance structures to minimize costs, particularly when the relationship between the buyer and seller is complex. Behavioral factors also play a role when selecting a specific transaction

(Williamson, 1975; Coase, 1937).

Stakeholder theory encompasses a broader spectrum of stakeholders compared to the traditional shareholder theory. The corporate governance structure may involve individuals directly representing significant stakeholder groups, as observed in previous research (Donaldson and Preston, 1995; Freeman, 1984).

According to the shareholder theory of corporate governance, an organization's primary objective is to maximize returns on investment for shareholders. Mechanisms such as contracts, processes, and policies are essential to ensure that managerial actions consistently serve the best interests of shareholders (Jensen and Meckling, 1976; Friedman, 1962).

The relationship between organizational actors is described by stewardship theory, in which managers act as stewards whose motivations are in line with those of their principals rather than being driven by their own personal goals. The governance model is centered on honesty to boost the company's long-term effectiveness Margaret and Michael (1995) Prioritizing, acquiring, facilitating, and connecting the company's internal and external resources is essential for reaching the company's objectives (Pfeffer and Salancik, 1978).

According to Müller (2009), project governance is a multilevel phenomenon that occurs at the confluence of project, program, and portfolio management levels. Its primary function is to promote the effective achievement of organizational and project objectives. Thus, it is defined by the strain between acknowledging the broad organizational objectives while also successfully achieving the goals set forth by specific projects. According to Weaver (2005), effective project governance increases transparency between organizational levels (to achieve project objectives), highlights the benefits of successful project governance, and has a favorable impact on the interchange of relevant information among diverse stakeholder groups. All of these elements impact how well a business performs.

According to Weaver (2005), successful project governance promotes the advantages of its effectiveness, increases transparency between organizational levels (to achieve project objectives), and has a positive effect on the sharing of pertinent information among various stakeholder groups. Each of these factors affects how well a corporation performs. To decide on it is essential to take into account not only the technical features of the tenderers, but also their economic, social, environmental, and other aspects, as well as the total long-term impact of the project results. Because of this, such needs can be satisfied by defining appropriate selection criteria throughout the procurement process. Primary criteria are discussed in greater depth for use in competitive tendering processes (Hanak, 2020; Lesniak,2012; Hopfe, 2013).

2.16.3 Governance Role in Construction and Contractor Selection

In real-time construction, where intricate tasks necessitate meticulous planning, coordination, and implementation, the process of governance decision-making holds utmost significance. The outcomes of a project, the level of satisfaction among stakeholders, and the overall success of the project are all impacted by the implementation of effective governance decisions.

This research provides valuable insights on enhancing decision-making processes to achieve favorable outcomes in construction projects. It accomplishes this by examining contemporary techniques, frameworks, and best practices in governance decision-making.

The success of construction projects is contingent upon the careful consideration and deliberation of contractor selection determinations. The implementation of sound governance decision-making processes guarantees that the chosen contractor possesses the necessary expertise, prior experience, and adequate resources to successfully accomplish the project within the designated timeframe, financial constraints, and in alignment with the project's objectives. This analysis explores the latest methodologies, frameworks, and best practices in governance decision-making. The objective is to enhance contractor selection and construction processes, thereby promoting project success.

2.16.3.1 Governance Role in Construction

Decision-making transparency is a crucial element for effective governance within the construction industry. Liu et al. (2020) underscored the significance of fostering open communication and facilitating information exchange among various stakeholders, including project owners, contractors, and regulatory agencies. The implementation of transparent decision-making processes fosters accountability and enhances the trust and assurance of stakeholders, ensuring that decisions are based on objective and verifiable criteria. Furthermore, the inclusion of stakeholders is of paramount importance in order to gain a comprehensive understanding of diverse perspectives, solicit valuable input, and facilitate consensus-building, thereby enabling the making of well-informed decisions (Sun et al., 2022). The inclusion of stakeholders in all stages of the decision-making process ensures the effective handling of their interests and concerns.

The utilization of data and analytics has become increasingly prevalent within the construction industry as a means to enhance the process of decision-making. According to Sadiq et al. (2021), stakeholders are able to analyze project performance, identify patterns, and anticipate potential risks through the utilization of data-driven methodologies. The utilization of real-time data by stakeholders has the potential to improve project efficiency and outcomes through the facilitation of more accurate and timely decision-making. However, the utilization of data-driven decision-making in governance enhances the efficacy of project monitoring and control, facilitating the implementation of proactive measures to promptly address and resolve issues.

Effective risk assessment and mitigation are crucial components for making sound governance decisions within the construction industry. The identification of potential risks and uncertainties that could hinder the progress of a project can be facilitated through the implementation of a comprehensive risk analysis, as suggested by Samuel et al. (2021). The implementation of risk mitigation techniques reduces the probability of unfavorable events and mitigates their negative impact on project performance (Kolte et al., 2023). Proactive risk management enables the adherence to project schedules and the optimal utilization of resources.

In order to uphold the integrity of the construction industry, it is imperative to make ethical considerations when making decisions regarding governance. Villalba-Romero et al. (2020) argue that the adherence to ethical norms promotes the values of fairness, honesty, and social responsibility in decision-making processes. The act of making ethical decisions within the construction industry contributes to the observance of established rules, regulations, and safety protocols, thereby bolstering the industry's reputation. In order to mitigate the ecological consequences of the industry, it is imperative to prioritize environmentally friendly strategies and sustainable practices (Tetteh et al., 2022).

Performance-based decision measures are increasingly gaining significance in governance decision-making within the construction sector. Stakeholders have the option to exercise caution in selecting potential partners by conducting an assessment of contractor performance, which encompasses an evaluation of past projects, adherence to budgetary constraints, and meeting established deadlines (Nkado et al., 2021). The project objectives are in accordance with performance-based decision indicators, ensuring that the selected contractors possess a track record of successfully executing projects. This approach promotes the adherence of contractors to elevated standards during the execution of projects, thereby enhancing their sense of responsibility and accountability.

The incorporation of technological advancements in decision-making has brought about significant changes in the construction industry. According to Tiwari et al. (2022), decision support systems (DSS) enable stakeholders to analyze complex data and situations, thereby facilitating more informed and efficient decision-making. The dissemination of comprehensive project information to stakeholders within a collaborative environment exemplifies the utilization of Building Information Modelling (BIM) as a technological tool that enhances the process of decision-making (Gong et al., 2023). The utilization of DSS and technological tools serves to augment the efficacy of coordination, decision-making, and communication processes within the realm of construction activities.

Legal compliance is an essential element in the decision-making process of governance within the construction industry. When making decisions, it is imperative to take into account the rules and regulations of all countries (Nnaji et al., 2023). Ensuring the safety of employees, minimizing potential legal risks, and mitigating project delays and costs are all achieved by adhering to safety standards, environmental regulations, and labor laws. In order to maintain the reputation of the sector and mitigate potential legal ramifications, it is imperative that governance decisions prioritize adherence to legal requirements.

The implementation of a culture that promotes ongoing education and development in governance decision-making has the potential to yield advantages for the construction industry. According to Ahamkara et al. (2020), it is important for stakeholders to assess the effectiveness of decisions and their outcomes after the completion of a project. The utilization of insights gained from past projects in decision-making processes has the potential to enhance project performance and all facets of project management.

2.16.3.2 Governance Role in Contractor Selection

The governance of contractor selection is contingent upon the level of transparency in the procurement process. According to Yang et al. (2020), the implementation of procurement methods that are open and transparent, ensuring that all eligible contractors have equal access to project information and assessment criteria, facilitates a fair and competitive selection process. The implementation of transparent procurement practices serves to mitigate favoritism and ensure the impartial and objective selection of goods, services, or contractors. The decision criteria to be considered encompass prior performance, technical competence, financial stability, and regulatory compliance, as outlined by Ameyaw et al. (2021). The implementation of transparency in the decision-making process and the utilization of precise assessment criteria enhance the credibility and reliability of contractor selection. The governance of contractor selection is enhanced through the involvement of stakeholders and the implementation of inclusive decision-making processes. According to Adekanmbi et al. (2022), stakeholder participation facilitates stakeholders' comprehension of project objectives, requirements, and constraints, while also fostering a sense of shared responsibility in decision-making processes. The decision-making process involves the participation of stakeholders, namely project owners, end-users, and project managers. The implementation of inclusive decision-making processes enhances the quality of decisions made and fosters stakeholder support, thereby leading to improved project execution and outcomes.

The process of governance decision-making facilitates the selection of contractors based on performance criteria. The process of performance-based selection involves the assessment of a contractor's historical performance on similar projects, their ability to adhere to project timelines, their proficiency in managing costs, and the level of satisfaction expressed by their customers (Ali et al., 2023). The integration of decision metrics with project goals is essential, as it allows for the objective evaluation of a prospective contractors ability to meet the requirements of the project through the analysis of performance data. The adoption of performance-based decision-making strategies facilitates the cultivation of contractor accountability and enhances the likelihood of achieving project objectives. The governance of contractor selection necessitates the evaluation and management of risks. The process of risk assessment involves the evaluation of the contractor's financial stability and project performance, as discussed by Kim et al. (2022). In order to minimize the impact of project execution, it is imperative to implement measures that effectively mitigate risks. The implementation of risk assessment and mitigation strategies enhances the process of contractor selection by ensuring that the chosen contractor possesses the capability to effectively handle any potential issues that may arise.

The advent of technology has facilitated the implementation of data-driven practices in the governance of contractor selection. According to Lakhan et al. (2021), the utilization of real-time data and analytics enables decision-makers to assess the performance of contractors, recognize potential hazards, and forecast the success of projects. The utilization of data-driven judgements serves to reduce the influence of subjectivity. Technology plays a pivotal role in enabling stakeholders to make informed decisions that align with project requirements and optimize project outcomes. The process of selecting a governance contractor necessitates the consideration of ethical issues. According to Ndiaye et al. (2020), the establishment of fair and impartial decision-making processes is crucial for fostering transparency and trustworthiness. The evaluation of a contractor's adherence to labor, ethical, environmental, and safety standards is of paramount importance. The implementation of ethical decision-making practices in the construction sector has been found to have a positive impact on both the reputation of the industry and the successful delivery of construction projects.

The process of selecting governance contractors should adhere to legal and ethical principles. According to Ezema et al. (2023), certain contractors are required to adhere to the labor, safety, and licensing regulations that are specific to the local area. The adherence to legal requirements enhances the process of decision-making and mitigates the potential risks faced by project owners. The governance of contractor selection should prioritize the ongoing development and integration of lessons learned. According to Kojo et al. (2021), stakeholders have the potential to improve future decision-making through the assessment of previous choices and project outcomes. Continuous improvement enhances the process of contractor selection and facilitates the acquisition of knowledge.

The classic contractor selection conventional delivery Method as shown in Figure 6 begins with the project owner or client hiring an architect or designer to generate precise construction drawings and specifications. The owner seeks bids from contractors when the designs are ready. The lowest qualified bidder is usually negotiated and awarded the contract based on price and other considerations. The DBB technique separates the design and construction stages, enabling competitive bidding and thorough project documentation, although it has limitations. Sequential activities may delay the project timeline, limited collaboration between the design and construction teams during planning, and the risk of cost overruns if design documents are incomplete or inaccurate, which could lead to change orders during construction. The client or stakeholder's involvement is essential for project success.

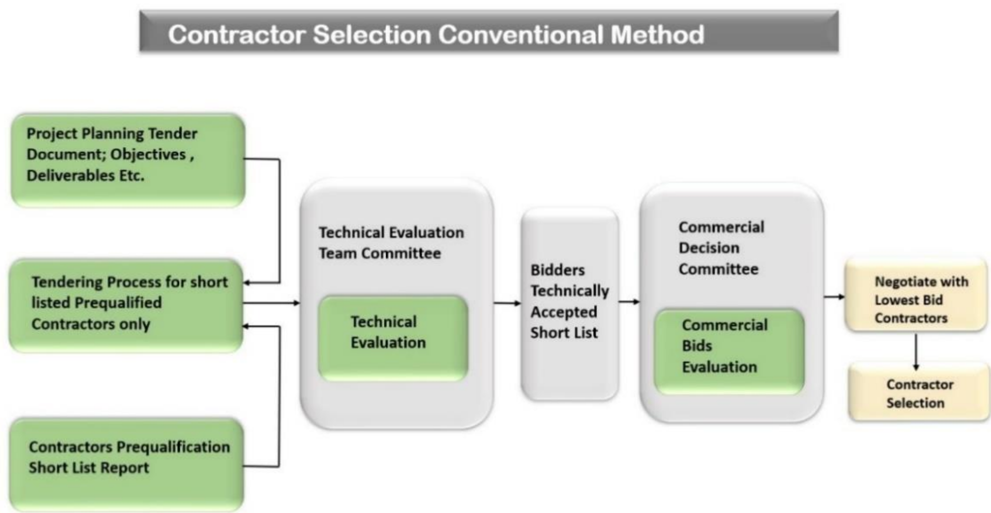

Figure 6. Contractor Selection Conventional Method

Construction managers should use a methodical and inclusive approach. They must strongly engage customers and stakeholders from the start to understand their requirements, expectations, and concerns. Meetings, surveys, and seminars may do this. Second, data must be recorded and organized to avoid misunderstandings. Digital collaboration platforms and project management solutions may simplify this. Third, construction managers must prioritize and analyze information to guide decision-making. Clients and stakeholders need to know how their input affects project planning and execution. Progress updates and transparency help develop confidence and construction managers may match their efforts with client and stakeholder demands throughout the project lifecycle, improving satisfaction, project delivery, and long-term partnerships.

Construction managers need sophisticated software tools to make educated and data-driven contractor selection choices. These algorithms objectively score possible contractors using previous contractor performance data, qualifications, financial capacity, and project-specific criteria. These decision support systems use complex algorithms and machine learning to quickly and correctly analyze massive datasets and find the best contractors based on track records and skills. This simplifies the selection process, increases transparency, and decreases bias, resulting in better contractor selections for construction managers. These tools also provide real-time monitoring and assessment throughout project execution, guaranteeing data-driven decision-making for best project results.

Sustainability criteria are used in contractor selection to evaluate and rank contractors based on their commitment and capacity to accomplish sustainability objectives. Construction managers evaluate the contractor's sustainability using environmental, social, and economic considerations. A contractor's history of using sustainable products, ethical labor practices, and contributing to local communities and economies may be considered. Construction managers emphasize sustainability throughout contractor selection to encourage ethical and environmentally conscious construction, reduce the project's ecological imprint, and support long-term social and economic advantages. This guarantees that contractors hired for projects meet the organization's sustainability goals, making the construction sector more sustainable and socially responsible.

The risk-based decision-making models or frameworks are used to evaluate and quantify contractors to improve project performance and reduce risks. Construction managers may evaluate contractor risk by examining financial stability, prior performance, safety records, and project-specific complications. Advanced risk assessment methods and probabilistic models can measure and objectively analyze these risk elements, helping construction managers make more informed and data-driven choices. Risk-based criteria improves contractor selection decreasing delays, budget overruns, and quality difficulties. Construction managers may avoid problems and improve project results by prioritizing risk management during contractor selection.

The new technology in construction such as BIM, AI, and IoT have changed construction contractor selection procedures. Construction managers may better comprehend a project's intricate details and needs using BIM's full digital depiction. This data-driven technique helps assess contractor skills and experience in meeting project requirements. AI algorithms may also get insights from massive volumes of contractor data, performance records, and qualifications. AI-powered decision support tools help construction managers choose contractors more objectively. The IoT also collects real-time data from building sites, providing construction managers with up-to-date information on the prospective contractors projects. This improves transparency and allows management to assess the contractor’s safety and performance. BIM, AI, and IoT improve contractor selection, data-driven decision-making, and construction project efficiency.

Inclusion and equity in contractor selection practices prioritizes different contractors and suppliers. Construction managers should include diversity and inclusion objectives in their contractor selection and procurement procedures. To increase contractor diversity, they may strongly request bids from large and small firms. The selection process may also assess a contractor’s personnel and supplier diversity programs. Construction managers should set clear assessment standards that reflect both conventional credentials and a contractor’s diversity initiatives for transparency and fairness. Monitoring and reporting diversity measures could increase accountability and development. Construction managers promote economic growth and social empowerment of underrepresented groups by embracing organization/company diversity in contractor selection practices. Where diverse contractor teams are valued internationally in construction, they improve project results in many ways. First, they bring together people with varied backgrounds, experiences, and viewpoints, thereby boosting creativity and innovation. Diversity of ideas helps teams solve difficult problems and promotes ongoing development. Second, diversified contractor teams can react better to changing project needs and unanticipated challenges. Thirdly, they promote communication and cooperation, creating a more inclusive workplace that values everyone's views. Team motivation and efficiency increase. In today’s globalized environment, a varied staff better understands and serves various clients. Diversity in contractor teams improves project quality, stakeholder satisfaction, and company reputation. These advantages apply to construction projects globally, not only in Qatar and the Gulf. Diverse contractor teams are valued internationally in construction.

The research study takes into account the governance decision for each process for all aspects of construction contractor selection, beginning with the project initiating objective and deliverables, continuing on through the budget estimation and execution plan during the project planning phase, and taking into account risk assessment and scope clarity so that stockholders can finalize their requirements to avoid change orders. Also, the project execution plan is acceptable in terms of duration for project execution as requirement. On the other hand, the contractor prequalification process requires the contractor to meet prequalification measures in order to qualify for bidding. These measures include the contractor’s expertise in similar projects, clear financial stability, and sustainable performance. In addition, the contractor has to include his risk-sharing agreement practice as a commitment if he is awarded the contract.

2.16.3.3 Governance Roll and Risk Sharing in Construction and Contractor Selection

The research study takes into account the governance for each process for all aspects of construction contractor selection. This begins with the project initiating objective and deliverables, continues on through the budget estimation and execution plan during the project planning phase, and finally takes into account risk assessment and scope clarity so that stockholders can finalize their requirements. The research study also considers the governance decision for each process for all aspects of construction. Additionally, it ensures the strategy for completing the project is appropriate in terms of the amount of time needed to complete it in accordance with the requirements. On the other hand, in order to qualify for bidding, the contractor is required to fulfill the contractor prequalification procedures as part of the contractor prequalification. These metrics include the contractor's experience working on projects that are comparable to the one at hand, their obvious financial stability, and their ability to maintain their performance over time. In addition to this, the contractor is required to include his risk-sharing agreement practice as a pledge in the event that the contract is awarded to him.

The study framework processes are explained with highlighted diagrams for the contractor selection Contractor Selection Governance under Risk-Sharing as shown in Figure 7 and the study framework FAHP Contractor Selection Matrix as shown in Figure 8.

1.Project Planning Validation: This includes the validation of the project scope, the involvement of decision teams accountable for client needs, the evaluation of project risk, and control over project execution planning.

2.Contractor Prequalification: This incorporates the following governance teams: competence in the contractor, financial stability in the contractor, performance in the contractor's capacity to maintain itself, and performance in the contractor's ability to share risks.

3.Contractor Selection Decision Model: The chosen choice model calls for prequalified contractors to submit bids based on particular specifications, which makes the selection process simple. This particular research model will make use of the framework (FAHP), which was selected, as a supporting tool.

The decision-making process includes prequalified contractors getting bids passed on certain criteria; this will make the process of choosing very straight forward. The chosen model, FAHP, will serve as a supporting tool for the research.

4.Risk-Sharing Agreement : During the process of selecting a contractor, a risk-sharing agreement has to be obtained and signed immediately after the contract for the project to be finalized. This will address the gaps left by the DBB delivery method in terms of the quality, safety, and efficiency, by avoiding project change orders.

The FAHP contractor selection matrix, as shown in Figure 8, is included in the research framework and presents the contractor selection as an alternative to the specified criteria and sub-criteria. This where FAHP is applied for the best selection.

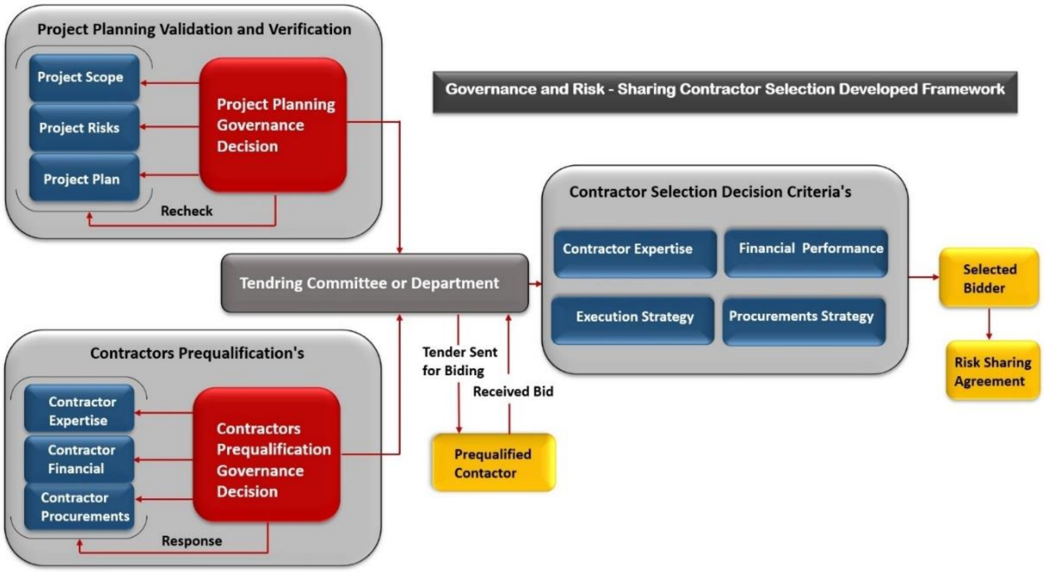

Figure 7.Contractor Selection Governance under Risk-Sharing

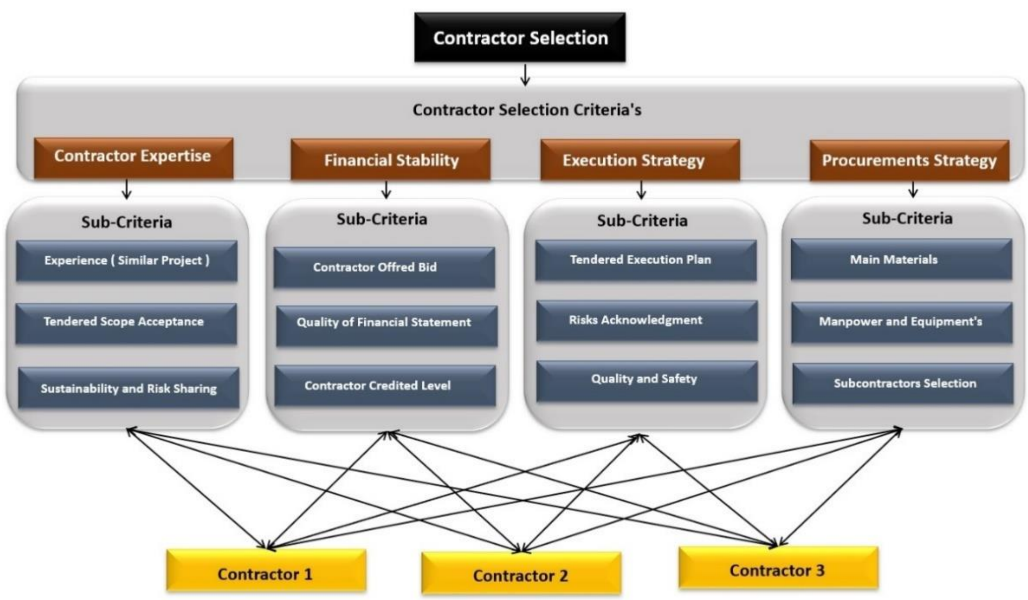

Figure 8.FAHP Contractor Selection Matrix

2.17 Literature Review Summary

2.17.1 Contractor Selection Framework Development

Government agencies in many Gulf countries, including Qatar, face challenges related to project planning, contractor prequalification, and contractor selection. Addressing these challenges requires enhanced coordination and communication among government agencies involved in project planning and execution. Complex infrastructure projects often involve multiple ministries and agencies, and a lack of coordination can lead to delays and inefficient project design and selection processes (Gulf Times, 2021).

To overcome these issues, there is a growing need for the integration of digital technology and data-driven decision-making across different phases of project management. This approach aims to optimize workflows, enhance transparency, and reduce errors (Deloitte, 2020). By fostering interagency collaboration and leveraging technology, Qatari government agencies can bridge these gaps and improve project planning, contractor prequalification, and contractor selection.

A significant portion of construction project delays and cost overruns in Qatar can be attributed to the selection of the wrong project delivery system (PDS). Often, owners choose PDS based on holistic criteria rather than making informed decisions based on PDS-specific expertise, resulting in losses and inefficiencies in the construction process (Riaz & Jaffery, 2013)

In Saudi Arabia, approximately sixty percent of building projects have experienced delays over the past decade. The choice of a contractor plays an important role in the ultimate success of a building project. Unfortunately, contractors for Saudi Arabian construction projects are often chosen based only on the lowest bid, without considering the qualifications of each bidder. This practice frequently leads to disputes and project delays. To address this issue, recent research aims to assist decision-makers in both the public and private sectors by developing a standardized framework for vetting potential contractors, conducting prequalification assessments, and selecting the most suitable candidates for projects (Othman and Ibrahim 2023) through the creation of a standardized framework. The significant building boom and the contractor's role in overcoming construction hazards make contractor selection crucial in Saudi Arabia (Bajaber & Taha, 2012). The expansion of the General Agreement on Tariffs and Trade (GATT) into the construction industry; the high rate of defaulted or failed projects; the high rate of disputes blamed on the contractor during the project execution stage (almost double); and the low number of studies all point to the need for investigating contractor selection. It is believed that irresponsible contractors are the result of a flawed selection process.

Mohamed Ibrahimi (2018) emphasizes the importance of planning and contractor prequalification criteria before contractor selection process. These criteria can significantly impact the competitive bidding used in public procurement and the quality of planning deliverables, following technical and commercial analyses. However, choosing the project contractor at the last minute primarily on pricing does not guarantee project success. The construction business is plagued by delays, cost overruns, and client-contractor quality conflicts. The contractor selection process is repetitive and wastes a considerable amount of money. Any new building project must go through it. The competitive bidding contract awarding procedure begins with an open or closed tender for the construction project and bidders present technical and financial proposals. The contractor’s capacity to perform the project on schedule, on budget, and with the desired quality is assessed via technical review. In this case, the client—government institutions—sets minimum technical evaluation criteria, and any contractor who meets all of them is considered qualified for the project. Only technical ideas are opened and examined to this point. From the competent contractors, the best fit for this job is chosen based on pricing. Here, the financial offer envelopes are unsealed, and the lowest-priced contractor is instantly picked since the decision maker (the client) considers that all bidders are eligible for the job and would gain most by choosing the lowest bidder. This is the ultimate contractor choice. However, practice and research show that pricing alone seldom leads to the best project delivery (Ibrahimi 2018).

The framework for contractor selection in the thesis, as shown in Figure 9 follows straightforward procedures, minimizing the need for extensive choices while avoiding extensive project appraisal. Planning and contractor prequalification procedures play an important role in ensuring the authenticity and quality of planning deliverables. The competence of contractors hinges heavily on the expertise of our sources in evaluating pertinent factors that align with the contractor selection criteria as shown in Figure 10. Beyond the conventional consideration of costs and nonprice criteria, there is a compelling case for a more comprehensive assessment of key factors, particularly the planning and contractor prequalification criteria. These aspects significantly influence the contractor selection process (Ibrahimi, 2018).

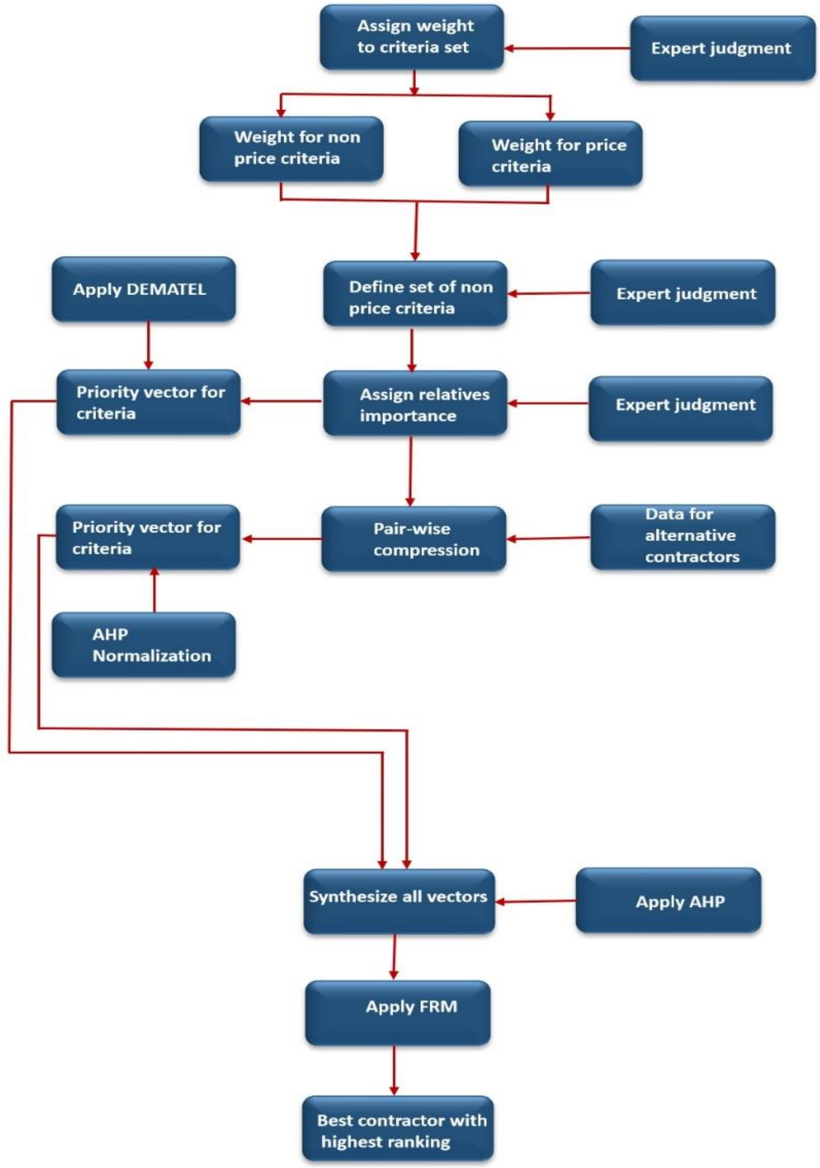

Figure 9.Contractor Selection (Source: Ibrahimi,2018)

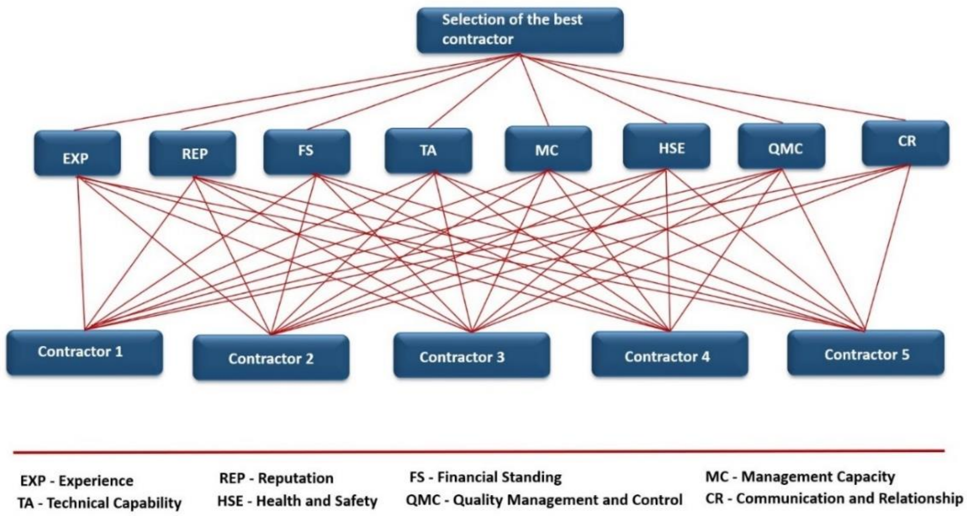

Figure 10. Criteria and Alternative Pairwise (Source: Ibrahimi,2018)

2.17.2 The Governance

2.17.2.1 Qatar Governance

Qatari construction projects must follow construction governance guidelines to ensure quality, safety, and openness. Qatar has many regulatory agencies and is programmed to regulate and enforce construction governance decisions. The Qatar Central Tenders Committee (CTC) manages government contract procurement and tenders, including building projects. The CTC strictly evaluates contractors based on their skills and expertise to ensure that only qualified and reputable contractors obtain government contracts (Central Tenders Committee, n.d.).

Qatar has used modern technology to improve construction governance and project management as shown in Figure 11. The government uses digital tools to monitor all building projects throughout the nation. This platform improves transparency, simplifies approval, and streamlines stakeholder contact, including government, contractors, and developers. Qatar’s technology-driven governance choices demonstrate its dedication to modernizing construction practices and meeting regulatory deadlines (Ministry of Municipality and Environment, n.d.).

The governance in Qatar is implemented by the global committee CTC, and is dependent on the organization as regulators in Qatar use technology-driven tools for governance improvement in construction projects. Contractors prequalification only makes the governance less effective and weak of implementation for project success.

Figure 11.Governance in Qatar (Source: Qatar Central Tenders Committee)

2.17.2.2 GCC Governance

In the other GCC Countries, certain governance policies are provided for the "Excite" project in Dubai, which issues permits and inspection grants. Saudi Arabia regulates licenses for contractors to ensure project BIM Dubai uses technology and platforms for governance construction and makes improvements accordingly through technology-driven tools.

Gulf Cooperation Council (GCC) nations must execute construction governance policies to ensure project success and industry transparency. Governments and regulators make construction governance choices in the GCC as shown in Figure 12. In the UAE, the Dubai Municipality enforces building rules and standards, issues permits, and inspects construction projects to guarantee compliance (Dubai Municipality, n.d.). The Saudi Contractors Authority (SCA) regulates and licenses contractors to ensure that competent and reputable firms work on construction projects (SCA, n.d.).

GCC nations also use new technology and digital platforms to expedite construction governance decisions and increase transparency. As with the "BIM Dubai" effort in the UAE, these platforms BIM for construction projects, allowing efficient collaboration, information exchange, and monitoring throughout the project lifetime. These technology-driven governance choices demonstrate the commitment of GCC nations to innovative building practices and regulatory compliance. The governance decision in construction in GCC has not developed well based on project needs and requirements only as global added by technology tools as supportive no sign to project planning phase this develop a weak governance decision suitable for implementation constructed project.

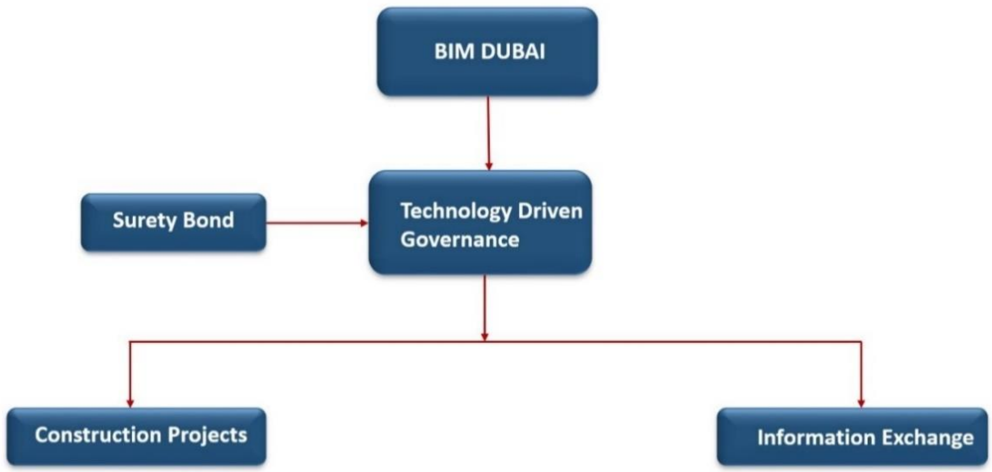

Figure 12.Governance in GCC (Source: BIM Dubai, UAE)

2.17.2.3 US Governance

A comprehensive regulatory structure at the federal, state, and municipal levels guides US construction governance choices. Building rules and regulations, which vary by state but commonly include the International Building Code (IBC) and the National Electrical Code, are crucial to construction governance as shown in Figure 13 . These regulations govern materials, design, and building processes to guarantee project safety and structural integrity. Local building departments and authorities enforce these regulations, issue permits and check for compliance (International Code Council, n.d.).

Construction licensing and certification are also important governance decisions. Contractors in the US must obtain state or municipal licenses, which may include education, experience, and exams. Construction contractors are licensed to confirm their qualifications and competence. Professional organizations and trade groups also provide certificates in specialized construction disciplines, boosting construction industry professionalism and knowledge (National Association of State Contractors Licensing

Agencies, n.d.). The US developed governance through the municipal regulator, taking into account international building code. The regulator focused on materials design and processes, including construction licenses. Based on these findings it appears that the governance is not considered much in construction and design, only the focus on the present regulations and licenses to the contractors. It is not clear enough about the governance enrolment this regulations and processes, which have limitations for complete implementation resulting in a successful project.

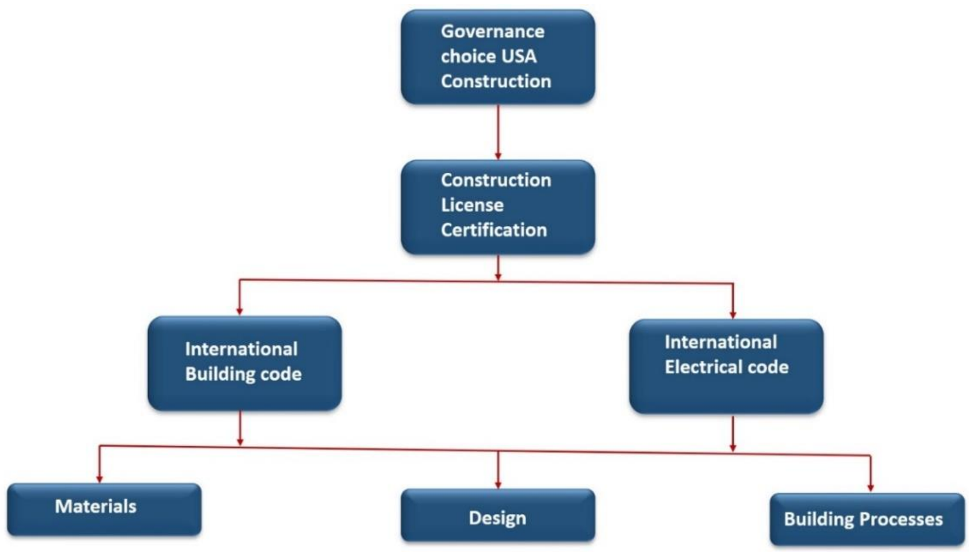

Figure 13.Goverance in USA (Source: International Building Code, USA)

2.17.2.4 The Study Governance Framework

The Developed governance framework covers the project phases, mainly the design phase and prequalification phase. These two phases are the major elements to be looked into, by adapting governance under risk sharing, as shown in Figure 14. The governance set up a dedicated team in each area of planning. Project Scope has to make the decision to check the scope requirement validation. The Risk Assessment team will ensure most of the risks are mitigated. The Project Plan team will ensure the plan is achievable by any contractor and this will be reflected on during construction.

The Bidder's Prequalification Governance Control Team will focus on the bidder's expertise, financial performance and requirements. The approved design and prequalified bidder will go forward to tendering. This approach is unique and is focused deeply on project internal phases processes, not on global rules and guidance, which in general is regulated by one committee or organization.

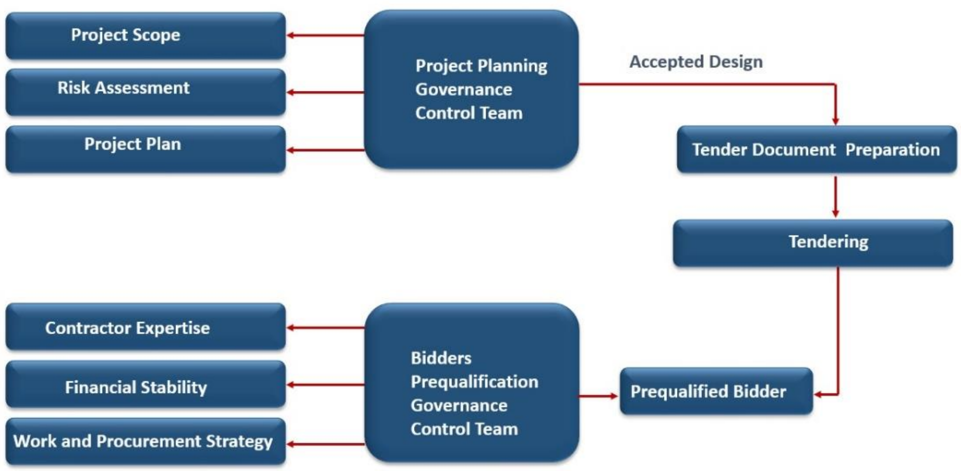

Figure 14.Study Framework Governance

2.17.3 The Risk Sharing

2.17.3.1 Qatar Risk-sharing

Qatar's building and infrastructure industries depend on project risk-sharing choices to distribute and manage risks among partners. Qatar uses well-defined contractual agreements to clarify each party's responsibility in a building project. As shown in Figure 15, these agreements generally feature risk-sharing procedures to spread financial, technical, and scheduling hazards among project partners. In Qatar, the Qatar Construction

Specification (QCS) guides construction projects and ensures risk management and quality (Public Works Authority - Ashghal, n.d.).

Qatar has also used insurance and surety bonds to share construction risk. To protect project owners from nonperformance or delays, contractors usually obtain performance bonds and other insurance. These insurance and bonding mechanisms allow insurers, contractors, and project owners to share risks and defend their interests (Gulf Insurance Review, 2020). These steps demonstrate Qatar's dedication to promoting building and infrastructure development while controlling and sharing risks with stakeholders. Qatar risk sharing is distributed among the project party's client and the contractor, as per their agreement through QCS. The risk sharing will be covered by insurance for both; the client will be covered by a surety bond and the contractor will be covered by a performance bond during project construction.

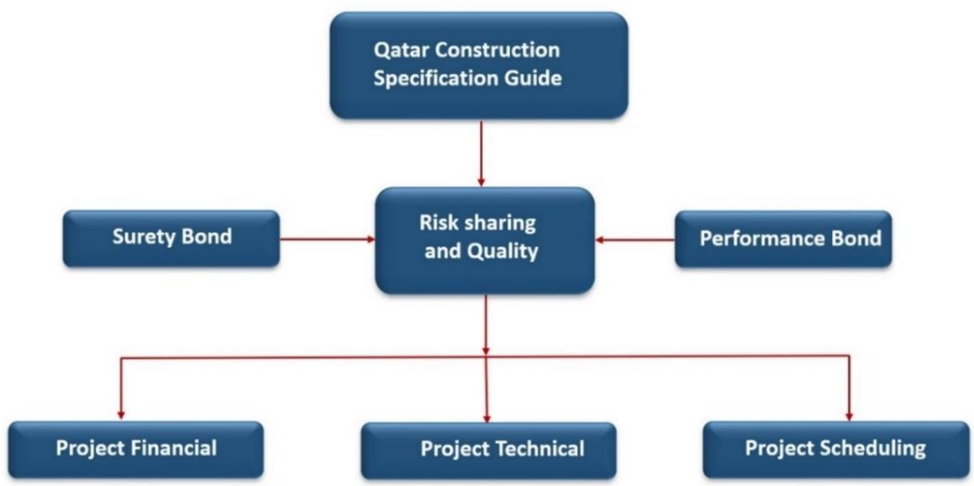

Figure 15.Risk-Sharing in Qatar Projects (Source: Qatar Construction Specification Guide)

2.17.3.2 GCC Risk-Sharing

Project risk sharing choices in the building and infrastructure sectors of GCC nations help parties distribute and minimize risks. These choices are usually implemented via contractual agreements and frameworks that allocate project risks. As shown in Figure 16, GCC nations use Public Private Partnership (PPPs) to share risk. In the UAE, the Abu Dhabi Investment Office (ADIO) promotes PPP projects to include the private sector in infrastructure development and shares risks and obligations (ADIO, n.d.). Insurance and surety bonds also help GCC nations execute project risk sharing choices. Contractors receive performance bonds and other insurances to safeguard project owners from nonperformance or delays. These instruments allocate financial risks between insurers, contractors, and project owners, providing security and risk reduction for large-scale GCC construction projects (Gulf Insurance Review, 2020). These measures demonstrate the commitment of GCC governments to encouraging private sector infrastructure development and managing and sharing risks among project players. Risk sharing choice in GCC has been developed to help both the owner and the contractor to share the minimum risks during construction. They use Public Private Partnerships (PPPs) to share risk. Both the owner and the contractor will have an insurance surety bond and performance bond through the GCC internal Committee to cover the risks.

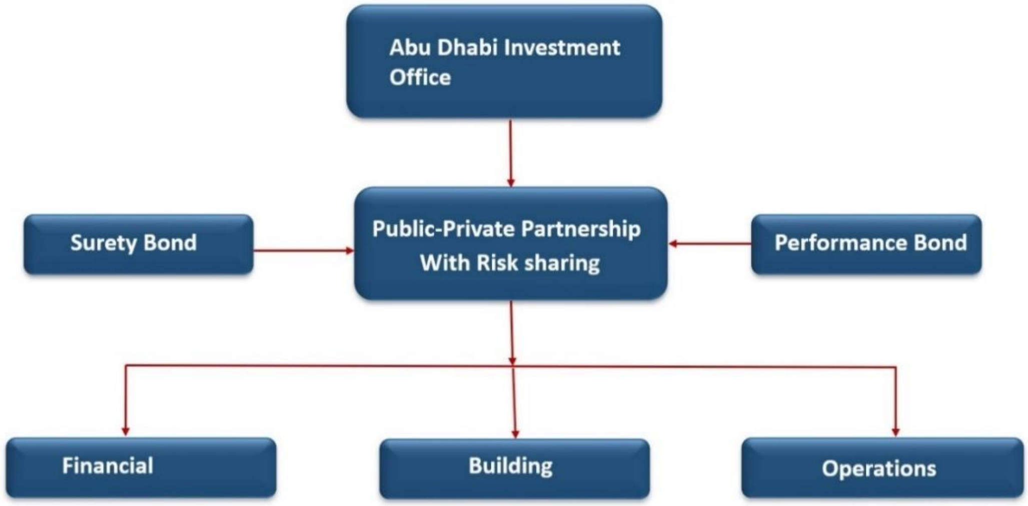

Figure 16.Risk-Sharing in GCC Projects(Source Abu Dhabi Investment Office)

2.17.3.3 US Risk-Sharing

Project risk-sharing choices are essential to US building and infrastructure projects to assign and manage risks among stakeholders. Formal contracts such as design-build contracts or PPPs stipulate obligations and risk-sharing. In PPPs, public and private partners share project risks to optimize risk distribution to the party best able to handle them Figure 17. These contractual agreements disperse finance, building, and operating risks to meet project objectives and reduce liabilities (Federal Highway Administration, n.d.).

Insurance and surety bonds are also used in the US to share construction risk. Contractors usually obtain performance bonds and liability insurance to safeguard project owners and financiers against nonperformance, delays, and other unexpected occurrences. These instruments help insurers, contractors, and project owners mitigate and share risk, improving construction project financial stability and success (National Association of

Surety Bond Producers, n.d.). In the US, project risk sharing is distributed among stockholders, design built contractors, and public private partnerships. As there are both construction risks and operational risks, there is insurance associated with it in terms of bonds. The surety bond will cover the owner and the performance bond will cover the contractor against risks caused by delay and unexpected situations.

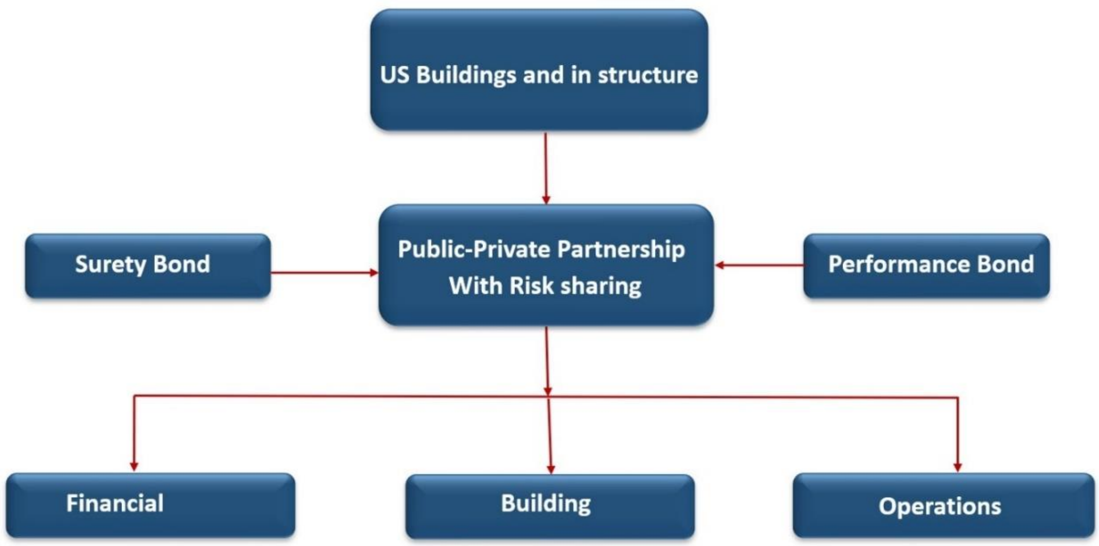

Figure 17.Risk-Sharing in US Projects (Source: US Federal Highway Administration, n.d.)

2.17.3.4 The Study Risk-Sharing

The Contractor Selection Risk Sharing Agreement, as shown in Figure 18, highlights the risk sharing performance and practice during prequalification. The bidder has to comply with the prequalification risk sharing statement beside the sustainability performance is taking as measure for risk sharing when the bidder selected as contractor the risk sharing agreement was to be sign with owner without cost implication or insurance to be made the risk sharing statement will classified which risks to be shared clearly ex, change the scope from client is not included would be variation but other terms of design improvement change manufacture change materials delays in shipments manufacture testing failure etc.

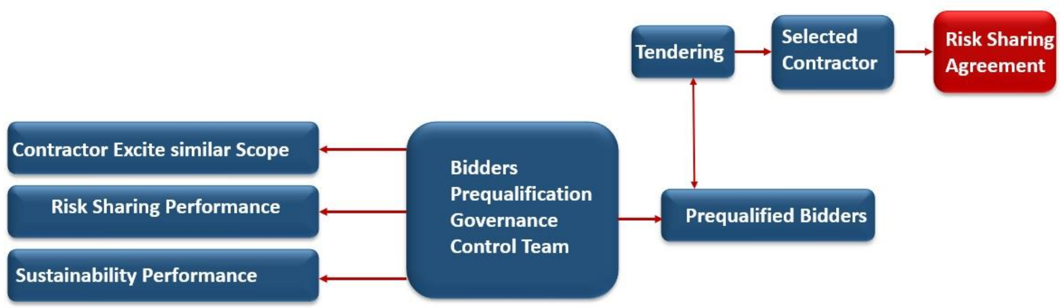

Figure 18.Contractor Selection Risk-Sharing Agreement

2.17.4 Developed Framework

The contractor selection, depicted is shown in Figure 19, plays a crucial role in validating and verifying project planning criteria for contractor selection. It considers all project phases, adapting to the project's nature and complexity, and prioritizes the best developed contractor governance selection under risk-sharing, as illustrated in Figure 20.

This approach focuses on two key aspects: project planning and contractor prequalification, both of which are subject to governance control. They encompass criteria such as project scope, risk management, and planning, similar to those within the domain of contractor prequalification. Key factors like contractor experience, financial performance, and procurement are thoroughly quality-checked as part of the governance process before documents are tendered for the selection of prequalified contractors.

The bidding process mandates that bidders comply with all tender document requirements, as outlined. To ensure project clarity and risk mitigation, each project must define a specific scope and address potential risks. An explicit execution plan is essential and includes specifications like risk-sharing agreements and sustainability performance. Bidders are given the choice to comply with these terms. If they do not, their bids will not proceed for further evaluation. Within the framework for contractor selection, the selected contractor is expected to agree to and sign a risk-sharing agreement with the project owner. Both parties commit to sharing project risks from the initial planning stage through execution until project handover, without the creation of additional insurance or bonds.

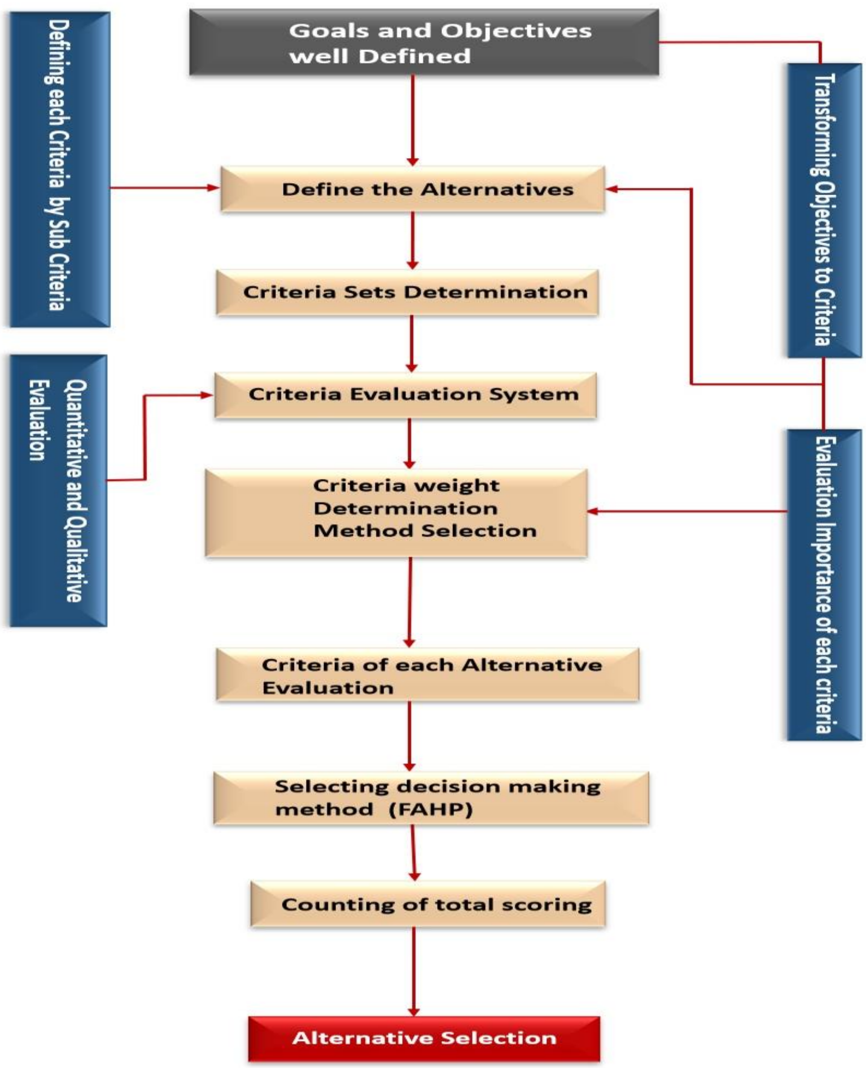

Figure 19.Developed Contractor Selection Decision

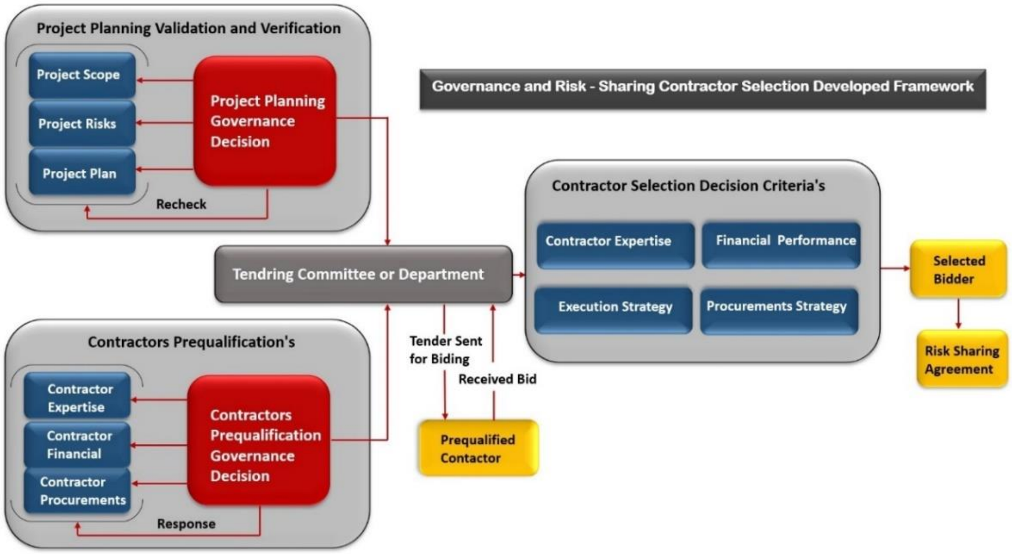

Figure 20.Developed Contractor Selection Framework

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter discusses the research methodology used in this thesis. This includes quantitative, qualitative, and mixed methods approaches. The qualitative method involves data collection through open-ended interview questions, while the quantitative method involves data collection through closed-ended questions (Alsobai et al., 2020).

In this thesis, a questionnaire, structured interview, and unstructured interviews were developed to collect data. Statistical analysis was applied to compute and interpret the collected data. A framework for the choice of contractors was enacted to address the contractor selection issues associated with the current state of construction projects.

3.1 Research Philosophy

Research philosophy includes paradigms that shape the researcher's viewpoint. Positivism and interpretivism dominate. Positivism, founded in the natural sciences, uses empirical observation and quantitative facts to find objective truths (Bryman, 2008). This thesis uses Pragmatism. Because pragmatic research uses mixed methodologies, this philosophy was chosen. We would survey for quantitative data to determine patterns and correlations and interview for qualitative data to record individual experiences. We use quantitative and qualitative data to explore how social media use affects mental health.

A survey technique was used for data collection and framework validation. In published literature, instrumental, descriptive, exploratory, and interpretative research are among the various forms of study (Liu, 2003). The study reported in this thesis is descriptive in nature.

The goal of descriptive research is to discover and record a phenomenon, process, or system, and it can be done using surveys (Liu, 2003). The advantage of using surveys lies in the fact that researchers are allowed to gather huge information in limited time. Surveys are simple to create and control; they are a low-cost tool when compared to other techniques, and they can be applied to provide data of a wide spectrum, attitudes, individual facts, previous behaviors, and thoughts.

3.2 Research Methods

A mixed-method approach (i.e., quantitative and qualitative approach) was used in this thesis. In construction management field, quantitative and qualitative research methodologies are the two most often advised kinds of investigation (Smith & Johnson, 2017). For the quantitative approach to be successful, it must be possible to conclude the relationships between variables in natural phenomena using mathematical models, hypotheses, and theories as illustrated in Figure 21 . However, although qualitative research may be used on a broad variety of subjects, its concentration is on human behavior and the reasons that drive it (Taylor et al.,2021).

3.2.1 Quantitative Approach

A quantitative approach is fundamental to the positivist paradigm of quantitative techniques, where correlations between variables are tested to investigate objective hypotheses. Regularly, these might be tested using statistical approaches to sort the data. The full report will be documented, which will comprise an introduction, literature review, and theoretical framework, as well as methods, results, and commentary (Creswell,2008). The quantitative research technique focuses on the gathering and computing of mathematical data and statistics. It is likely structured on a more statistical use of mathematical data (Creswell,2017). The quantitative technique was chosen because it provides robust findings and may explain changes in the data. Quantitative methods help researchers calculate and analyze data because of their statistical capabilities.

The quantitative approach was facilitated through a questionnaire. In the questionnaire, the intention of the research was briefly described, and the respondents were assured that their responses would be kept private. A five-point Likert scale was used to gauge how strongly respondents agreed or disagreed with the assertions on the following scales: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. The “unsure” scale placed replies in the middle, indicating that the reaction was neither certain as positive nor uncertain as negative; therefore, it was considered neutral. Details on questionnaire design are discussed in Section 3.3.

The goal of this thesis was to collect information about the elements that influence clients’ prequalification contractor decisions, as well as the reasons why clients choose contractors that are not particularly committed to health and safety. The information was gathered by sending questionnaires to construction professionals in Qatar, including different sectors in government and private companies, electricity and water organizations, and the oil and gas industries. The sample for data collection included construction stakeholders, architects, builders, clients, construction project managers, governmental and private planning, as well as operation managers and engineers.

The quantitative analysis aimed for objectivity by creating hypotheses and testing them through surveys. The collected data were then analyzed using statistical methods.

3.2.2 Qualitative Approach

The qualitative approach is widely recognized as an interpretive and naturalistic method that delves into the exploration of meanings individuals attribute to their decisions, attitudes, and behaviors within the social milieu. It is a research technique that facilitates a deep understanding of research and its contextual background, enables the exploration of causal relationships, assesses the effectiveness of interventions, and contributes to the formulation of theories or strategies (Dey,1993). Qualitative research, with its focus on human experiences and perspectives, plays a pivotal role in gaining rich insights and informing decision-making processes. Interviews, document analysis, observation, and audio/visual materials are just a few of the suggested data gathering techniques that researchers have proposed over the last several decades (Creswell, 2007).

In this thesis, the qualitative approach was used to obtain further information about (a) the suitability and completeness of the criteria used in the design of the framework, (b) the appropriateness of the proposed framework within the Qatar context, and (c) the verification and validation of the proposed strategy. This information was obtained through interviews and discussions with a focused group of senior experts in construction projects. During the interviews, members of the focused group were asked open-ended questions that helped them express their views clearly.

A theoretical basis for this thesis and the formulation of the research questions were done through literature reviews, which included an inventory of existing research and theory formation in the construction contractor selection process. A number of past construction projects were also reviewed to understand how public projects are planned and executed. Based on the literature review, suitable research methods were identified, and research questions and hypotheses were developed. The overall research process used in this thesis is illustrated below:

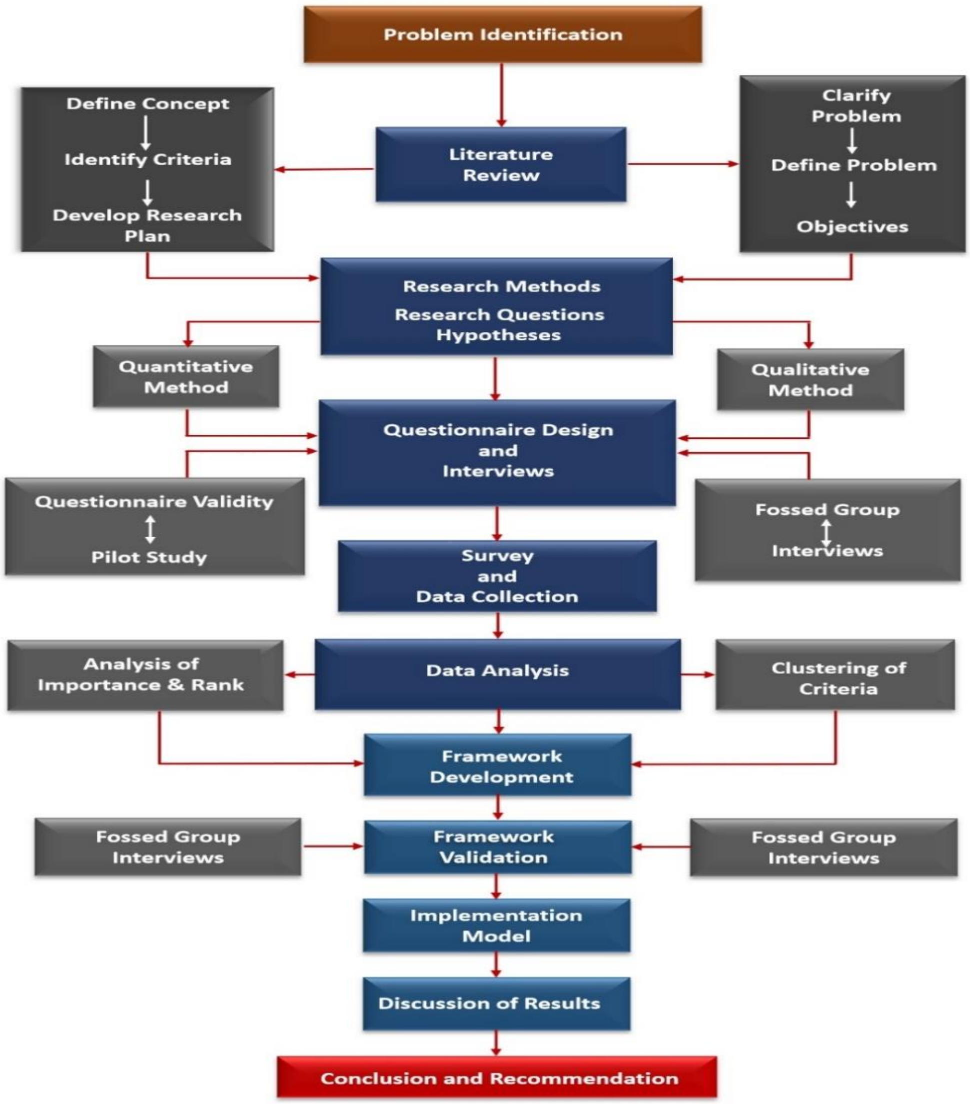

Figure 21.Process of Research used in this Thesis

3.3 Questionnaire Design

Surveys serve as a prevalent method for collecting data regarding people's expertise and opinions. However, the accuracy and reliability of survey results necessitate a high degree of standardization. Standardization ensures that the survey questions, response options, and methodology are consistent and uniform, making it possible to generalize the findings to a broader audience. This uniformity in survey design and administration is essential to maintain the credibility and validity of the collected information, ensuring that it can be effectively disseminated and applied to inform decisions or research in various contexts. In this thesis, a questionnaire was created for the purpose of gathering data and information from construction experts. A group of decision-makers in the planning, contract, projects, and operation sector in Qatar, comprising managers, senior engineers, engineers, and project managers, were given the questionnaire. To enable respondents to feel comfortable responding, some private and undesired information—specifically, respondent earnings, hours of employment, and treatment—was omitted from the questionnaire's three major portions.

The term "successful replies" refers to survey responses that meet specific criteria for categorization as successful. In this context, successful replies are those survey responses in which the respondents have provided comprehensive and detailed answers to the survey questions while adhering to all the survey's requirements and guidelines. Cases that were incorrectly categorized include those in which the respondent did not finish the whole survey. Instances when respondents were reluctant to complete survey questions or provided absurd or amusing replies were classified as examples where it was impossible to contact them for the reasons.

The questionnaire was designed to guarantee accurate findings and a high response rate.

Section One: General Information

This section is divided into three questions requiring different information on participants, such as type of jobs, education, and experience in the construction industry.

Section Two: Project Governance Decision

This section has 10 questions on expert opinion about governance in construction projects, particularly the role of governance during the early phases of the project.

Section Three: Project Execution Contractor Selection

This section covers the contractor selection process for project execution. It includes subsections such as project planning validation, i.e., project scope – 8 questions, project risks – 5 questions, and project execution plan – 5 questions.

Section Four: Bidding Contractors Prequalification

This section covers the prequalification stage at which contractors are pre-qualified based on criteria such as expertise – 6 questions, financial stability – 4 questions, as well as procurements and work strategy – 5 questions.

Section Five: Contractor Selection Decision Criteria

This section covers contractor selection based on criteria such as project planning criteria – 3 questions and prequalification – 3 questions.

Section 6: Risk Sharing Agreement

This section covers expert opinion on a risk-sharing agreement when a project is awarded – 4 questions.

In the latter part of the questionnaire, the researcher sought to meticulously define and evaluate the current state of contractor selection procedures. Respondents were asked to share their opinions on several crucial aspects related to this topic. This segment aimed to gather valuable insights into the practices and perceptions surrounding contractor selection processes. These included the kinds of useful criteria, the process currently used to choose contractors, the manner in which they collect prequalification data, the types of information to be gathered, and the techniques employed to evaluate and categorize potential contractors.

In addition to the questions, respondents were provided with an explanation for each question to help the responder better comprehend the study's objective by giving them further information. To further explain the intent and enjoin the criterion, short explanations of their significance were also included in the questionnaire.

3.4 Case Study Interview

To enhance the research findings, case study interviews with several experts and professionals were conducted. There were two series of interviews:

a. A series of unstructured interviews was first conducted to gather information on the difficulties associated with the construction contracting sector. Preliminary research was undertaken with several engaged parties. Interviewees were asked open-ended questions regarding the case study challenges and issues they encountered while working in this industry. The questionnaire was created using the problems that had been gathered to determine their relative relevance.

b. A series of scheduled interviews followed. After assessing the results of the questionnaire, a combination of structured case study interviews with (focus groups) experts and professionals, including various managers and project engineers, was carried out to ascertain the accuracy of the outputs and improve the outcome of the study. Interviewees were questioned about the case study causes of the dramatic and surprising outcomes.

3.5 Data Collection

Primary or secondary data gathering depends on study objectives, resources, and the applicability of existing data to answer research questions, as shown in Figure 22. Researchers use both strategies to strengthen their investigations and analyses.

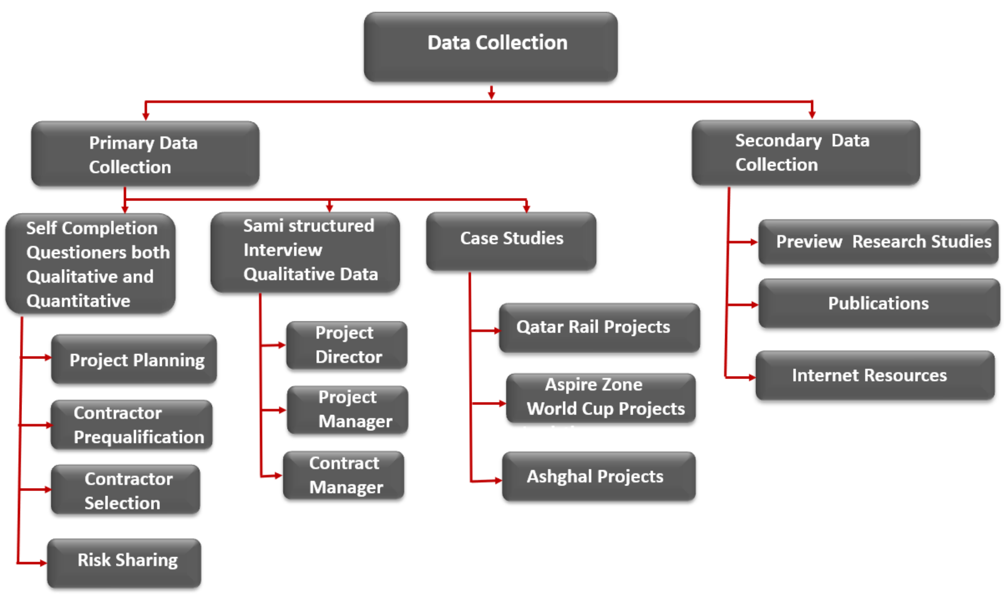

Figure 22. Data Collection

Primary Data Collection: For a research study, primary data is collected directly from individuals, sources, or observations. This strategy allows researchers to obtain data tailored to their goals and inquiries. Primary data collection methods encompass surveys, interviews, experiments, observations, and focus groups. Researchers employ these methods to address specific research inquiries, guaranteeing the relevance and precision of the gathered data (Malhotra & Birks, 2006).

Secondary Data Collection: Uses data acquired by other people, organizations, or agencies for purposes other than the researcher's study. Researchers analyze secondary data to gain insights, draw conclusions, or answer research questions without collecting data. Academic literature, government papers, commercial records, and public databases are secondary data sources. This strategy is cheaper and faster than primary data collection, although data relevance, accuracy, and availability may be limited (Bryman, 2015).

Every survey should use the optimal data-gathering strategy to enhance response rates. Each data collection instrument has its own qualities and applications. Selecting an appropriate data collection method hinges on multiple considerations such as the research subject, participant attributes, data intricacy, sampling frame details, and sample size. As outlined by Julie (2007), Cherry (2011), and Denzin and Lincoln (2003), four primary data collection methods serve as categorizations in research methodology. Personal interviews, when conducted by skilled and well-trained interviewers, often yield higher response rates across various groups. This is because proficient interviewers can provide clarifications, allowing participants to gain a better understanding while completing intricate surveys. Moreover, it enables additional data collection. In cases where respondents provide inaccurate or partial answers, interviewers can request further information to enhance data quality. They can also assess how the interview affected the respondent and offer assistance if needed. Nonetheless, it's important to acknowledge that personal interviews come with limitations, as they demand skilled, well-prepared, and punctual interviewers to maintain their effectiveness and reliability.

3.5.1 Pilot Study

Pilot studies, a critical preparatory phase in research, refine research methods and processes, making the main study more robust. This small-scale exploration tests data gathering techniques and experimental protocols and addresses potential issues. A well-conducted pilot study reduces resource waste and helps researchers refine their research objectives and assumptions. Like a rehearsal, it ensures the main study's success. According to Teijlingen et al. (2008), pilot studies help identify and resolve methodological and logistical issues before a larger investigation, improving research quality and reliability.

3.5.1 Collected Primary Data

Every research project requires pilot experiments. These help the researcher evaluate and ensure the authenticity and reliability of the investigation before it commences. Therefore, interviews with public sector procurement officials were conducted using a semi-structured format.

In response to feedback from participants in the pilot study, two questions were identified as potentially redundant, prompting the need for modification. Furthermore, improvements were made by rectifying various grammatical errors and providing clarifications to certain questions. These refinements aim to enhance the questionnaire for upcoming respondents and improve its overall quality.

Building upon insights derived from the pilot study, the questionnaire underwent a refinement process to ensure the consistency and validity of every clause and paragraph.

The final survey retained only those questions directly relevant to the research topic, thereby enhancing the questionnaire's precision and effectiveness.

3.5.2 Data Validity

In a mixed methodology study, the type of research approach used in the procedure has an impact on data analysis. Consequently, the following analytical techniques were employed:

Investigating Outliers: The primary focus of research validity is to demonstrate that the study accurately assesses what it was intended to test, and that the results are accurate. Validity is often confirmed by seeking expert opinions on the research (Golshani & Nahid, 2003; Mora, 2014). When constructing a survey, Lund (2012) advises researchers to ensure both field coverage and content validity. For survey content validity, all three conditions must be met.

3.6 Reliability

Research reliability is the consistency and stability of measurement or data collection methods across time and under different conditions. It ensures that study outcomes are reliable and not influenced by random errors. When applied repeatedly on the same sample or by multiple observers, a reliable research instrument or measuring tool yields consistent results (DeVellis, 2016). Replicability demands high dependability so that other researchers can obtain similar results using the same study or measuring equipment. To minimize errors and variations that may impact research findings, surveys, scales, and observational methods must be meticulously designed and tested.

3.7 Validity and Reliability Impacts

Validity and reliability are crucial for research credibility. Validity evaluates how well a study instrument or procedure measures the target construct or phenomena. A study without validity may provide misleading or incorrect conclusions as it fails to appropriately analyze the concept of interest (Trochim & Donnelly, 2008). On the other hand, reliability refers to the consistency and stability of study results over time and under varied settings. Unreliable research tools and techniques might lead to inconsistent results, making it difficult to draw conclusions or replicate the study (Babbie, 2016). Thoroughly addressing validity and reliability issues improves research quality and rigor by increasing the likelihood of obtaining accurate and consistent findings.

3.8 Administrative Process Data Collection Questioners

Before the surveys, meetings and emails were the primary means of communication with the selected businesses, managers, ministries, and organizations. Interviewers met face-to-face to schedule appointment dates with participants, including senior project managers, directors, and construction project clients.

Prior to respondents filling out the questionnaire, assistants explained the survey to address any concerns they may have had. Researchers were typically present during questionnaire surveys to clarify and simplify items that participants found challenging to comprehend. It was essential to translate numerous questions into colloquial Arabic.

The pilot research proved instrumental in identifying participant data and information access restrictions. It also shed light on data source accessibility and availability. The questionnaire was designed to collect data, evaluate contractor selection practices, and aid in creating a framework. Questionnaire surveys function as a rapid and effective means of gathering respondents' opinions. The pilot research highlighted the extent of participant data and information access constraints. Additionally, it underscored data source availability and accessibility. Given these factors, it is crucial to consider the following when completing the main questionnaire:

Keep the questionnaire concise since many respondents were hesitant to finish long questions.

Selecting the appropriate data gathering method to enhance survey response rates is crucial. Data gathering instruments have various qualities and applications. The selection of a data collection method hinges on various factors, including the research topic, characteristics of the study population, the volume and intricacy of the data, details about the sampling frame, and the sample size. Personal interviews, telephone interviews, and email/web questionnaires were employed to obtain data.

3.9 Survey Process

In the process of selecting specific variable criteria, it is crucial to establish clear major criteria and sub-criteria, as illustrated in Figure 3-3. This clarity enables decision-makers to make informed choices and select the most optimal course of action. In the context of this multicriteria selection dilemma, the ability to choose the best-suited contractor, someone capable of effectively advancing the project towards its objectives, holds paramount importance. It underlines the critical nature of sound decision-making in construction projects. Through this study, an integrated method for multicriteria contractor selection was developed. Two preparatory stages were necessary to establish this strategy: The investigation of the current contractor selection procedures used in both developed and developing nations, along with the identification of the characteristics within the various systems that are most beneficial for evaluating contractors, constituted the initial steps in the development of this approach.

The next stage involved conducting a questionnaire survey with the aim of identifying and assessing the current state of contractor selection procedures.

3.10 Framework Development Approach

Various documented methodologies exist for creating a framework, but they typically share a common approach of bottom-up abstraction. This involves scrutinizing existing solutions and extracting general principles from them. When embarking on framework development, it's crucial to remember that every framework should align with its intended purpose.

3.10.1 Data Analysis

To provide answers to the study’s questions, the data were analyzed using the Statistical Package for Social Science (SPSS) tool. Descriptive statistical analysis was performed using means, frequencies, standard deviations, averages, sums, regression, and one-way variance analysis. The researcher combined the Interval and Ratio scale into one and referred to it as the Scale variable to indicate the estimation level of contractors’ responses for examination in order to evaluate the findings.

In the realm of data analysis, the first pivotal step is to identify the suitable statistical tests. This decision is contingent on factors like the study design, the hypotheses or research questions under examination, and the nature of variables in use.

3.10.2 The Correlation

In this study, the primary strategies for examining the relationship between two quantitative variables will be these approaches. They are preferred due to their popularity and widespread utilization, offering effective means to analyze and understand the connection between such variables. This choice is justified by the primary data source for the study which is a questionnaire survey that primarily involves contractor ranking criteria and sub-criteria.

3.10.3 Methods of Analysis

The data were entered into the SPSS, where variables were created for all questions and sub-questions. Value labels were used to code each answer option, resulting in a total of 12 variables being used in the study. Liu (2003) distinguishes three types of content analysis: qualitative, quantitative, and structural content analysis. While a sample of 54 responses, despite being quantitative data, was deemed insufficient for a thorough statistical analysis, a sample size exceeding 100 responses would be considered adequate. It is crucial to choose the right sample size for your survey, taking into consideration the population's size, the margin of error, and the desired level of confidence. The majority of statisticians concur that a sample size of at least 100 is necessary to obtain any form of significant results.

Basic SPSS capabilities, including statistics and custom tables, were employed. Frequencies, means, distributions, and rankings were obtained with their assistance. Graphs were created in Microsoft Excel to help illustrate statistical data. These results from the questionnaire analysis served as a foundation. An interview is an example of qualitative data, and the goal of analysis is to determine what the data means (Fellows & Liu 2003). The data were processed using no specific analytic technique. Instead, the researcher sought to understand the respondents' perceptions, ideas, and views on the study area by identifying patterns.

Since the interviews were mostly structured, many questions were asked in the same order in each session. This strategy provided a very clear structure for the answers and simplified the transcription and analysis process. The data were analyzed in two stages. First, the interviews were categorized according to the project name and responses. Then, the most intriguing and illustrative quotations from the interviews were selected and incorporated into the results.

3.11 Summary of the Chapter

The research methodologies used in this study have been thoroughly discussed. The chosen research techniques and methods have been comprehensively explained in this chapter. Moreover, the study strives to provide a clear comprehension of the research approach and its applicability within the study's context. It delves into the fundamental features, advantages, and limitations of quantitative, qualitative, and hybrid research methodologies. The questionnaire survey aims to provide insights into the current practices of contractor selection, drawing from both qualitative and quantitative data sources. This survey is directed at decision-makers across the public and private sectors, encompassing contractors, clients, project managers, and consultants. The SPSS statistical tool will be employed.

The subsequent stage of the study involves ranking the selection criteria discovered in the first step, creating a route map, and evaluating the framework based on the established criteria. Construction experts will participate in the SPSS survey Question's . Chapter 6 will provide a brief description and explanation of the SPSS survey methodology, data gathering techniques, stages, and analysis. The final phase of this study involves a case studies and framework validation. Real-life data will be used to validate the constructed model. This method employs a hybrid framework.

CHAPTER 4: FRAMEWORK DEVELOPMENT

4.0 Framework for Contractor Selection

4.1 Overview

The proposed contractor selection framework is a risk-sharing contraction selection process base that includes governance in the early project phases before construction. The framework provides guidelines on the assessment and selection of contractors based on their capability to successfully manage project risks while adhering to defined governance processes. This process occurs during the contractor selection phase of the governance and risk-sharing framework. In this strategy, the focus is placed on evaluating the risk management techniques of the contractor, as well as their compliance with rules and their commitment to developing transparent governance structures that encourage accountability and effective project results. When selecting a contractor, the inclusion of governance and the risk-sharing is expected to help in mitigating risks, improving project performance, and ensuring a collaborative partnership that is beneficial to both the owner and the contractor.

Laryea, Mensah and Leiringer (2020) have conducted research that investigates the presence of risk-sharing mechanisms in the selection of contractors. This research emphasizes the need for contractors who should have the ability to successfully manage project risks. This study emphasizes the importance of contractual clauses and risk distribution measures that cultivate a sense of shared responsibility between the owner and contractor. In addition, Alreshidi, E., & Aziz, R. F. (2016) investigated the function of governance in the selection of contractors and emphasized the relevance of governance measures such as stakeholder involvement, transparency, and accountability. The study emphasizes the importance of effective governance structures in contributing to the successful selection of contractors and project execution.

Over the past few years, the incorporation of governance and risk-sharing into contractor selection processes has garnered a lot of attention for improving the quality of projects. Famiyeh, Ameyaw, Osei-Tutu and Amoakoh (2020) explored the implementation of a risk-sharing procurement model in the process of contractor selection. This developed framework calls for the owner and the contractor to share both the risks and the potential benefits of the project. The research highlights the fact that this paradigm encourages cooperation, provides performance incentives, and decreases the risk of disagreements occurring. In addition, Arditi and Gunduz (2018) emphasized the significance of governance mechanisms in the process of contractor selection. More specifically, they concentrated on the governance of the relationships that exist between contractors and subcontractors. According to the findings of their study, efficient governance structures lead to improvements in the selection of contractors and the management of subcontractors. It is possible to improve project performance, reduce risks, and successfully execute projects by including governance considerations and risk-sharing models in the contractor selection process.

The framework purposed in this study is about criteria and sub-criteria for contractor selection were based on the attributes of project planning and contractor prequalification. These attributes are ultimately the organization's or private companies' internal decision departments governed by restricted final approvals before proceeding to tender. Thus, the criteria and sub-criteria were designed and structured based on the contractor selection framework.

The Purposed framework in this thesis consist of the main sections; (1) project planning and validation, (2) Contractor prequalification, and (3) the contractor selection process. The following sub-sections provide details on (a) the importance of each subsections and various techniques and methods used to implement the proposed framework, (b) details on how the subsections in the framework were developed and assembled, and (c) the impact of each of the sub-sections of the proposed framework.

4.2 Project Planning Validation under Governance

To guarantee that the project plan is comprehensive, accurate, and achievable, it must undergo a regulated decision process known as Project Planning Validation and Verification in detailed as shown in Figure 21. As part of the governed decision process, it is important to review the scope of the project, determine its feasibility, confirm timelines and milestones, assess the budget and resource allocation, acquire stakeholder buy-in, perform a risk assessment, and update the plan regularly until final approval. Investors, customers, or project managers can rest easy knowing that their project plan will have a solid footing for implementation if it undergoes these processes.

Framework planning criteria and sub-criteria were developed by using scope validation, stakeholder requirements, and the organization's aim as well as future needs from the project . The change of orders and variances in the construction process can be minimized if decisions about the building's design, materials, and finishing touches are made early on. For a project to succeed, it is necessary to validate its planning. Analytical Hierarchy Process (AHP) and other decision-making techniques may help validate project planning, according to Karim and Saaty (2006). Project stakeholders may use the AHP to rank project options by cost, time, and risk. This thesis underlines the relevance of governance choices in project planning validation, especially in terms of aligning project objectives with organizational goals. Munns and Bjeirmi (1996) emphasized the relevance of governance choices in project planning by highlighting the need for a complete project plan that includes all key stakeholders. These studies underline the relevance of decision-making tools and governance choices in project planning validation to obtain effective project results.

The proposed framework in this study is a specialized group, the governance team, performs risk assessments and provides recommendations on which threats should be documented and which should be minimized. To ensure that bidders accurately portray their position in the bidding process, the registered project risks should be included as sub-criteria in the project tender document.

The tendered project execution plan will have a clear and realistic duration for a specific project and has a buffer of time for any unanticipated delays beyond the contractor's and client's control. This duration will be reflected clearly for the bidder's positions during the bidding process.

The detailed project planning validation Framework in this study is shown in Figure 23 which covers all project processes before execution, from project planning and contractor prequalification to the tendering process for contractor selection and risk-sharing agreement between the client and the selected contractor. For project planning and contractor prequalification processes, a governance team has been assigned to ensure the quality of each criterion. The selection of criteria is based on the opinions of experts who were interviewed and provided feedback on the importance of each one. The quality of each criterion is ensured before tendering, as seen below. This process will finalize the decision through governance for project planning scope and deliverables, which will be Risks and Project Plan through three organization internal governance teams: Project scope validation governance team, Project risk Assessment governance team, and Project execution plan governance team.

Project scope: Requirements and deliverables are the major aspects of the project which are to be fully checked and validated to avoid cost overrun or variations later by fully addressing all stockholders' requirements.

Project risks: Project risk assessment is mostly required for any project in identifying the risk, mitigating the risk, and addressing the remaining risks to be as part of the tender for all pre-qualified bidders.

Project Eexecution Plan: The project execution plan should consider the active project milestones durations and project execution environment duration to be sure that the contractor has flexibility during construction and avoid fast-track construction which may develop delays and additional variations.

Figure 23.Detailed Project Planning Validation

4.3 Contactor's Pre-Qualification under Governance

The prequalification process for contractors involves a controlled decision prequalification-governed team that evaluates and selects possible contractors for a project or job based on the contractor's skills, experience, financial performance, and other factors. Pre-qualifying contractors ensure that only capable contractors are chosen for a project. Odeyinka and Yusif (2014) found that governance choices affect pre-qualification. Financial stability, technical capacity, and prior success are important pre-qualification requirements, according to the research. Research suggests that proper governance can ensure fairness and transparency in the pre-qualification process. Zhang, Smith and Brown (2018) found that governance choices in contractor selection, especially pre-qualification, are crucial. The report advised using governance decisions to create a uniform pre-qualification process that selects contractors objectively and without prejudice. These results highlight the relevance of governance choices in pre-qualification to pick competent contractors for projects.

During the prequalification process, which is conducted by good governance, a contractor's qualifications and records are thoroughly examined to ensure that they are fit for the job at hand. The purpose of the prequalification process, which includes governance, is to guarantee that the chosen contractor can complete the project as specified.

Therefore, the research framework lays out the standards by which the organization's specialized team determines whether a contractor meets the requirements to be considered a *pre-qualified* participant in a given tender.

The contractor's expertise includes (a) performance in executing a project scope similar to the one at hand along with the associated execution plan, and (b) how the contractor fares as a sustainable contractor, concerning financial stability reflected in his ability to conduct the project in a sustainable manner, utilizing an appropriate execution strategy along with a comprehensive procurement plan.

The contractor needs to comply with the risk-sharing agreement during the prequalification process. If they do not comply with the agreement, they will be disqualified from bidding. The framework proposes that a clear statement is provided for all bidders to acknowledge the condition.

The detailed Pre-qualification process, as shown in Figure 24, as detailed prequalification will finalize the best bidders as ranking decisions through governance. The bidders will be pre-qualified based on three criteria: Bidder Expertise criteria, Bidder Financial Stability criteria, and Bidder Project Execution Strategy criteria which will determine eligibility to participate in the project tender.

Bidder's Expertise: All bidders must meet prequalification requirements, which include having expertise in a similar project, a good record in life and safety, as well as a history of sustainability and risk-sharing practices. Previous experience and knowledge of integrated project concepts are also important.

Bidder's Financial Stability: All pre-qualified bidders must meet the financial statement requirements to qualify for pre-qualification.

Bidder Project Execution Strategy: During the prequalification process, each bidder is required to present their plans for materials, manpower workforce requirements, and work strategy for their running projects. This approach is evaluated and judged based on the bidder's ability to demonstrate their manpower workforce skills, materials manufacturers, and suppliers, as well as their ability for project management and risk sharing. Essentially, this show cases the bidder's ability to execute the project successfully with a well-planned approach.

Bidder Procurements and work Strategy : Any bidder has own plans for materials and man power workforce requirements and work strategy for his running projects this approach has to be presented and submitted during prequalification for evaluations and judgment shown the manpower workforce skills and materials manufactures and suppliers also shown his ability for project management and risk sharing during project execution.

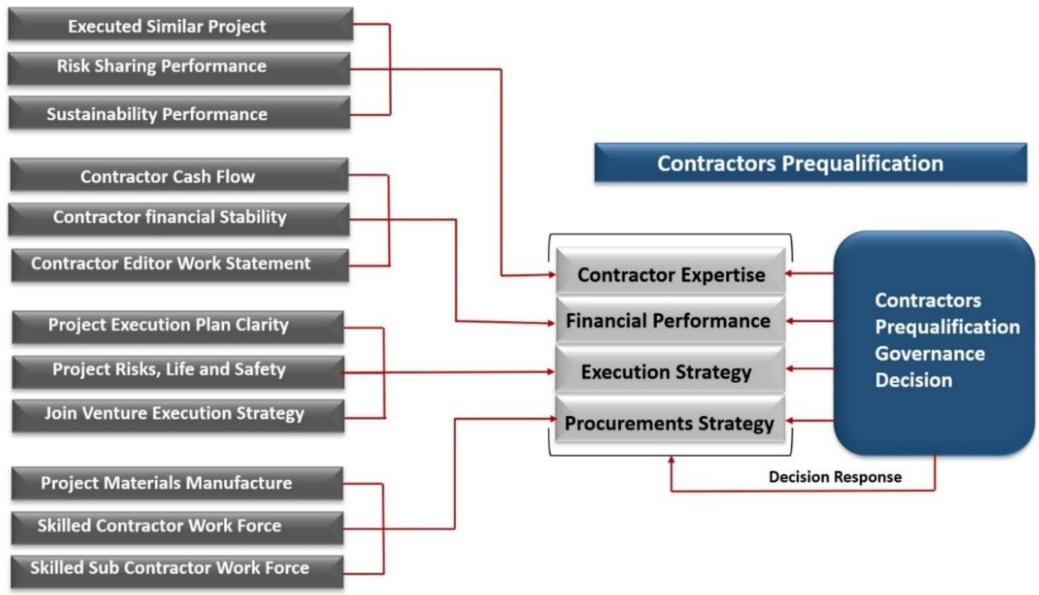

Figure 24.Detailed Contractor Prequalification

4.4 Contractor Selection

The selection process will be based on a decision model that ranks the shortlisted candidates. As shown in Figure 25 Only pre-qualified contractors/bidders will be invited to participate in the tender. The selection of these contractors/bidders will be based on their prequalification criteria and their compliance with the terms and conditions of the tender document.

The framework's contractor selection criteria include Contractor Past Performance, which requires the shortlisted contractors to present evidence of their past performance and requirements that outline the processes for selecting a contractor after receiving bids and comparing them to those outlined in the shortlisted contractor’s proposals.

The contractor selection will be based on reply of each pre-qualified contractor on the tender document and their position of compliance for each project planning as stated within the project execution and milestone requirements and measured requirements of each that meets the project's overall execution milestones as the contractor will be selected based on the Fuzzy Analytic Hierarchy Process (FAHP). Pre-qualified contractors are required to detail the executed strategy for execution in terms of activities and milestones upon receiving the tender document and to convey their viewpoint during the bid process. In addition, the pre-qualified contractor must demonstrate their position clearly regarding the project's registered risks, which are included in the tender and must be either accepted or rejected, with the latter option incurring either additional cost or time. The pre-qualified contractor must also consider the project's life and safety, presenting their life and safety record demonstrating their work on site and accident statistics.

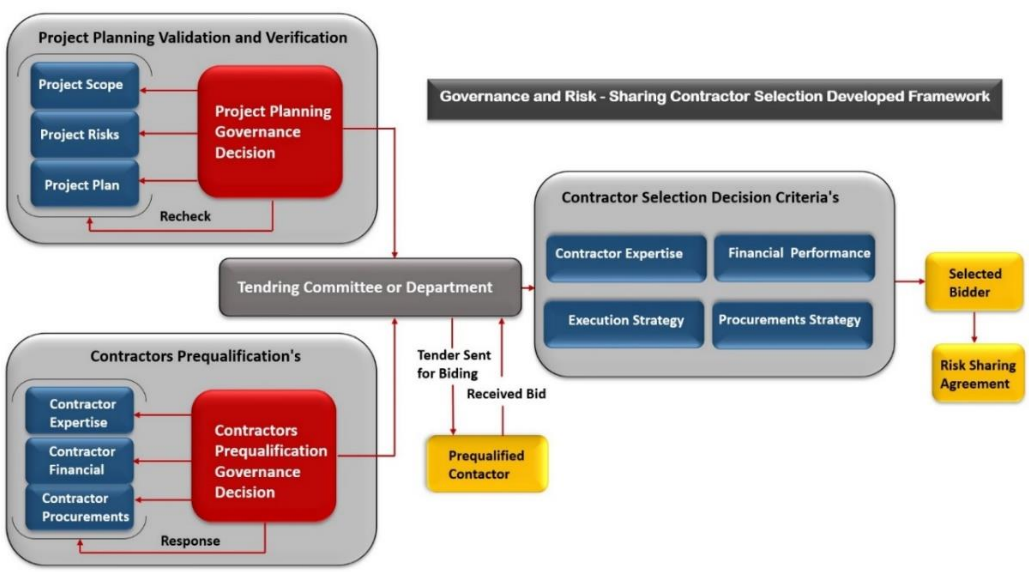

Figure 25.Contractor Selection Processes

4.5 Selected Contractor Risk-Sharing Agreement

The risk-sharing agreement process, as shown in Figure 26, applies to the selected contractor based on the contractor selection process. At the end of the project tendering process, the client and the selected contractor will enter into an agreement. This agreement covers the entire project process, from planning to completion, and outlines the shared risks between both parties. The agreement will be based on signed documents with clear conditions that specify the risk-sharing arrangement.

The contractor's prequalification was presented as one of the sub-criteria for accepting and pre-qualifying the contractor as primary criteria based on their risk-sharing past performance. This was done to ensure that the contractor would be able to complete the project. Construction companies are increasingly using risk-sharing agreements to manage project risks. Lee and Kim (2019) found that risk-sharing agreements may fairly divide risks between owners and contractors. The study reveals that governance choices are critical to the risk-sharing agreement process, notably in identifying shared risks and choosing a risk distribution mechanism. El-Sayegh and Zahoor (2010) emphasized the risk pooling agreement's relevance to project risk management. Risk pooling agreements may improve owner–contractor interaction, minimize disagreements, and contribute to project success, according to the research.

This risk-sharing agreement will be highlighted as a joint agreement between the project client and the contractor about sharing risks and any changes that could happen during the project construction or any changes as required corrected in design change orders during execution could be accrued. It will also cover any unforeseen risks and environmental delays that will ultimately relieve the project owner of additional costs and maintain a stable project budget.

Figure 26. Risk-Sharing Agreement

4.6 The Importance of Proposed Contractor Selection Framework

4.6.1 Contractor Selection Methods Overview

Conventional Design-Bid-Built (DBB) is a method of project delivery that is used often in the construction business. It is a step-by-step procedure that begins with the project owner engaging the services of either an architect or an engineer to design the project. After the design has been finished, the owner will request bids from several contractors based on the design documentation. The bids from the contractors are then evaluated by the owner based on the criteria that have been established beforehand. These criteria may include cost, qualifications, experience, and time. The contract for the construction work is then given to the contractor who submitted the offer that the owner considers to be the most beneficial. This classic DBB strategy provides openness, enables competitive bidding, and gives the owner a variety of contractor choices from which to choose one.

Several studies have investigated the typical DBB contractor selection process. Price and time commitment were shown to be the most important considerations in the DBB technique by El-Diraby and AbouRizk (2003), who investigated the elements that influence contractor selection when using the DBB method. They also emphasized the need to have well-defined project criteria and a method for evaluating bids. Kwek, Chew and Yiu (2015) investigated the dangers that are connected to the selection of contractors in DBB and recommended risk management techniques as a means of reducing these dangers. They stressed the need to conduct exhaustive contractor prequalification processes and conduct exhaustive evaluations of bids to reduce the likelihood of possible dangers. The results of these studies throw a spotlight on the traditional DBB contractor selection procedure as well as the aspects that should be taken into consideration while seeking good project outcomes.

One of the most common methods of conventional contractor selection is a Request for Proposal (RFP) process. In this process, the owner or client prepares a document outlining the project's scope of work, specifications, and requirements. Interested contractors submit a proposal outlining their technical qualifications, experience, and cost. The owner or client evaluates the proposals based on a set of predetermined criteria and selects the contractor with the best proposal.

Another common method of conventional contractor selection is the Request for Qualifications (RFQ) process. In this process, the owner or client issues a document requesting interested contractors to provide information about their technical qualifications, experience, and references. Based on this information, the owner or client creates a shortlist of qualified contractors and invites them to submit a proposal.

Conventional contractor selection methods typically focus on technical qualifications and cost. The contractor's experience, expertise, and previous project successes are often evaluated, along with the proposed cost of the project. The selection process is typically objective and based on predetermined criteria. However, these methods may not take into account other factors, such as the contractor's management style, risk management capabilities, and ability to work collaboratively with the owner or client Cotts and Mullen (2009).

While conventional contractor selection methods have been used and are familiar to many in the construction industry, they may not always result in the best contractor for the project. As a result, alternative approaches that include governance and risk-sharing in contractor selection methods have acquired popularity in recent years McCaffer and Raouf (2006).

These methods place greater emphasis on risk management, accountability, and transparency and are designed to select a contractor who can manage risks and deliver the project on time and within budget Chan, A. P., and Chan, D. W. (2004).

Overall, there are several types of project delivery methods used in the construction industry, including:

1. **Design-Bid-Build (DBB):** With this method, the owner or client hires a design team to create a complete set of construction drawings and specifications. The project is then put out to bid, and interested contractors submit their proposals. The owner or client selects the contractor with the lowest bid, provided they meet the project's technical qualifications.
2. **Design-Build (DB):** In this method, the owner or client hires a DB team to create the construction drawings and specifications and construct the project. The DB team is responsible for managing the project from start to finish. The owner or client selects the DB team based on their technical qualifications, experience, and cost.

3. **Construction Management-At-Risk** (CMAR): This is a project delivery method that is commonly used in the construction industry. It involves a contractual agreement between the owner, the construction manager, and the contractor, in which the construction manager assumes the risk and responsibility of managing the construction project. In this method, the owner or client hires a construction manager who acts as a consultant during the design phase and as a general contractor during construction. The construction manager is responsible for managing the project's cost, schedule, and quality. The owner or client selects the construction manager based on their technical qualifications, experience, and cost.
4. **Multiple Prime Contracts (MPC):** In this method, the owner or client hires several prime contractors to work on specific parts of the project. Each prime contractor is responsible for managing their respective part of the project, and the owner or client is responsible for coordinating the work between the contractors. The owner or client selects each prime contractor based on their technical qualifications, experience, and cost.

These conventional project delivery methods vary in terms of the level of control and risk management. Some methods, such as DB and CMAR, provide greater control over the project and allow for more risk management, while others, such as DBB and MPC, provide less control and risk management. The selection method chosen will depend on the project's specific needs and objectives.

4.6.2 Governance with Risk Sharing in Contractor Selection Framework

When discussing governance and risk sharing in contractor selection, we are referring to the process of choosing a contractor for a project that involves considering various contractual and risk management systems. This strategy emphasizes determining whether the contractor is capable of efficiently managing risks, complying with rules, and establishing governance structures that guarantee accountability and transparency throughout the lifetime of the project. The incorporation of governance and risk-sharing mechanisms into the process of selecting a contractor has the goals of reducing the chance of possible hazards, improving the overall performance of the project, and promoting effective collaboration between the owner and the contractor. According to the findings of research conducted by Laryea, Ameyaw and Ankrah (2019), it is essential to include risk-sharing clauses in contracts to properly assign and manage project risks. In addition, Agarwal, Gupta and Sharma (2018) highlighted the relevance of governance structures in the process of aligning the interests of the owner and the contractor, supporting rapid decision-making, and lowering the uncertainties associated with the project. Improved project results and effective project delivery are both facilitated by the incorporation of governance and risk-sharing factors into the contractor selection process.

The governance with the risk-sharing contractor selection method is a procurement approach that involves the selection of contractors based on established governance criteria, as well as the allocation of risks and rewards between the owner and the contractor. This method promotes transparency, accountability, and collaboration in the contractor selection process, leading to improved project outcomes (Smith, A.2022).

The risk-sharing aspect of the contractor selection framework proposed in this thesis involves the allocation of risks and rewards between the owner and the contractor. The contractor takes on a share of the project risks, such as risks related to schedule delays, cost overruns, and quality issues, and all related to effectively managing these risks to minimize their impact. In return, the contractor also shares in the rewards of the project, such as bonuses or incentives for meeting project milestones or delivering high-quality work. This promotes collaboration between the owner and the contractor, as both parties have a vested interest in the success of the project and work together to manage risks and optimize project outcomes (Smith, J.(2020).

Overall, the governance with risk-sharing contractor selection method provides a structured and collaborative approach to contractor selection, promoting transparency, accountability, and risk management in the construction project. This method can lead to improved project outcomes, increased stakeholder trust, and successful project delivery. In addition, it requires careful planning, clear communication, and effective risk management to ensure its successful implementation. Therefore, it is essential to thoroughly evaluate and tailor this approach to the specific needs and requirements of each construction project. In general, governance with a risk-sharing contractor selection method can be a valuable approach for construction project stakeholders to achieve successful project outcomes as discussed bellow.

1. The method promotes improved contractor performance by incentivizing the selected contractor to manage risks effectively. The contractor is invested in the project's success as they share in the risk and reward of the project, leading to better project outcomes and reducing the risk of project failure, which can be costly in terms of time, resources, and reputation.

2. Governance with risk-sharing contractor selection methods promotes transparency and accountability in the contractor selection process. The use of established prequalification criteria, evaluation criteria, and risk-sharing mechanisms ensures that the selection process

is fair and ethical, with accountability established at all levels of the process. This builds trust among stakeholders and promotes a positive project environment. The risk-sharing mechanism also promotes collaboration between the owner and the contractor, enabling the effective management of risks and the successful delivery of the project.

3. Governance with risk-sharing contractor selection methods helps to mitigate risks associated with project execution. The risk-sharing mechanism incentivizes the contractor to manage risks effectively, reducing the risk of delays, cost overruns, and quality issues that can arise during the construction phase. This approach also promotes collaboration between the owner and the contractor, enabling the effective management of risks and the successful delivery of the project.

4. Governance with risk-sharing contractor selection methods provides an opportunity to optimize project outcomes. The risk-sharing mechanism incentivizes the contractor to minimize risks and optimize project outcomes, leading to higher-quality construction, lower costs, and faster delivery. Overall, the governance decision and risk-sharing contractor selection method offer significant benefits to construction project stakeholders, promoting improved project outcomes, increased stakeholder trust, and transparency and accountability in the contractor selection process.

4.7 DBB and Purposed Framework Delivery Comparison

4.7.1 Contractor selection method in DBB

One of the project delivery method is Design-Bid-Build (DBB), and it involves selecting the contractor through a process of competitive bidding. The process of selecting a DBB contractor normally consists of two separate parts, the first of which is the design phase, followed by the bidding phase. During the design phase of the project, the owner will choose either an architect or an engineer to establish the project's design and requirements. When the design is finished, the owner will send out bid requests to numerous contractors, asking them to base their proposals on the design papers. The bids are submitted by the contractors, which typically include cost estimates, timetables, and qualifications. After that, the owner will examine the bids and choose the contractor based on the criteria that have been set, such as the lowest offer, the credentials of the contractor, experience, and reputation. This procedure provides openness and competition and gives the owner the ability to choose the contractor who most effectively satisfies their criteria while staying within the allotted budget.

Contractor Selection is a process in which the owner or client evaluates contractors based on their technical qualifications, experience, and cost. The primary objective is to select a contractor who can deliver the project at the lowest possible cost while meeting the required technical specifications. In contrast, contractor selection based on governance with risk-sharing is a process in which the owner or client shares the project's risk with the contractor. This means that the contractor has a stake in the project's success and is incentivized to manage risks and deliver the project within budget and on time.

Risk-sharing administration, on the other hand, has a different way of making decisions. This signifies that the contractor has an interest in the success of the project and is motivated to manage risks and execute the project on time and within budget because they have a stake in the project's success. For instance, Lee, Kim and Park (2018) analyzed the criteria that owners use in the selection of DBB contractors and found that owners typically take into consideration aspects such as bid pricing, contractor experience, and previous performance. This was discovered in their findings. In a separate piece of research, Glick, B. (2018) underlined the significance of having a well-defined bidding procedure as well as clear assessment criteria to guarantee that the selection process is both fair and objective. Because of how clear and open it is, the DBB contractor selection technique is widely used in the construction business. This is because it enables owners to evaluate many contractors and pick the one that is best fit for their project based on preset criteria.

One of the key differences between contractor selection in DBB and the proposed contractor selection method is the level of risk management. Conventional contractor selection typically places the risk on the owner or client, while governance with risk-sharing contractor selection shares the project risks with the contractor. In conventional DBB contractor selection, the contractor's primary objective is to minimize cost, which can lead to compromises in quality and safety. In governance with risk-sharing contractor selection, the contractor has a stake in the project's success and is incentivized to manage risks and deliver the project on time and within budget.

Another key difference between these two approaches is the level of transparency and accountability. Conventional contractor selection is often opaque, with decisions made based on subjective criteria. This transparency and accountability can help build trust between the owner or client and the contractor, which can lead to a more productive working relationship. In terms of outcomes, governance with risk-sharing contractor selection is likely to result in contractors who are better equipped to manage risks and deliver the project within budget and on time while conventional DBB contractor selection may result in contractors who are primarily focused on minimizing cost, which can lead to compromises in quality and safety.

4.7.2 Governance with Risk-Sharing Contractor Selection

It is crucial to recall that there are some difficulties with the governance of the risk-sharing contractor selection process. Thorough risk assessment, careful negotiation of risk distribution and reward-sharing agreements, and clear communication are all necessary for effective implementation. Additional administrative and monitoring measures could be necessary to guarantee compliance with the agreed-upon risk-sharing agreements. Successfully combining governance and risk-sharing contractor selection techniques can result in better project outcomes, increased stakeholder confidence, and successful project completion.

As conclusion the selected criteria for the contractor selection governance risk-sharing framework are more specific and focused on the requirements needed for a successful project execution. The framework provides a useful tool for assessing a contractor's competence and suitability to carry out the work required in a specific project. The criteria are specified to ensure that any contractor awarded the contract complies with all requirements, thus reducing the likelihood of contractual disputes between the client and contractor. The specificity of the criteria aims to avoid any potential contractual obligations or variations that could arise, providing clarity to both the client and the contractor, and minimizing any potential confusion or misunderstandings. Therefore, the framework is necessary to ensure the success of the tendering process and avoid disputes that may arise from vague or general criteria. The specified criteria, the design criteria offer clarity to both the client and the contractor, minimizing any potential confusion or misunderstandings.

Conventional DBB contractor selection and governance with risk-sharing contractor selection are two different methods for contractor selection for a construction project. While conventional contractor selection places greater emphasis on cost, governance with risk-sharing contractor selection places greater emphasis on risk management, accountability, and transparency. Governance with risk-sharing contractor selection is likely to result in selecting contractors who are better equipped to manage risks and deliver the project within budget and on time.

CHAPTER 5: Framework Implementation Using FAHP Decision Model

5.0 Overview

Construction projects involve many stakeholders; therefore, selecting the appropriate contractor is essential. The process of choosing a contractor is complicated and requires careful evaluation of various aspects, including experience, knowledge, past record, financial stability, and managerial qualities. Clients require a powerful decision model that effectively guarantees openness, justice, and efficiency. This model defines the critical procedures and criteria involved in selecting a contractor, ensuring that the process is consistent with the client's goals, and provides a framework for assessing and comparing the many available contractors. A thoughtfully built model assists clients in making informed and objective decisions; it limits the risk and leads to selecting a contractor best prepared to deliver the project effectively.

5.1 Construction Management Issues

Managing a construction project entails planning, coordinating, and controlling all aspects of its execution from the beginning to the end. It can be challenging for several reasons, including budget overruns, scheduling delays, safety hazards, quality control, communication failures, resource management, environmental requirements, and coordination and collaboration among stakeholders. The key to effective management is foreseeing prospective challenges and developing solutions to address them.

Construction management is a complex discipline that demands careful planning, attention to detail, and effective communication and collaboration. Construction managers can raise the probability of their projects' success by planning for anticipated challenges and implementing solutions to address them.

5.2 Developing a Multicriteria Decision-Making Model

Multicriteria decision-making (MCDM) involves making decisions based on several different criteria. Creating an MCDM model requires first recognizing the issue at hand, establishing the criteria, assigning them weights, evaluating the available options, compiling the scores, and conducting the sensitivity analysis. An MCDM model can be created by applying several methodologies, including the Analytic Hierarchy Process (AHP), the Analytic Network Process (ANP), SAW, and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). It is essential to include the many stakeholders in the decision-making process to ensure that their priorities and points of view are considered. In addition to the preferences of those responsible for making the decision, the prevailing issues will have a role in determining which approach is selected.

5.3 Multi-Criteria Decision-Making Models in Construction Management

MCDM is an essential tool for improving how decisions are made in construction management. An MCDM model uses a structured method to evaluate and rank different options or solutions, considering cost, time, quality, sustainability, and risk factors. By combining methods like the AHP, the ANP, and the TOPSIS, building workers can make well-informed decisions that lead to the best possible results for a project. In recent years, MCDM techniques have become more popular because they can manage the complexity and uncertainty of construction projects. This helps with project planning, resource allocation, and stakeholder satisfaction (Kerzner, 2017; Singh & Jain, 2018; Turskis et al., 2016).

5.4 Fuzzy Analytic Hierarchy Process in Construction Management

The Fuzzy Analytic Hierarchy Process (FAHP) model is frequently utilized for MCDM in the field of construction management. It is an extension of AHP that uses language variables to express the decision-makers' subjective opinions. Hence, it is beneficial in circumstances when the information is imprecise or uncertain. The FAHP helps construction project decision-makers handle uncertainty and imprecision. FAHP allows cloudy or ambiguous information to be seen during decision-making, unlike AHP. FAHP helps construction industry professionals voice and analyses their thoughts and preferences while evaluating project solutions across several categories using fuzzy sets and language considerations. This strategy helps make tough contractor selection, risk assessment, and project prioritization choices, improving construction management. (Chen & Hwang, 1992; Erturul & Karakaşolu, 2008; Liu et al., 2013).

5.5 Fuzzy Analytic Hierarchy Process in Contractor Selection

Selecting contractors frequently involves using the FAHP, which is an MCDM process. It addresses issues of ambiguity and uncertainty by utilizing fuzzy logic in the decision-making process. In FAHP, important criteria for selecting a contractor are identified and weighted; the importance is determined by a pairwise comparison method, and weights are calculated by accumulating scores using a fuzzy arithmetic operator. All these steps are part of the selection process.

"The Fuzzy Analytic Hierarchy Process (FAHP) has emerged as a powerful technique in the context of contractor selection within the construction industry, providing a structured approach to accommodate the uncertainties and subjectivity inherent in the decision-making process. By integrating fuzzy logic and the Analytic Hierarchy Process (AHP), FAHP allows construction project stakeholders to consider multiple qualitative and quantitative criteria simultaneously. This method enables decision-makers to assess and rank potential contractors based on attributes such as experience, financial stability, technical competence, safety records, and reputation, while considering the imprecise nature of the available data and the subjective opinions of experts. Numerous studies have demonstrated the efficacy of FAHP in enhancing the objectivity and transparency of contractor selection processes, ultimately leading to more informed and reliable decisions in construction project management." (Cheng & Wu, 2012; Javanshir et al., 2017; Tuzkaya et al., 2009).

5.6 Contractor Selection Processes

Several variables must be considered to identify an appropriate contractor for a construction project that utilizes governance and risk sharing. These include performing a comprehensive background check, reviewing the individual's proposals, and negotiating the contract terms besides evaluating the individual's capacity, approach to risk management, communication skills, and compliance with regulations and standards. When looking for the best contractor for the task, it is essential to emphasize evaluating important elements, including the contractor's level of experience and skill, as well as their reputation, resources, and ability to comply with rules. Strategies for efficient communication and risk management are also essential to finish the project with a positive outcome.

5.6.1 Project Planning Governance Validation Decision

This entails assessing the project plan, methodology, roles and responsibilities, communication, and reporting processes to ensure they are appropriate for the project and comply with relevant rules. The objective is to reduce the risks while simultaneously increasing the likelihood of a successful outcome for the project.

The overarching objective of the governance validation of project planning is to guarantee that the project is planned in line with industry standards and has a solid foundation for success. The organization has a better chance of a successful project if it validates the project planning governance, as it reduces the risks involved.

5.6.2 Contractor Prequalification Governance Decision

The prequalification of contractors is essential in finding the most qualified contractor for a building project. The experience and track record of the applicant, as well as their financial stability, technical aptitude, quality management systems, health, safety, and environmental management systems, risk management systems, and dedication towards using local material, are the prequalification requirements. These criteria guarantee that the chosen contractor completes the project successfully while adhering to the governance and risk-sharing framework that applies to Qatar.

5.7 Contractor Selection FAHP Calculation Model

5.7.1 Overview

The role of contractor selection in the decision framework and its decision criteria are explained later in the chapter. Figure 27 and Figure 28 presents the contractor evaluation decision criteria as a complete framework. By narrowing the detailed criteria into sub-criteria therefor each criteria has three sub-criteria to be measured against , each contractor for there selection based on their submitted documents. Figure 28 shows how these sub-criteria are used for selecting contractors.

Every criterion has a given value. Table 1 presents the criteria's used to evaluate the contractors' performance. This differentiates each contractor from the others based on each sub-criterion, as shown in Table 2 every contractor will have a ranking—low, medium, or high—assigned for each sub-criterion to compare them during the FAHP ranking calculation. For selection a assigning weight from 1- 9 as weight for each contractor during the selection to be a base on for sub-criteria of each criteria calculation.

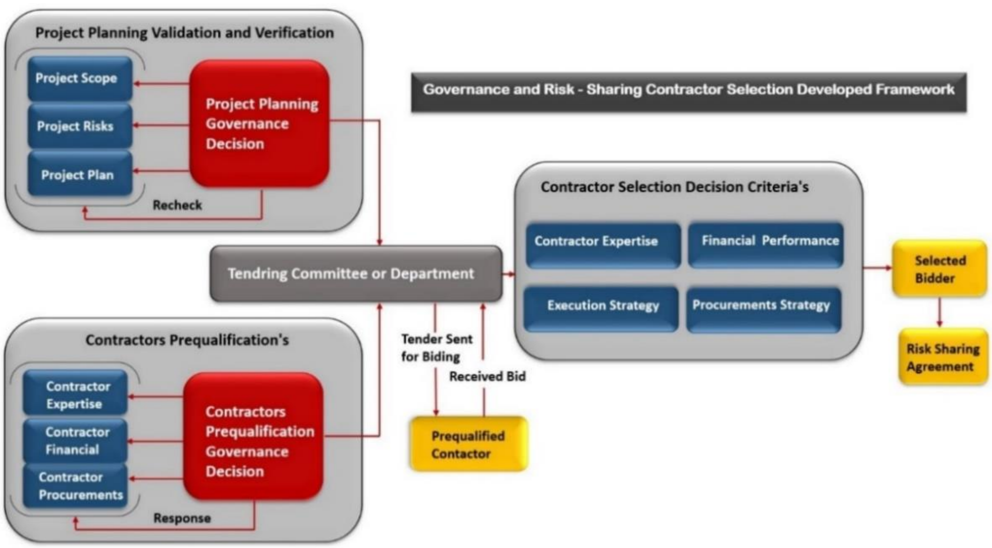

Figure 27.Contractor Selection Governance Risk-sharing Decision Criteria's Framework

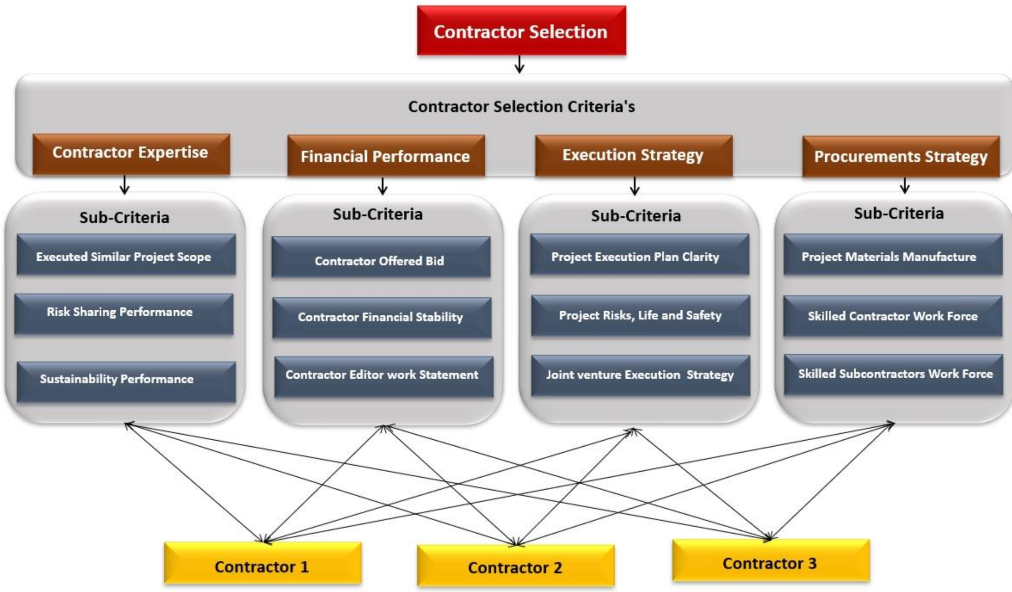

Figure 28.Subcriterias and Contractors (Alternatives) Pairwise Comparison

5.7.2 Relationship Between Data Analysis and FAHP Calculation Findings

For the model criteria best ranking and compression an internally communication was conducted with project expert in one of Qatar organization to evaluate the Model Criteria's based on there practical experience though the questioners for FAHP calculation purpose therefore FAHP calculation for the framework criteria and sub-criteria has a close relationship with the thesis questionnaire used for data collection, as explained below:

- The Contractor Expertise criteria and sub-criteria **(Implement Similar Project Scope, Risk-Sharing Performance, and Sustainability Performance)** in the FAHP calculation are related to the thesis data analysis as per the questionnaires in Sections 2.1 and 2.3 in APPENDIX B.

- Financial Performance criteria and sub-criteria **(Contractor Offered Bid, Financial Stability, and Contractor Editor Work Statement)** in the FAHP calculation are related to the thesis data analysis as per the questionnaire in Section 2.2 in APPENDIX B.

- The Execution Strategy criteria and sub-criteria **(Project Execution Plan Clarity, Project Risks, Life and Safety, and Joint Venture Execution Strategy)** in the FAHP calculation are related to the thesis data analysis as per the questionnaire in Section 2.3 in APPENDIX B.

- The Procurement Strategy criteria and sub-criteria **(Project Materials Manufacture, Skilled Contractor Work Force, and Skilled Subcontractors Work Force)** in the FAHP calculation are related to the thesis data analysis as per the questionnaire in Section 2.3 in APPENDIX B.

Based on the above, contractor selection using the FAHP calculation model will provide good insight and approach as a mathematical model for selecting any contractor in an actual situation.

5.7.3 Framework Model with a Constructed Project

For this study, an already Implemented projects data organizations has been approached for premotion   to utilized the there data to be used   for purposed framework model. The implemented projects data where located in variety of Qatar construction organizations and ministries most of completed projects information and data where normally archived locally was difficult to obtain these archived data for research purpose due to conditionality, for that reason an internally communication was conducted with some projects expert in these organization to gather as match as could of information which is as minimum and less than the expectation which will not serve the Model to be tested.

An project as implemented Project with limited data was used for the developed framework as a supplies power station project to a newly developed manufacturing industry project; the power station project deliverables include constructing a new substation building with complete boundaries, roads, and infrastructure. The proposed project is unique in the Qatar power industry as it will involve constructing a high-voltage power station of 400 KV equipped with switchgear and transformers along with a cable network transmission line.

The project was anticipated to be completed in no more than eighteen months, including the necessary logistics approvals. The project plan was developed based on this estimation and was designed to be as realistic as possible while still meeting the deadline for the contract signed with the developers.

Clear procedures for controlling scope changes were implemented, and the project scope was governed and validated, with deliverables verified as meeting specified objectives.

Project risk assessment was performed in accordance with the governance decisions, with risks being clearly identified, registered, and mitigated as part of the explicit project risks to be included in the bidding. Project Execution Plan: This plan is assessed by the Governance Decision to ensure that it is both realistic and intelligible to bidders.

Constructed 400 KV Substation Project Delivery List

Civil Works

1. Switchgear connected buildings

2. Complete substation boundary with internal roads

3. Switchgear yards with a foundation

4. Cable trenching with a foundation

Substation Main Equipment

1. Transformers

2. Switchgear

3. Cables

4. Internal control system

Substation Power System Construction Requirements

1. An 18-month completion plan

2. Substation system integration with system control

3. Substation to be remotely monitored and controlled

4. Two months of testing and commissioning

5.8 Prequalified Bidders (Alternatives) Model Simple Case

The prequalified contractors selected based on the prequalification governance decisions in the early Contractor Prequalification phase is limited to three bidders who qualified to bid tender documents for the 400 KV Substation project, by considering that Contractor 1 (C1), Contractor 2 (C2), and Contractor 3 (C3) are the best selected prequalified bidders. The used proposed sample project for this study, is to be evaluated for selection based on the FAHP decision-making model. The important criteria and sub-criteria for contractor selection decisions are summarized below.

Contractor Selection Framework Model

Contractor Selection Criteria

- Contractor Expertise
- Financial Performance
- Execution Strategy
- Procurement Strategy

Contractor Selection Sub-criteria

Contractor Expertise Sub-criterion

- Executed Similar Project Scope
- Risk Sharing Performance
- Sustainability Performance

Financial Stability Sub-criterion

- Contractor Offer Bid
- Contractor Financial Stability
- Contractor Editor Work Statement

Execution Strategy Sub-criterion

- Project Execution Plan Clarity
- Project Risks, Life and Safety
- Joint Venture Execution Strategy

Procurement Strategy Sub-criteria

- Project Materials Manufacture
- Skilled Contractor Work Force
- Skilled Subcontractors Work Force

Alternatives: Bidders/Contractors

- Contractor 1 ----- C1
- Contractor 2 ----- C2
- Contractor 3 ----- C3

5.9 Fuzzy Analytic Hierarchy Process

Overview

Contractor selection is an important step in every construction project. The FAHP is a decision-making tool for evaluating and ranking potential contractors based on a variety of factors, Below are the processes for using FAHP for contractor selection:

Determine the Criteria

Determine the main factors for contractor selection. They may include experience, technological skills, work quality, affordability, and dependability.

Determine the Sub-criteria

Determine the main factors for contractor selection as major factors. They include the main sub-criteria, such as past performance, workload, management ability, and procurements.

Establish the Hierarchy

Establish a hierarchy for each criteria and its sub-criteria. Experience and technical expertise, for example, can be the sub-criteria of the fundamental critериria of competence.

Assign Weights

Allocate weights to the criteria based on their respective importance. Pairwise comparisons can be used to assign weights on a scale of 1 to 9, with 1 representing equal importance and 9 representing extreme importance.

Consider the Alternatives

Assess each contractor using language characteristics such as "Strong (H)," "Intermediate (M)," or "Moderate (L)." A membership function can be used to transform these assessments into fuzzy numbers.

Determine the Scores

Using the FAHP algorithm, determine the scores for each contractor based on the criteria and weights. The scores indicate the contractor's overall suitability for the job.

Rate the Contractors

Based on their scores, rank the contractors and choose the one most qualified for the project.

5.10 Contractor Selection Criteria and Sub-Criteria - FAHP Model

The contractor selection was performed using the FAHP model, applied to the selected and evaluated criteria and sub-criteria. The evaluation was carried out by contacting and interviewing project management experts in different organizations to obtain their points of view about the importance of the framework's criteria and associated sub-criteria for each contractor. These factors will determine the selection of a suitable contractor for project execution that is presented in the framework FAHP calculation starting from criteria's comparison followed by each sub-criteria's against each contractor based on certain of ranking as a outcome of what collected of information's from local experts.

5.10.1 Perform Pairwise Comparisons

The comparisons between the framework criteria's and related criteria's for contractor selection was based on dissection project management expertise at one of Qatar industry and with different engineers as experts in Qatar organizations based on there outcomes FAHP calculations preformed:

For each criteria and sub - criteria , perform pairwise comparisons to determine their relative importance. Use a scale of 1 to 9 to indicate how much more important one criterion is than the other. For example, if you think price is twice as important as quality of work, assign a value of 2 to price and 1 to quality of work.

5.10.2 Pairwise Comparison

1- **Execution Strategy and Financial Performance Comparison**: Execution Strategy is ranked "Very Strong" to "Extreme important" compared to Financial Performance.

2- **Contractor Expertise and Execution Strategy Comparison**: Contractor Expertise is ranked "Strong" to "Very Strong" to "Extreme Importance" compared to the Execution Strategy.

3- **Contractor Expertise and Procurement Strategy Comparison**: Contractor Expertise is graded "Very Important" compared to the Procurement Strategy.

4- **Financial Performance and Execution Strategy Comparison**: Financial Stability is graded "Moderate" to "Strong Importance" compared to the Execution Strategy.

5- **Financial Performance and Procurement Strategy Comparison:** Financial Performance is ranked "Strong" to "Very Strong Importance" compared to the Procurement Strategy.

6- **Procurement Strategy and Execution Strategy comparison:** The Procurement Strategy is ranked more important than the Execution Strategy.

Priority Criteria Matrix A: Comparison of Size n x n

Priority Vector X: Eigen Vector of size n x 1

Table 1.Fuzzy Scale Relative Importance Table

Relative Importance	Scale of Relative Importance	Fuzzy Scale
Equal Importance	**1**	**(1, 1, 1)**
Moderate Importance	**3**	**(2, 3, 4)**
Strong Importance	**5**	**(4, 5, 6)**
Very Strong Importance	**7**	**(6, 7, 8)**
Extremely Strong Importance	**9**	**(9, 9, 9)**
Intermediate Value	**2**	**(1, 2, 3)**
Intermediate Value	**4**	**(3, 4, 5)**
Intermediate Value	**6**	**(5, 6, 7)**
Intermediate Value	**8**	**(7, 8, 9)**

Table 2. Frame Work Criteria Compression Matrix step 1

	Contractor Expertise	Financial Performance	Execution Strategy	Procurement Strategy
Contractor Expertise	1	1/8	1/7	1/5
Financial Performance	8	1	4	6
Execution Strategy	7	1/4	1	4
Procurement Strategy	5	1/6	1/5	1

Table 3. Frame Work Criteria Compression Matrix step 2

	Contractor Expertise	Financial Performance	Execution Strategy	Procurement Strategy
Contractor Expertise	1	0.125	0.166	0.2
Financial Performance	8	1	4	6
Execution Strategy	6	0.25	1	5
Procurement Strategy	5	0.166	0.2	1

Pairwise Comparison Matrix - Criteria Matrix

Criteria Matrix

$$\begin{pmatrix} 1 & 0.125 & 0.166 & 0.2 \\ 8 & 1 & 4 & 6 \\ 6 & 0.25 & 1 & 5 \\ 5 & 0.166 & 0.2 & 1 \end{pmatrix}$$

Sum 20 1.54 5.366 12.2

Normalization Pairwise Comparison - Criteria Matrix A

$$\textbf{Criteria Matrix} = \begin{pmatrix} 0.05 & 0.08 & 0.030 & 0.016 \\ 0.4 & 0.649 & 0.74 & 0.491 \\ 0.3 & 0.162 & 0.186 & 0.409 \\ 0.25 & 0.107 & 0.037 & 0.081 \end{pmatrix}$$

$$\text{Sum} \quad \mathbf{1.00} \quad \mathbf{1.00} \quad \mathbf{1.00} \quad \mathbf{1.00}$$

$$\textbf{Priority Vector (X)} = \begin{pmatrix} \mathbf{0.04} \\ \mathbf{0.57} \\ \mathbf{0.264} \\ \mathbf{0.118} \end{pmatrix} \begin{matrix} \text{Least Important criterion} \\ \text{Most Important criterion} \\ \text{Second Most Important criterion} \\ \text{Second Least Important criterion} \end{matrix}$$

Calculating the Consistency Ratio (CR)
Calculating the Consistency Index (CI)
Calculating the Consistency Vector (λ)

X1: (1 X 0.04) + (0.125 X 0.57) + (0.166 X 0.264) + (0.25 X 0.118) = **0.184**
X2: (8 X 0.04) + (1 X 0.57) + (4 X 0.264) + (3 X 0.118) = **2.3**
X3: (6X 0.04) + (0.25 X 0.57) + (1 X 0.264) + (4 X 0.118) = **1.11**
X4: (5 X 0.04) + (0.166 X 0.57) + (0.2 X 0.264) + (1 X 0.118) = **0.465**

$$\mathbf{AX} = \begin{pmatrix} 1 & 0.125 & 0.166 & 0.25 \\ 8 & 1 & 4 & 3 \\ 6 & 0.25 & 1 & 4 \\ 5 & 0.166 & 0.2 & 1 \end{pmatrix} \times \begin{pmatrix} 0.04 \\ 0.57 \\ 0.264 \\ 0.118 \end{pmatrix} = \begin{pmatrix} 0.184 \\ 2.3 \\ 1.11 \\ 0.465 \end{pmatrix} = \lambda \times \begin{pmatrix} 0.04 \\ 0.57 \\ 0.264 \\ 0.118 \end{pmatrix}$$

$$\text{Consistency Vector } (\lambda) = \begin{pmatrix} 0.184/0.04 \\ 2.3/0.57 \\ 1.11/0.264 \\ 0.465/0.118 \end{pmatrix} = \begin{pmatrix} 4.6 \\ 4 \\ 4.2 \\ 3.94 \end{pmatrix}$$

Consistency Vector λ = 4.6 + 4+ 4.2 + 3.94/4 = **4.185**

Consistency Index CI = λ – n/n -1 = 4.185 - 4/4-1 = **<u>0.061 ≤ 0.1</u>**

Consistency Ratio (CR)

CR = CI/R

In practice, a **CR** of 0.1 or below is acceptable, and a higher value at any level indicates that the calculation warrants examination.

When the number of raw matrices = 4, the RI will be 0.9 from the random index table.

CR = 0.061/0.9 = **0.068 ≤ 0.1,** so it is acceptable. **Section 1, APPENDIX B**

Criteria's FAHP Pairwise Comparison Results

From the FAHP model's criteria comparison, we observed that ranking the criteria from the highest to lowest priority shows that **Financial Performance (0.59)** is the highest ranked criterion, and **Procurement Strategy (0.37)** is second, followed by **Execution Strategy (0.27)** and **Contractor Expertise (0.04)**.

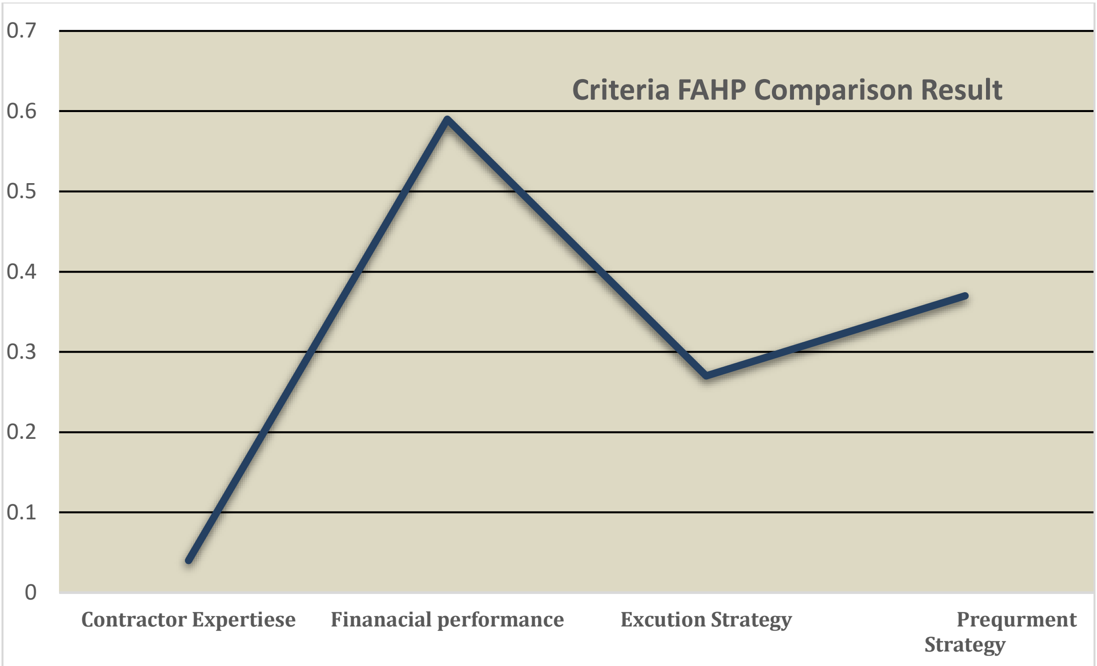

Figure 29.Criteria’s FAHP Comparison Result

5.11 Contractor Expertise Sub-criteria's- Alternatives FAHP Calculations

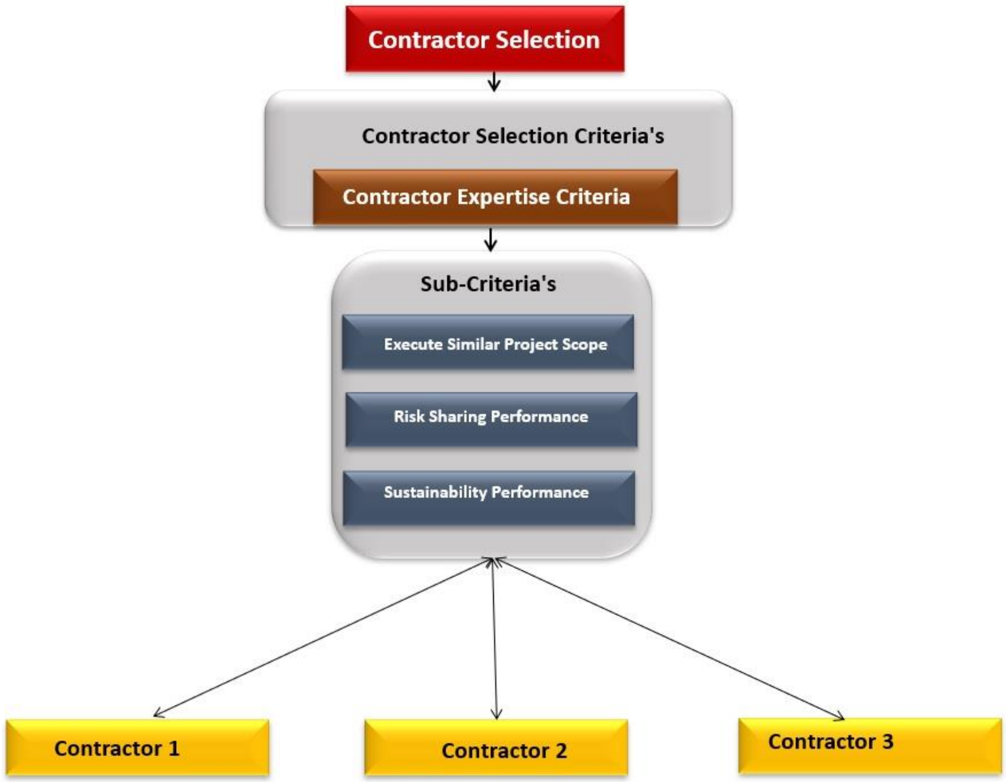

Figure 30.Contractor Expertise Sub-Criteria's- Alternatives

5.11.1 Execute Similar Project Scope Sub-criteria – Alternative FAHP Calculation

Table 4. Execution Similar Project Scope Sub-Criteria Contractors Ranking Measures

Sub-Criteria	Contractor Ranking Measures		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Execute Similar Project	Strong (H)	Moderate (L)	Intermediate (M)
Risk Sharing Agreement	Intermediate (M)	Strong (H)	Moderate (L)
Sustainability Performance	Strong (H)	Moderate (L)	Intermediate (M)

Ranking Scale for Each Contractor During Evaluation
Strong **60% (High),** Intermediate **30% (Medium)**, and Moderate **10% (Low)**

Section 2 (2.1), APPENDIX B

Execute Similar Project Scope Sub-criterion: FAHP Comparison Results

From the FAHP model's criteria comparison, we observed that ranking the criteria from the highest to lowest priority shows that **Contractor 1 C1 (0.56)** has the highest rank, and **Contractor 3 C3 (0.30)** is second, followed by **Contractor 2 C2 (0.14)** for the Execute Similar Project sub-criterion.

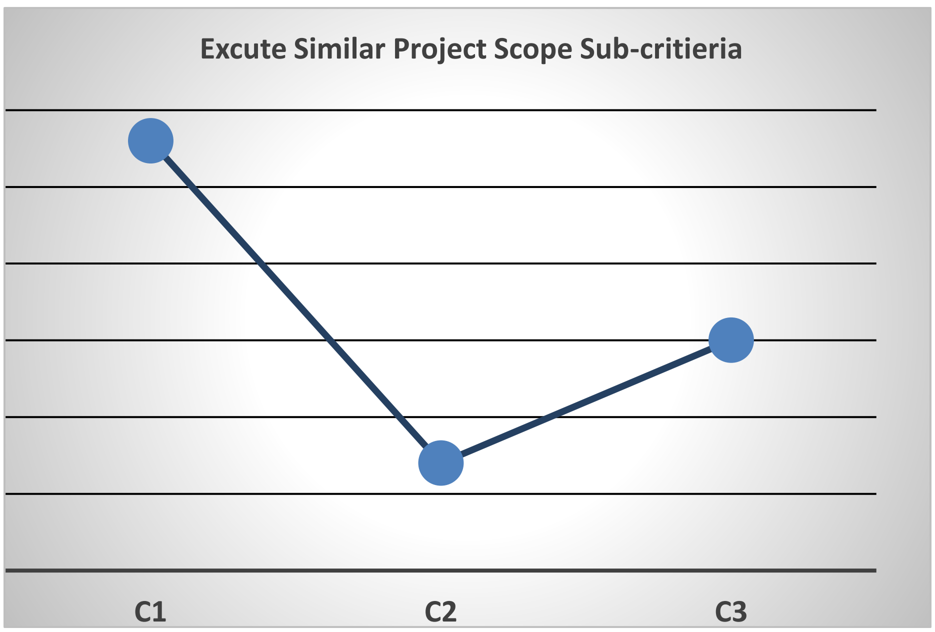

Figure 31.Contractors Comparison Result for Execute Similar Project Sub-Criteria

5.11.2 Risk-Sharing Performance Sub-Criteria – Alternative FAHP Calculation

Table 5. Risk-Sharing Performance Sub-criteria Contractor Ranking Measures

Sub-Criteria	**Contractor Ranking Measures**		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Execute Similar Project	Strong (H)	Moderate (L)	Intermediate (M)
Risk-Sharing Agreement	Intermediate (M)	Strong (H)	Moderate (L)

Sustainability Performance	Strong (H)	Moderate (L)	Intermediate (M)

Ranking Scale for Each Contractor During Evaluation
Strong **60% (High),** Intermediate **30% (Medium)**, and Moderate **10% (Low)**

Section 2 (2.2), APPENDIX B

Risk Sharing Performance Sub-criterion: FAHP Comparison Results

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 2 C2 (0.55)** is ranked the highest, and the second is **Contractor 1 C1 (0.35),** followed by **Contractor 3 C3 (0.10),** for the Risk-Sharing Performance sub-criterion.

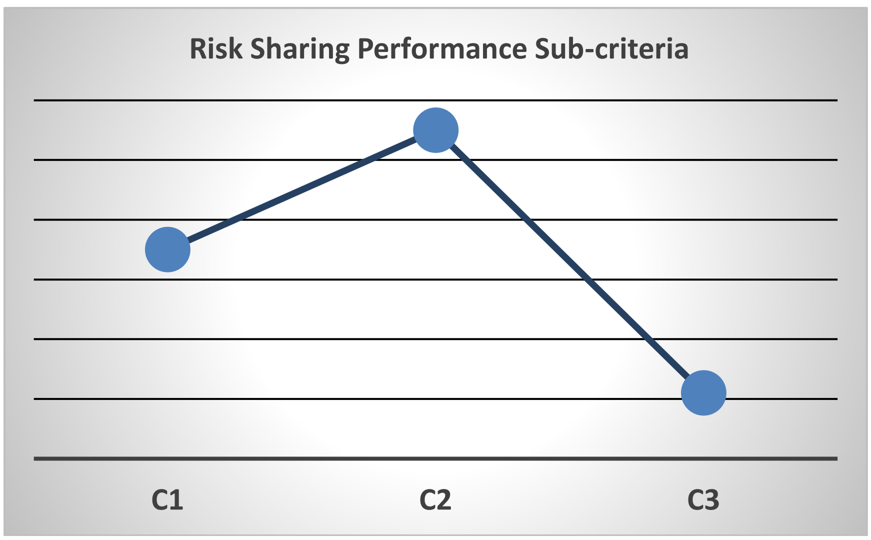

Figure 32.Contractors Comparison Result for Risk-Sharing Performance Sub-Criteria

5.11.3 Sustainability Performance Sub-criteria's - Alternatives FAHP Calculation

Table 6.Sustainablity Performance Sub-criteria Contractor Ranking Measures

Sub-Criteria	Contractor Ranking Measures		
	Contractor 1 (C1)	Contractor 2 (C2)	Contractor 3 (C3)
Execute Similar Project	Strong (H)	Moderate (L)	Intermediate (M)
Risk Sharing Agreement	Intermediate (M)	Strong (H)	Moderate (L)
Sustainability Performance	Strong (H)	Moderate (L)	Intermediate (M)

Ranking Scale for each Contractor during Evaluation
Strong **60% (High),** Intermediate **30% (Medium),** and Moderate **10% (Low)**

Section 2 (2.3), APPENDIX B

Sustainability Performance Sub-criterion: FAHP Comparison Results

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 1 C1 (0.59)** has the highest ranking, and **Contractor 3 C3 (0.30)** is second**,** followed by **Contractor 2 C2 (0.11),** for the Sustainability Performance sub-criterion.

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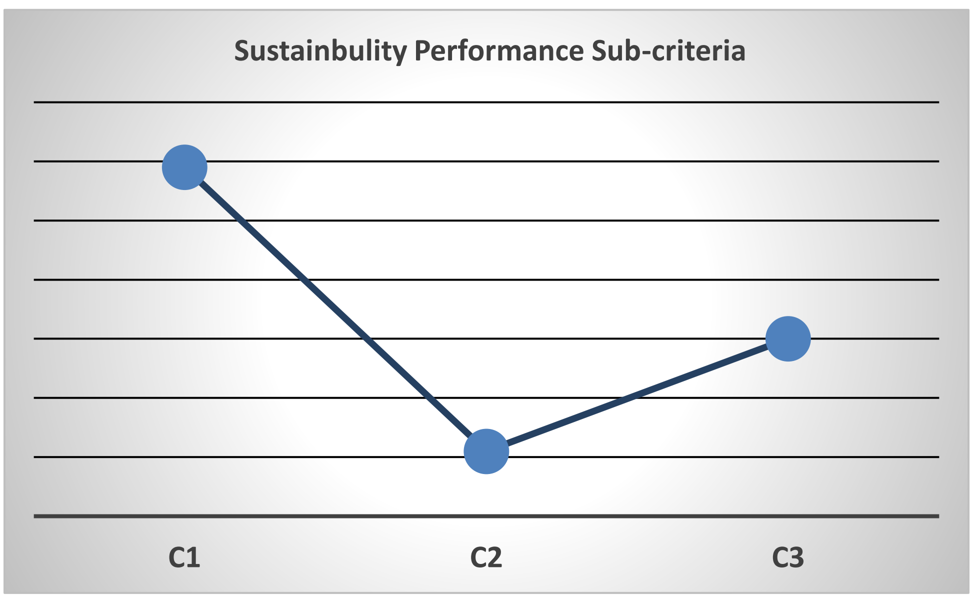

Figure 33.Contractors Comparison Result for Sustainability Performance Sub-criteria

5.12 Financial Performance Sub-Criteria's - Alternatives FAHP Calculations

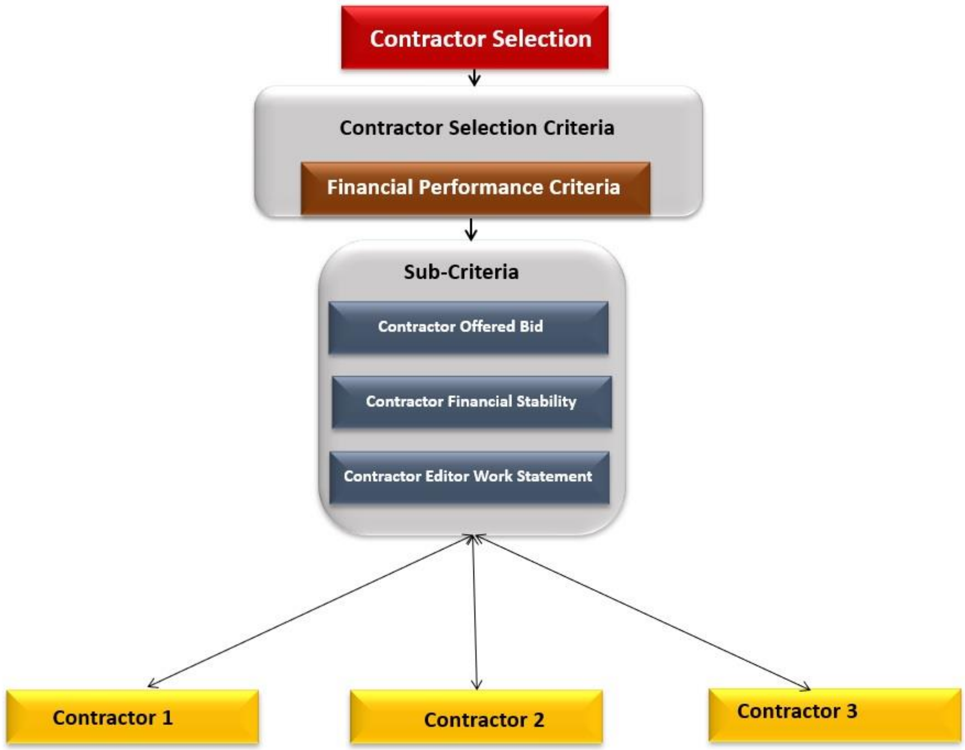

Figure 34. Financial Performance Sub-criteria's – Alternatives

5.12.1 Contractor Offered Bid Sub-Criteria- Alternatives FAHP Calculation

Table 7.Contractor Offered Bid Sub-criteria Contractor Ranking Measures

Sub-Criteria	Contractor Ranking Measures		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Contractor Offered Bid	Intermediate (M)	Moderate (L)	Strong (H)
Contractor Financial Stability	Moderate (L)	Intermediate (M)	Strong (H)
Contractor Editor Work Statement	Strong (H)	Intermediate (M)	Moderate (L)

Ranking Scale for each Contractor during Evaluation
Strong **60% (High),** Intermediate **30% (Medium),** Moderate **10% (Low)**

Section 3, (3.1), APPENDIX B

Contractor Offered Bid Sub-criterion: FAHP Comparison Result

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 1 C1 (0.65)** has the highest ranking, and **Contractor 2 C2 (0.25)** is second**,** followed by **Contractor 3 C3 (0.1),** for the Contractor Offered Bid sub-criterion.

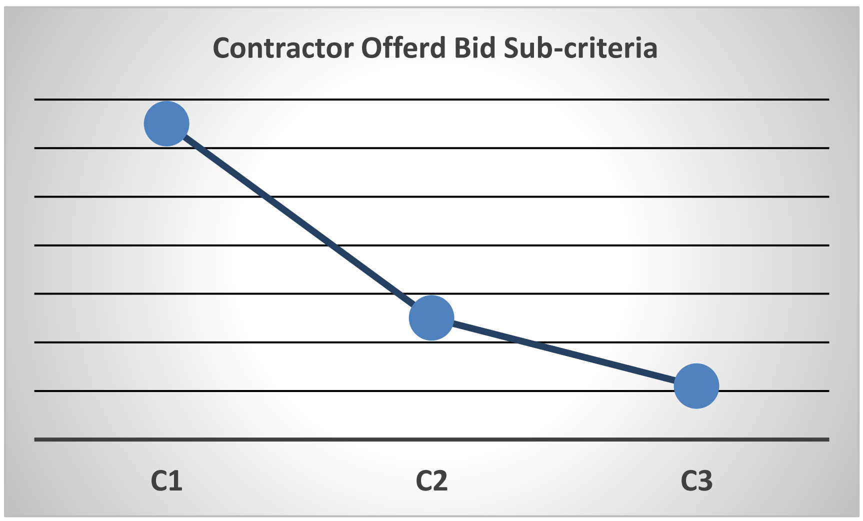

Figure 35.Contractors Comparison Result for Offered Bid Sub-Criteria

5.12.2 Contractor Financial Stability Sub-Criteria- Alternatives FAHP Calculation

Table 8.Contactor Financial Stability Sub-criteria Contractor Ranking Measures

Sub-Criteria	**Contractor Ranking Measures**		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Contractor Offered Bid	Intermediate (M)	Moderate (L)	Strong (H)
Contractor Financial Stability	Moderate (L)	Intermediate (M)	Strong (H)
Contractor Editor Work Statement	Strong (H)	Intermediate (M)	Moderate (L)

Ranking Scale for Each Contractor During Evaluation
Strong **60% (High),** Intermediate **30% (Medium),** Moderate **10% (Low)**

Section 3 (3.2), APPENDIX B

Contractor Financial Stability: FAHP Comparison Results

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 3 C3 (0.58)** is the highest ranked, and **Contractor 2 C2 (0.31)** is second, followed by **Contractor 1 C1 (0.11)** for the Contractor Financial stability sub-criterion. the final lowest priority.

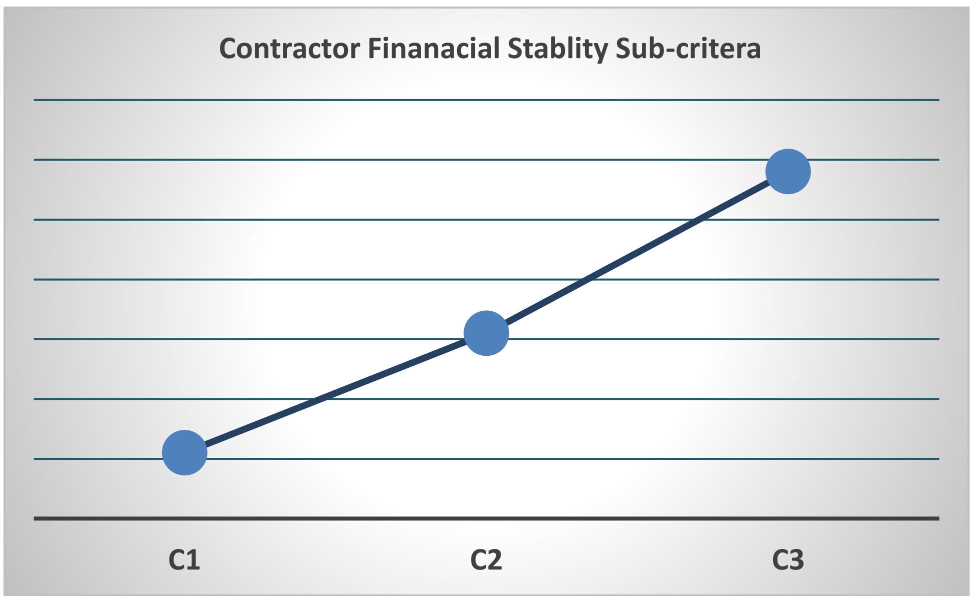

Figure 36.Contractors Comparison Result for Financial Stability Sub-Criteria

5.12.3 Contractor Editor Work Statement Sub-Criteria -Alternatives FAHP Calculation

Table 9.Contractor Editor Work Statement Sub-criteria Contractor Ranking Measures

Sub-Criteria	Contractor Ranking Measures		
	Contractor 1 (C1)	Contractor 2 (C2)	Contractor 3 (C3)
Contractor Offered Bid	Intermediate (M)	Moderate (L)	Strong (H)
Contractor Financial Stability	Moderate (L)	Intermediate (M)	Strong (H)
Contractor Editor Work Statement	Strong (H)	Intermediate (M)	Moderate (L)

Ranking Scale for each Contractor during Evaluation
Strong **60% (High),** Intermediate **30% (Medium), and** Moderate **10% (Low)**

Section 3 (3.3), APPENDIX B

Contractor Editor Work Statement Sub-criterion: FAHP Comparison Result

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 1 C1 (0.58)** has the highest criteria, and **Contractor 2 C2 (0.31)** is second, followed by **Contractor 3 C3 (0.11)**, for the Contractor Editor Work Statement sub-criterion.

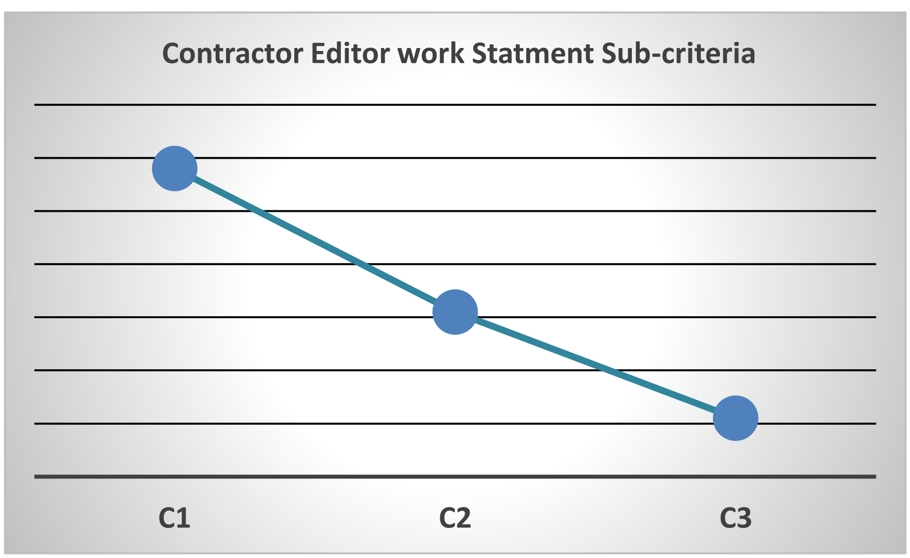

Figure 37.Contractors FAHP Comparison Result for Editor Work Statement Sub-Criteria

5.13 Execution Strategy Sub-Criteria-Alternatives FAHP Calculations

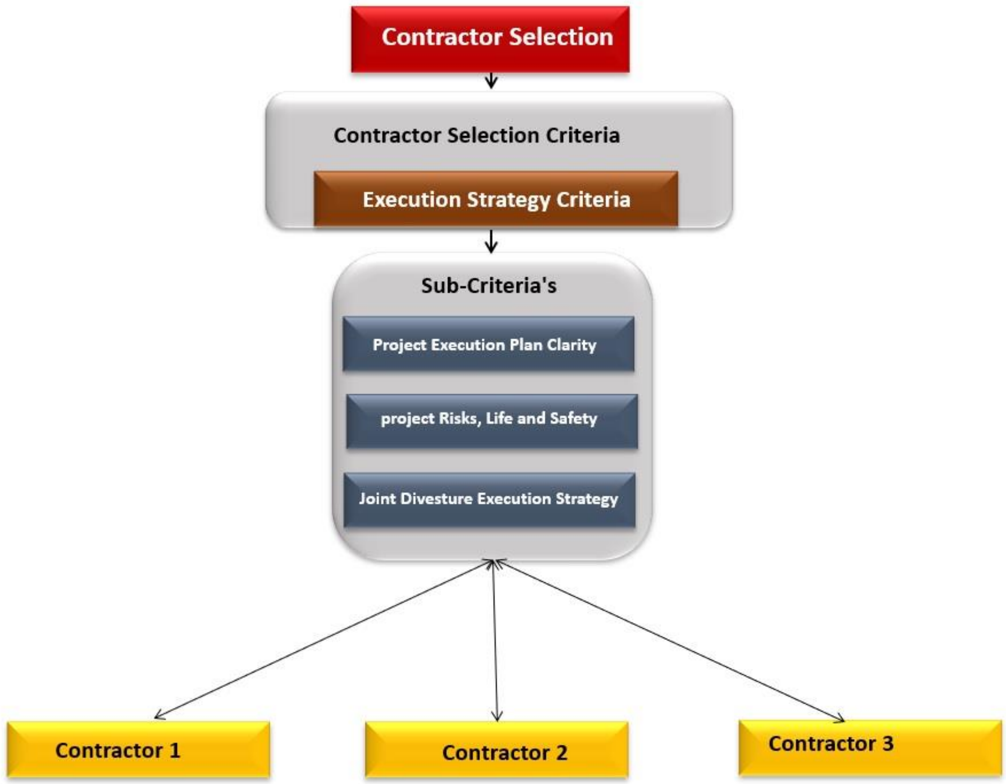

Figure 38.Excution Strategy Sub-Criteria's – Alternatives

5.13.1 Project Execution Plan Clarity Sub-Criteria – Alternatives FAHP Calculation

Table 10.Project Execution Plan Clarity Sub-criteria Contractor Ranking Measures

Sub-Criteria	**Contractors Ranking**		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Project Execution Plan	Moderate (L)	Strong (H)	Intermediate (M)
Project Risk , Life and Safety	Intermediate (M)	Moderate (L)	Strong (H)
Joint Venture Execution Strategy	Strong (H)	Intermediate (M)	Moderate (L)

Ranking Scale for Each Contractor During Evaluation
Strong **60% (High),** Intermediate **30% (Medium),** Moderate **10% (Low)**

Section 4 (4.1), APPENDIX B

Project Execution Plan: FAHP Comparison Result

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 1 C1 (0.65)** has the highest ranking, followed by **Contractor 2 C2 (0.25),** and **Contractor 3 C3 (0.1),** for the Project Execution Plan sub-criterion.

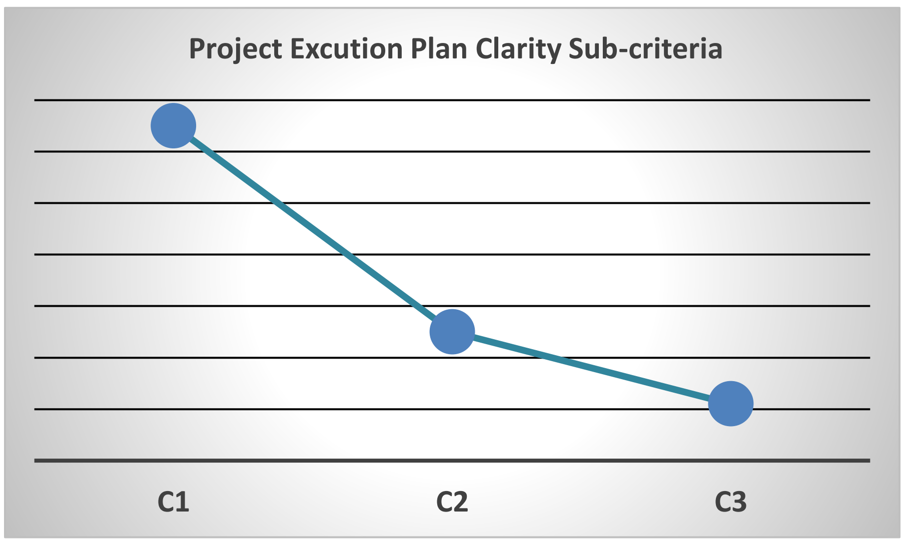

Figure 39.Contractors FAHP Comparison Result for Project Execution Plan Clarity Sub-criteria

5.13.2 Project Risk, Life and Safety Sub-Criteria – Alternatives FAHP Calculation

Table 11.Project Risk, Life and Safety Sub-criteria Contractor Ranking Measures

Sub-Criteria	Contractor Ranking		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Project Execution Plan	Moderate (L)	Strong (H)	Intermediate (M)
Project Risk , Life and Safety	Intermediate (M)	Moderate (L)	Strong (H)
Joint Venture Execution Strategy	Strong (H)	Intermediate (M)	Moderate (L)

Ranking Scale for each Contractor during Evaluation

Strong **60% (High),** Intermediate **30% (Medium),** Moderate **10% (Low)**

Section 4 (4.2), APPENDIX B

Project Risk, Life and Safety: FAHP Comparison Results

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 3 C3 (0.51)** has the highest ranking, and **Contractor 1 C1 (0.35**) is second, followed by **Contractor 2 C2 (0.14),** for the Project Risk, Life and Safety sub-criterion.

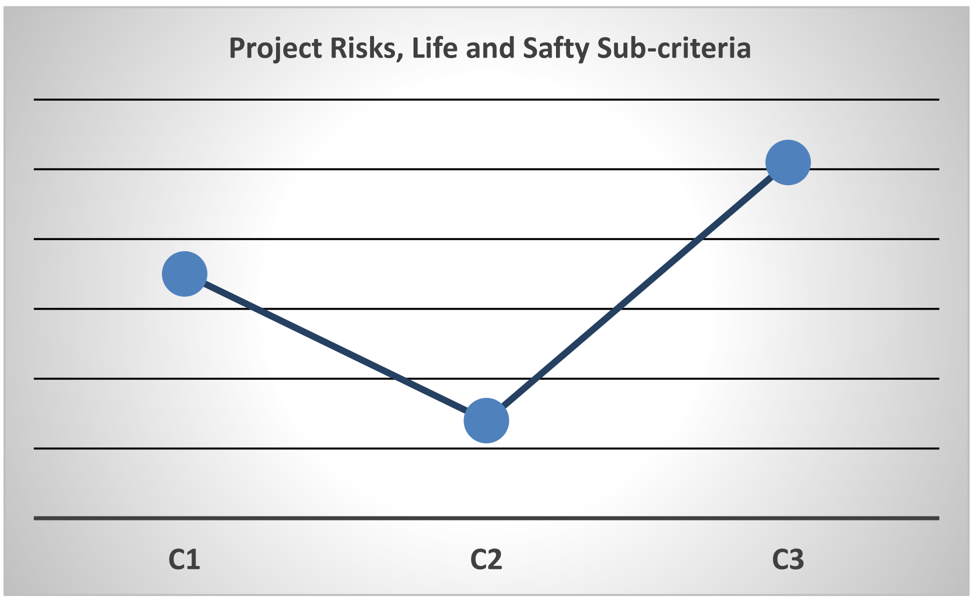

Figure 40.Contractors Comparison Result for Project Risk, Life and Safety Sub-criteria

5.13.3 Joint Venture Execution Strategy Sub-Criteria – Alternatives FAHP

Calculation

Table 12.Jointventure Execution Strategy Sub-criteria Contractors Ranking Measures

Sub-Criteria	Contractor Ranking Measures		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Project Execution Plan	Moderate (L)	Strong (H)	Intermediate (M)
Project Risk , Life and Safety	Intermediate (M)	Moderate (L)	Strong (H)
Joint Venture Execution Strategy	Strong (H)	Intermediate (M)	Moderate (L)

Strong **60% (High),** Intermediate **30% (Medium),** Moderate **10% (Low)**

Section 4 (4.3), APPENDIX B

Joint Venture Execution Strategy Sub-criterion: FAHP Comparison Result

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 1 C1 (0.58)** has the highest ranking, followed by **Contractor 2 C2 (0.31),** and **Contractor 3 C3 (0.11),** for the Joint Venture Execution Strategy sub-criterion.

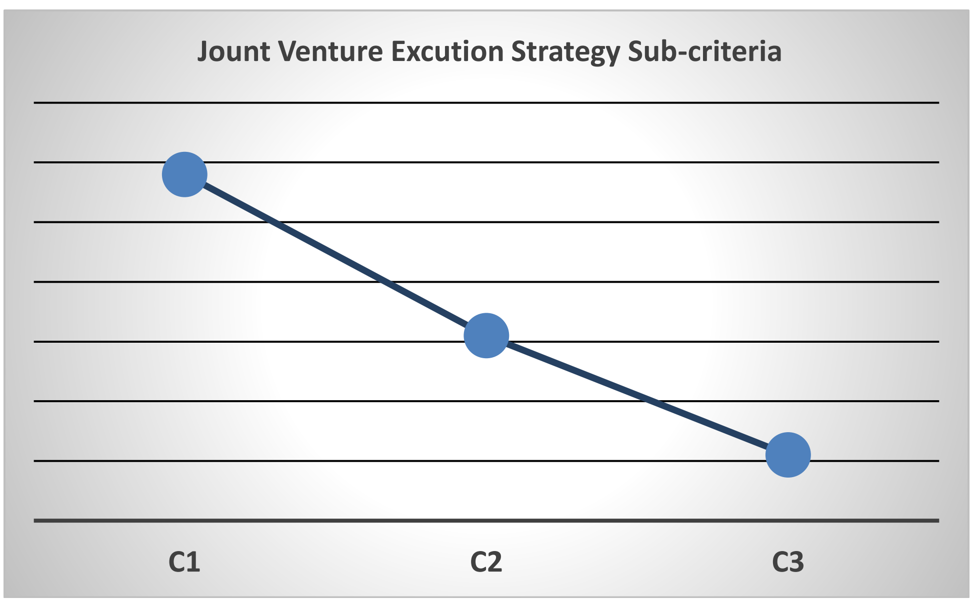

Figure 41.Contractor Comparison Result for Joint Venture Execution Strategy

5.14 Procurement Strategy Sub-Criterion-Alternatives FAHP Calculations

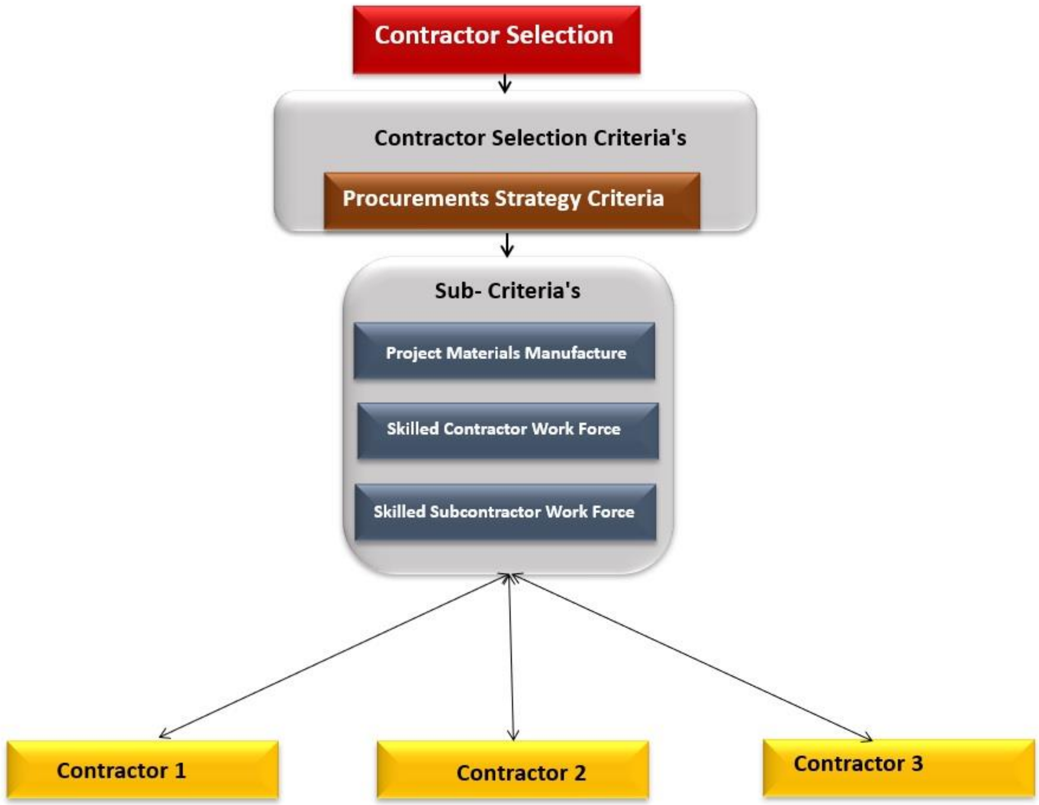

Figure 42.Procurment Strategy Sub-Criteria's - Alternatives

5.14.1 Project Materials Manufacture Sub-Criterion-Alternatives FAHP Calculation

Table 13.Project Materials Manufacture Sub-criteria Contractor Ranking Measures

Sub-Criteria	**Contractor Ranking Measures**		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Project Materials Manufacture	Moderate (L)	Intermediate (M)	Strong (H)
Skilled Contractor Work Force	Strong (H)	Intermediate (M)	Moderate (L)
Skilled Subcontractor Work Force	Moderate (L)	Strong (H)	Intermediate (M)

Ranking Measures Scale for Each Contractor During Evaluation
Strong **60% (High),** Intermediate **30% (Medium),** Moderate **10% (Low)**

Section 5 (5.1), APPENDIX B

Project Materials Manufacture Sub-criterion: FAHP Comparison Result

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 3 C3 (0.59)** has the highest ranking, and **Contractor 2 C2 (0.31)** is second, followed by **contractor 1 C1 (0.10),** for the Project Materials Manufacture sub-criterion.

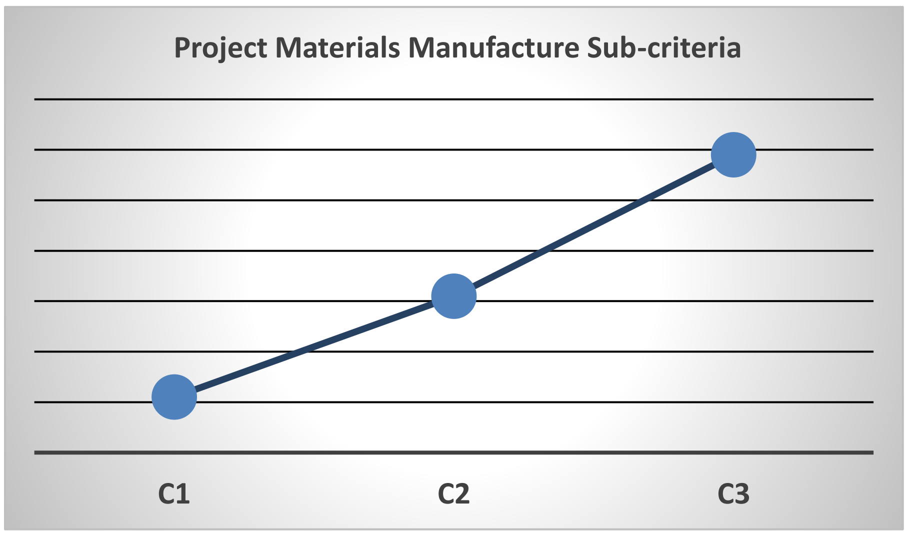

Figure 43.Contractor Comparison Result for the project Materials Manufacture Sub-criteria

5.14.2 Contractor Skilled Work Force Sub-criteria - Alternatives FAHP Calculation

Table 14. Contractor Skilled Work Force Sub-criteria Contractor Ranking Measures

Sub-Criteria	Contractors Ranking Measures		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Project Materials Manufacture	Moderate (L)	Intermediate (M)	Strong (H)
Skilled Contractor Work Force	Strong (H)	Intermediate (M)	Moderate (L)
Skilled Subcontractor Work Force	Moderate (L)	Strong (H)	Intermediate (M)

Ranking Measures Scale for Each Contractor During Evaluation
Strong **60% (High),** Intermediate **30% (Medium),** Moderate **10% (Low)**

Section 5 (5.2), APPENDIX B

Contractor Skilled Work Force Sub-criterion: FAHP Comparison Result

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that **Contractor 1 C1 (0.56)** has the highest ranking, followed by **Contractor 2 C2 (0.33)**, and **Contractor 3 C3 (0.11),** for the Contractor Skilled Work Force sub-criterion.

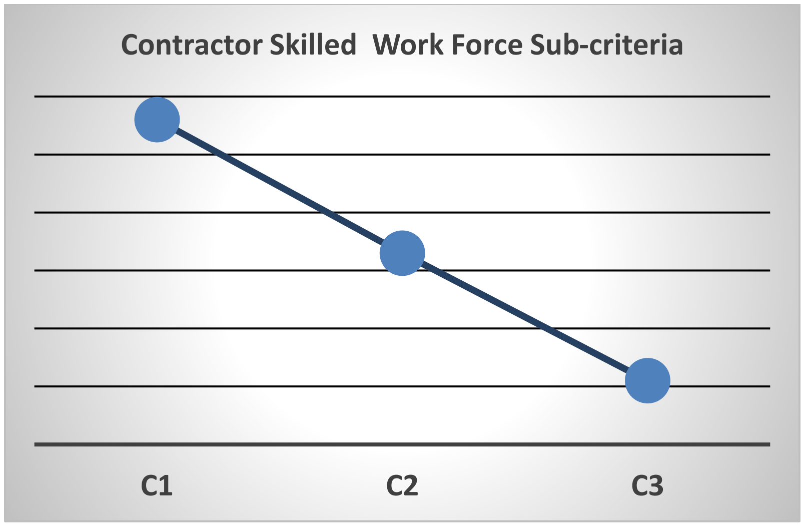

Figure 44.Contractors FAHP Comparison Result for Skilled Contractor Work Force Sub-criteria

5.14.3 Subcontractor Skilled Work Force Sub-criteria-Alternatives FAHP Calculation

Table 15.Skilled Subcontractor Work Force Sub-criteria Cofactors Ranking Measures

Sub-criteria	Contractor Ranking Measures		
	Contractor 1 (C1)	**Contractor 2 (C2)**	**Contractor 3 (C3)**
Project Materials Manufacture	Moderate (L)	Intermediate (M)	Strong (H)
Skilled Contractor Work Force	Strong (H)	Intermediate (M)	Moderate (L)
Skilled Subcontractor Work Force	Moderate (L)	Strong (H)	Intermediate (M)

Ranking Measures Scale for Each Contractor During Evaluation
Strong **60% (High),** Intermediate **30% (Medium),** Moderate **10% (Low)**

Section 5 (5.3), APPENDIX B

Skilled Subcontractor Work Force Sub-criterion: FAHP Comparison Results

From the FAHP model's criteria comparison, we observed that ranking the sub-criteria from the highest priority to lowest shows that Contractor 2 **C2 (0.58)** has the highest ranking, followed by **Contractor 3 C3 (0.31)**, and **Contractor 1 C1 (0.11)**, for the Skilled

Subcontractor Work Force sub-criterion.

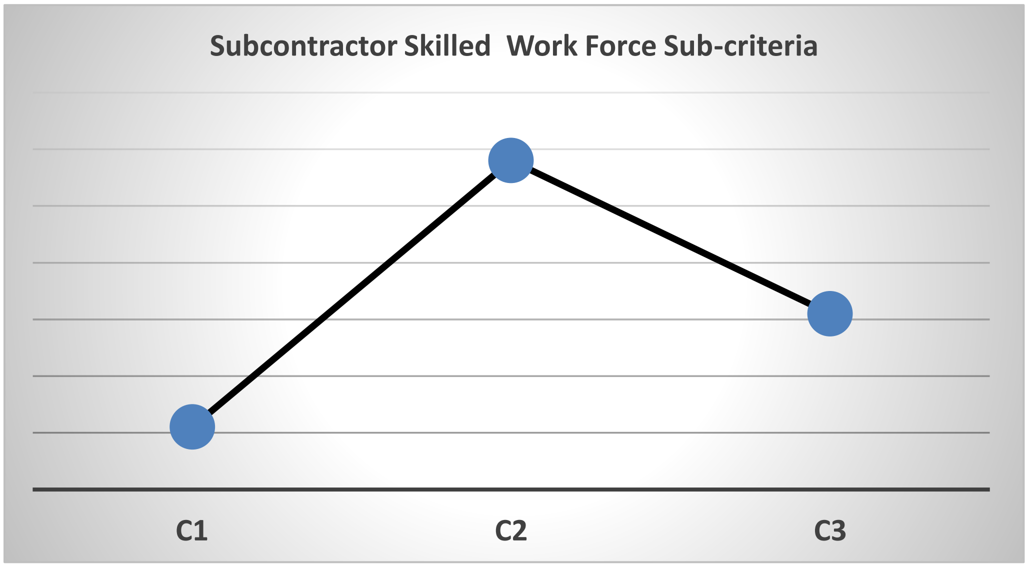

Figure 45.Contractors FAHP Result for Skilled Subcontractor Work Force Sub-criteria

Table 16.Contractor Selection FAHP Final Result

Criteria	Sub-criteria	Contractor 1 (C1)	Contractor 2 (C2)	Contractor 3 (C3)
Contractor Expertise	Execute Similar Project	0.56	0.14	0.30
	Risk-Sharing Performance	0.35	0.55	0.10
	Sustainability Performance	0.59	0.11	0.30
Financial Performance	Contractor Offered Bid	0.65	0.25	0.10
	Risk-Sharing Agreement	0.11	0.31	0.58
	Sustainability Performance	0.58	0.31	0.11
Execution Strategy	Execution plan Clarity	0.65	0.25	0.10
	Project Risk , Life and Safety	0.35	0.14	0.51
	Joint Venture Execution Strategy	0.58	0.31	0.11
Procurement Strategy	Project Materials Manufacture	0.10	0.31	0.59
	Skilled Contractor Work Force	0.56	0.33	0.11
	Skilled Sub-contractor Work Force	0.11	0.58	0.31
Total	**Final Contractor Ranking**	**5.21**	**3.59**	**3.22**

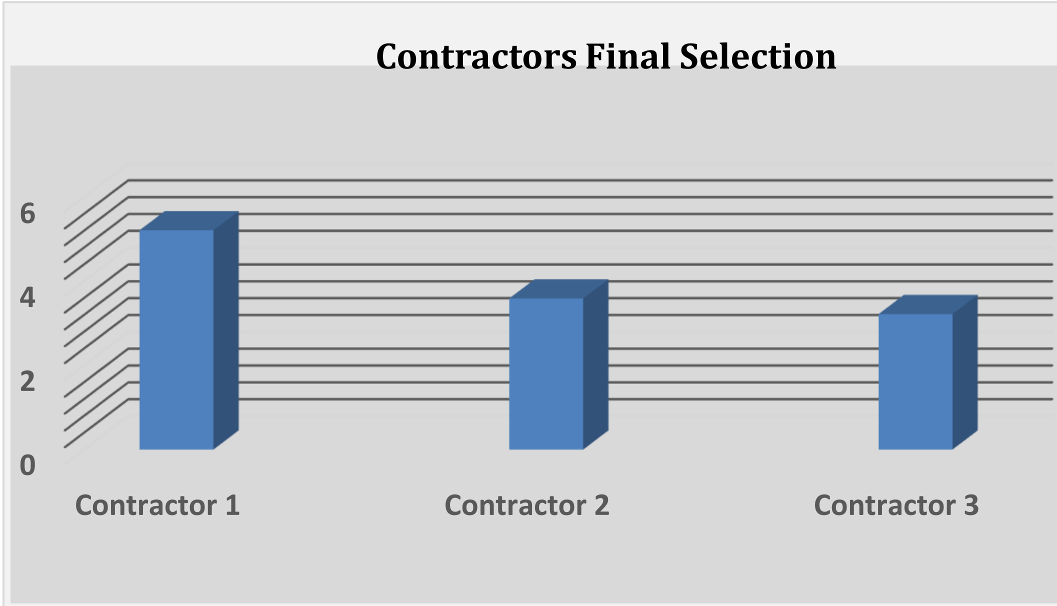

Figure 46.Project Contractor FAHP Final Result for Selection

Conclusion

It can be seen from the contractor summary Table 5-3 that Contractor 1 (C1) receives the highest ranking compared to the others. They are followed by Contractor 2 (C2), who is ranked the second highest, and Contractor 3 (C3), with the lowest rank. It seems that this is due to their strength and weakness levels in the sub-criteria comparison and their compatibility with each other; it will reflect on their ability to meet the project execution requirements according to each project assigned criterion.

CHAPTER SIX: DATA ANALYSIS

6. Overview:

This chapter provides empirical evidence, analysis and findings based on the survey and interviews conducted during the research outlined in this thesis. Descriptive statistics discussed in this chapter represents frequency tables and graphs that were used to summarize data gathered, hypothesis tested and the reliability, validity of the scales of measurements, and the results interpret findings sensitively as a basis for making recommendations that are practicable and comprehensive.

6.1 Designing of Methodology Analysis

Many questionnaires were distributed; only 55 completed questionnaires were the base for computing the results. Several questionnaires were removed from the analysis for the following reasons: questionnaires completed by those who never had the focus discipline answers, non-responses, and some with a lot of missing data were. This means that all mentioned type of questionnaires, out of total (more than 70) was distributed, were completely discarded from the analysis. The verity received just 55 questionnaires were used in analysis and then interpret the findings.

The questionnaire for the survey administered was developed based on the contractor selection created to determine the constructs and contents to be measured. There are many construct measures in this survey: (1) demographic information, and (2) project governance and (3) project execution contractor selection. There are 33 items developed for each construct that measure contents including: a) project planning validation; (b) bidding contractor prequalification(c) contractor selection criteria, and (d) risk sharing agreement roles. It has been determined that the final version of the questionnaire, which includes this question, is construct and content valid.

Each item in the questionnaire is given five recoded responses (Likert's scale): 1 for strongly disagree, 2 for disagree, 3 for neutral, 4 for agree, and 5 for strongly agree. Items that measured the same construct were arranged in the same group.

6.2 Statistical Analysis

Statistical analysis was performed using SPSS Statistics software (version 21.0). Descriptive frequencies and percentage were calculated for the variables. Reliability and validity were used to evaluate the internal consistency of the questionnaires, to achievement the hypotheses of study chi-square test, specially, Somers'd and Kendall's tau-c were used.

6.3 Reliability and Validity

Test reliability and validity are two technical properties of a test that indicate the quality and usefulness of the test. These are the two most important features of a test. Reliability refers to the degree to which a test is consistent and stable in measuring what it is intended to measure. Validity refers to degree which the test actually measures what it claims to measure and who appropriate and meaningful are the inferences, conclusion, and decision based on the test scores.

Before conducting any analysis on the data, all the data's reliability was analyzed based on Cronbach's α value. The reliability and validity of the data were shown in Table 16.

Table 17.Reliability and Validity for the main hypotheses Study

Hypothesis statement	Reliability	Validity	Items	Interpretation
Project planning governance decisions	0.751	0.867	10	Strongly Valid
project planning and validation	0.909	0.953	18	Strongly Valid
Bidding contractor's prequalification	0.904	0.951	15	Strongly Valid
Contractor Selection Decision Criteria's	0.854	0.924	6	Strongly Valid
risk-sharing agreement role	0.785	0.886	4	Strongly Valid
For all questionnaire	0.938	0.969	53	Strongly Valid

The reliability of the questionnaire was evaluated using Cronbach's α coefficients for internal consistency and Pearson's correlation coefficient for test-retest reliability. As Table 16 shows, Cronbach's α coefficients for the total questionnaire and each statement were 0.938, 0.751, 0.909, 0.904, 0.8854, and 0.785, respectively, which means that Cronbach's α coefficients were acceptable for project planning governance decisions, project planning and validation, bidding contractor's prequalification, contractor selection decision criteria's, and risk-sharing agreement role.

Cronbach's α (correlation coefficient) ranged from 0.70 to 0.79 almost good, ranged from 0.80 to 0.89 very good, and from 0.90 to 1.0 excellent. In this study for all questionnaire the correlation coefficients 0.938 can be indicated as excellent reliability, and for project planning governance decisions, and risk-sharing agreement role were 0.751, 0.785 (range: 0.70 to 0.79), which indicated as good reliability, for contractor selection decision criteria's 0.854 (range:0.80 to 0.89), which indicated as very good reliability, and for, project planning and validation, and bidding contractor's prequalification, were 0.909, 0.904 (range: 0.90 to 1.0), which indicated as excellent reliability. On the whole, the correlation coefficient to the questionnaire was 0.938, which indicated that the questionnaire had excellent reliability.

6.4 Descriptive Statistics

The frequency distribution analysis was performed on the demographic variables to identify the respondents' general information. Section A of the questionnaire had 3 questions to identify; job title, education level, and experience of the research sample section B, C, D, and E of the rest questionnaire had many questions frequencies.

Table 17 analyses the various demographic characteristics of the participants. Supporting tables and figures are provided, together with comparative information from the questionnaire, where appropriate.

Table 18.General Information Response

Job title	Frequencies	Percentage %
Project Manager	12	21.8
Dept. Manager	14	25.5
Engineer	25	45.5
Contract Engineer	4	7.3
Education Level	Frequencies	Percentage %
Bachelor	29	52.7
Master	21	38.2
PhD	4	7.3
Other	1	1.8
Experience	Frequencies	Percentage %
Less than 5 years	2	3.6
From 5 to 9 years	6	10.9
From 10 to 14 years	7	12.7
From 15 to 19 years	12	21.8
20 years or above	28	50.9

The job Title

The participants were asked what their job title is. Composition of the participants was 21.8% project manager, 25.5% Dept. manager, 45.5% engineer, and 7.3% contractor engineer (see Figure 47). It is submitted that engineers are still, in some instances, more likely to be the designation and thus the distribution of the sample was considered to be reasonably representative.

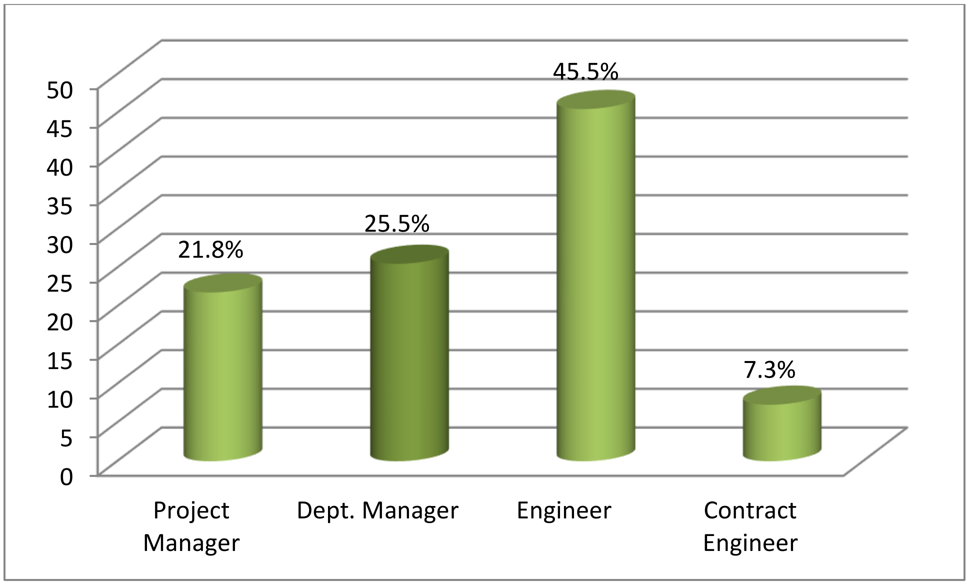

Figure 47.Respondents Job Title

Education level

Regarding the educational background of the participants, (Figure 48) indicates that 52.7% had completed bachelor, 38.2% had master degree, and 7.3% had PhD holders, 1.8%. Only very low percentages of the participants had other education level like diplomas and certificates.

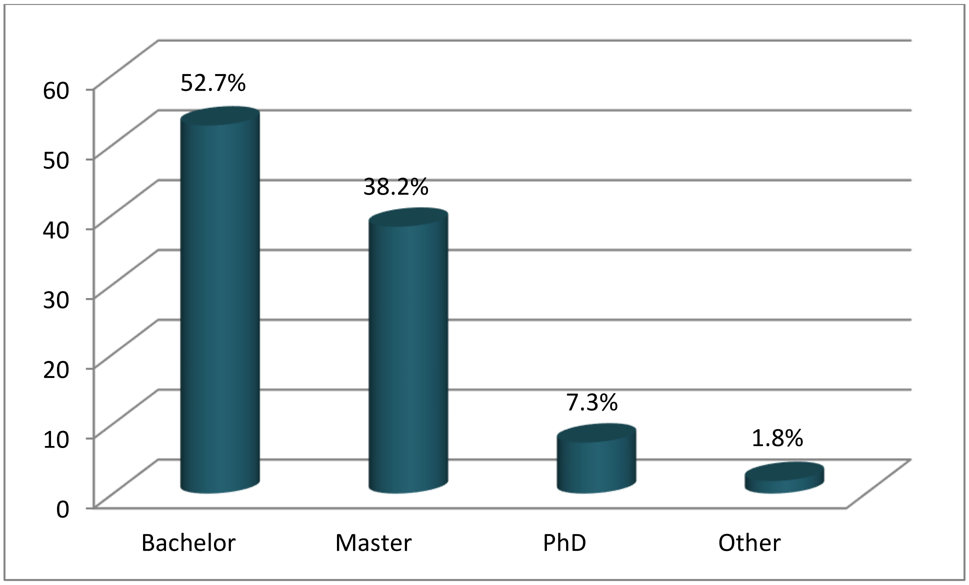

Figure 48.Respondents Education Level

Experience

Considering the participants experience in the study, (Figure 49) shows that 3.6% respondents had less than 5 years' experience. 10.9% had experience ranged from 5 to 9 years. 12.7% had experience ranged from 10 to 14 years. 21.8% had experience ranged from 15 to 19 years, and 50.9% respondents had experience 20 years or above.

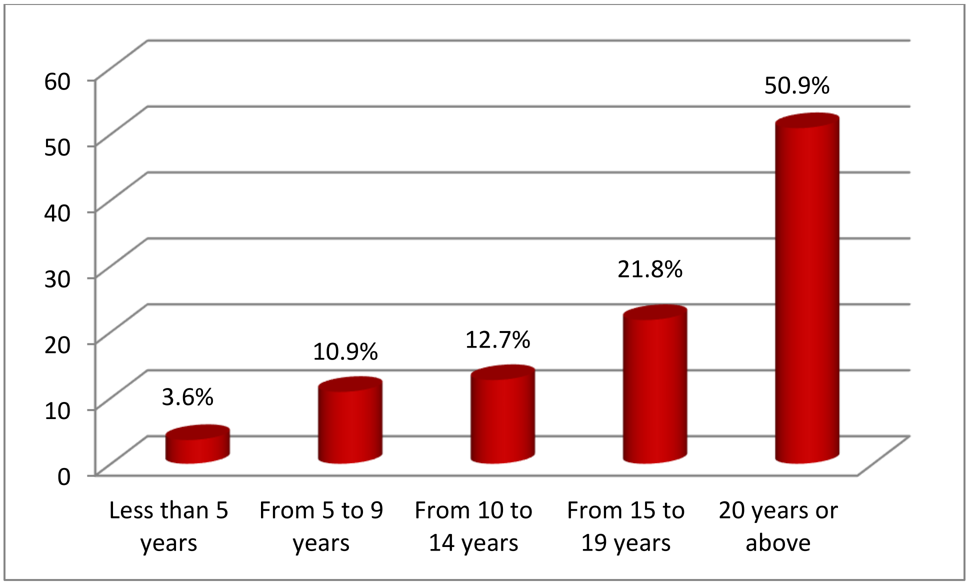

Figure 49.Respondents Experience Level

Table 19.The Familiar Level of Respondents with Governance Decision

Answer	**Frequencies**	**Percentage%**
Yes	47	85.5
Sometimes	4	7.3
No	4	7.3
Total	55	100

Table 20.The level of importance of Governance in Construction Projects

Importance	Frequencies	Percentage %
High Importance	52	94.5
Medium Importance	3	5.5
Total	55	100

6.5 Project Governance

As a part of section B, asking respondents for how familiar they are with project governance (see figure 50), 85.5% of respondents answered yes were familiar with project governance and 7.3% answered sometimes, and while the same percent answered No. It clear that project governance was familiar. In addition, respondents were asked about what the importance of governance decisions in construction projects (figure 51). 94.5% of respondents answered there is high importance of governance decisions in construction projects, and the rest was medium importance.

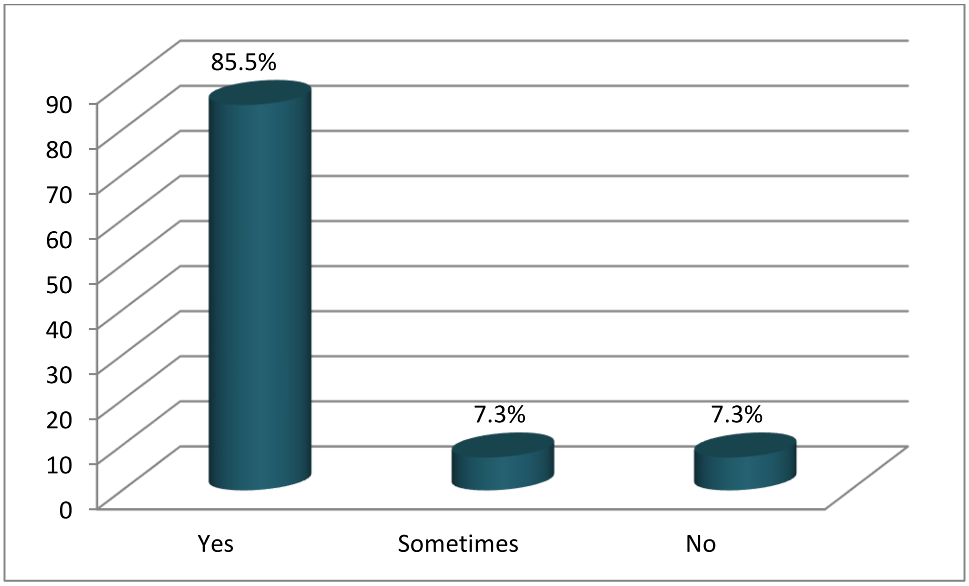

Figure 50.The Familiar Level of Respondents with Governance Decision

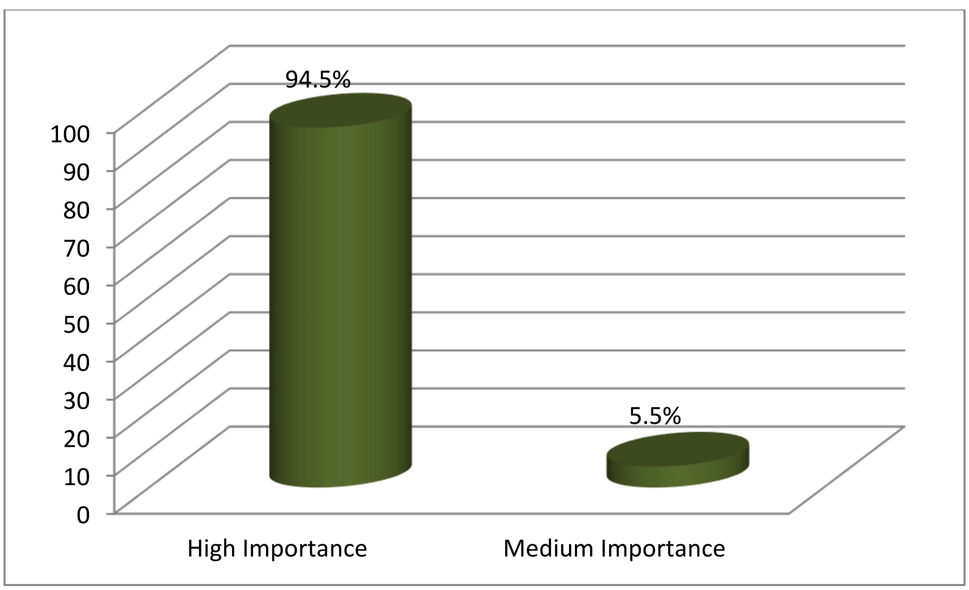

Figure 51.The Importance of Governance Decisions in Construction Projects

Table 20 shows the response about the project governance decision and how can help to ensure that projects are delivered on time. For this section, from descriptive shown in table a large percentage of participants approved project governance decision variables' results, representative a favorable reaction to the decision. Similar results were obtained for other statements, where most participants have positive impact on project scope, project risk, and for project overall Execution plan. Also, the governance decisions on the contractor prequalification process have a beneficial impact on the selection of suitable contractors; suitable financial stability and suitable procurements.

Table 21.Project Governance Decision

Statements	Respondents answers		
	Yes	Sometimes	No
a. Do you think governance decisions in project planning will have positive impact on project scope?	51 92.7%	3 5.5%	1 1.8%
b. Do you think governance decision in project planning will have positive impact on project risks?	48 87.3%	6 10.9%	1 1.8%
c. Do you think governance decision in project planning will have positive impact on project overall Execution plan?	50 90.9%	5 9.1%	0 0.0%
d. Do you believe that including governance decisions on the contractor prequalification process will have a beneficial impact on the selection of the most suitable contractors	52 94.5%	3 5.5%	0 0.0%
e. Did you Agree that governance decisions on the contractor prequalification process will have a beneficial impact on the selection of contractors with the most suitable financial stability?	49 89.1%	5 9.1%	1 1.8%
f. Do you believe that governance decisions on contractor prequalification process will have a beneficial impact on the selection of contractors with the most suitable procurements?	48 87.3%	7 12.7%	0 0.0%

Statements	Respondents answers		
	Yes	Sometimes	No
g. Do you believe that governance decisions on contractor prequalification process will have a beneficial impact for contractor selection with risk sharing believes as common standard during execution?	47 85.5%	7 12.7%	1 1.8%
h. Do you believe that governance decisions on contractor prequalification process will have a beneficial impact on the selection of contractors with the high project substantial standard as Measures?	43 78.2%	8 14.5%	4 7.3%

6.6 Project Execution Contractor Selection

Project contractor selection in this study covers project major sections and subsection to select a suitable contractor for project execution. The most suitable contractor is expected to execute ideal delivery which covers project planning validation, bidding contractors prequalification, contractor selection measures and align risk sharing.

6.6.1 Project Planning Validation

Project Scope

Tables 21 show the respondent's opinions for the project scope. It is clear that most answers strongly agree and agree on the statements study. Large percentages agree that scope changes control is a major consideration during project execution with importance tasks. This is because unclears project objectives will negatively affective the project cost, and schedule, and the unspecified project deliverables can cause delays and cost overruns, while uncontrolled changes orders impact on the project budget and project planning schedule.

Table 22.Project Scope

Statements	Respondents answer Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. Scope change control must be taken as a major consideration during project execution.	36 65.5%	19 34.5%	0 0.0%	0 0.0%	0 0.0%
b. Throughout the project planning phase, standards management is an important task.	23 41.8%	27 49.1%	5 9.1%	0 0.0%	0 0.0%
c. Project's schedule will be negatively affected by unclear project objectives during construction.	36 65.5%	15 27.3%	2 3.6%	2 3.6%	0 0.0%
d. Project's cost will be negatively affected by unclear project objectives during construction.	32 58.2%	18 32.7%	4 7.3%	1 1.8%	0 0.0%
e. Unspecified project deliverables can cause project delays	35 63.6%	17 30.9%	3 5.5%	0 0.0%	0 0.0%
f. Unspecified project deliverables can cause project cost overruns.	32 58.2%	20 36.4%	3 5.5%	0 0.0%	0 0.0%
g. Uncontrolled change orders during construction will seriously impact the project's budget.	37 67.3%	14 25.5%	4 7.3%	0 0.0%	0 0.0%
h. Uncontrolled change orders during construction will seriously impact the project's schedule.	35 63.6%	18 32.7%	2 3.6%	0 0.0%	0 0.0%

Project Risks

Table 22 shows the results of respondents about the project risk. It clear that almost answered strongly agree and agree for all statements, especially for the contractor's performance in terms of project efficiency and mitigation management strategy for bidding before contractor selection. The contractor's performance in terms of project efficiency may be significantly impacted during construction if project risks are correctly and not correctly acknowledged earlier phases of project planning, also, the bidding document for contractors' evaluation during the tendering process, report on project hazards should be included.

Table 23.Project Risks

Statements	Respondents Answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. An approved project risk mitigation management strategy must be created before a project is put out for bidding before contractor selection.	28 50.9%	17 30.9%	9 16.4%	1 1.8%	0 0.0%
b. The contractor's performance in terms of project efficiency may be significantly impacted during construction if project risks are correctly acknowledged earlier in the project planning	24 43.6%	22 40.0%	7 12.7%	2 3.6%	0 0.0%
c. The contractor's performance in terms of project quality may be significantly impacted during construction if project risks are not correctly acknowledged in	27 49.1%	25 45.5%	3 5.5%	0 0.0%	0 0.0%

Statements	Respondents Answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
the early phases of project planning.					
d. A project risk mitigation strategy is often required to be prepared during the planning phase for any anticipated risks during construction.	31 56.4%	21 38.2%	3 5.5%	0 0.0%	0 0.0%
e. In the bidding document for contractors' evaluation during the tendering process, a report on project hazards should be included.	26 47.3%	16 29.1%	11 20.0%	2 3.6%	0 0.0%

Project Execution Plan

Table 23 shows that respondent's answers of the project execution plan. Results revealed that a large number of participants either strongly agreed with or agreed with the statements made by variables. This suggests that their view on a high level of agreement in relation to project execution plan, indicating control standards in project integration management, and completed tasks early in the planning phase, taking into account process time. Execution plan should be created and approved as a viable plan during the planning phase before inviting bids in ordered properly maintained to affect project duration depending on complexity and nature of a project.

Table 24.Project Execution Plan

Statements	Respondents Answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. Throughout project construction, integrated change order control standards are a crucial stage in project integration management.	28 50.9%	22 40.0%	5 9.1%	0 0.0%	0 0.0%
b. Project deliverables must be carefully planned as completed tasks early in the planning phase, taking into account process time	19 34.5%	32 58.2%	3 5.5%	1 1.8%	0 0.0%
c. A project execution plan should be created and approved as a viable plan during the planning phase before inviting bids.	20 36.4%	26 47.3%	8 14.5%	1 1.8%	0 0.0%
d. Depending on the complexity of a project, if the project execution plan is not properly maintained, it will affect project execution duration.	27 49.1%	24 43.6%	4 7.3%	0 0.0%	0 0.0%
e. Depending on the nature of a project, if the project execution plan is not properly maintained, it will affect project execution duration.	27 49.1%	24 43.6%	4 7.3%	1 1.8%	0 0.0%

6.6.2 Bidding Contractors Prequalification's

Contractors Expertise

Table 24 shows the respondents opinions about the contractor expertise. Most answers strongly agree and agree about statements. Thus, the contractor must satisfy the project integration in order to be taken into account during the prequalification process and contractors must have high standard of technical expertise. Similarly, the individuals agreed that contractor's ability to demonstrate technical expertise must be considered during prequalification process.

Table 25.Contractor Expertise

Statements	Respondents Answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. The contractor must understand sustainable building practices in order to pass the prequalification requirements.	22 40.0%	21 38.2%	9 16.4%	3 5.5%	0 0.0%
b. A contractor must satisfy the project integration in order to be taken into account during the prequalification process.	21 38.2%	27 49.1%	4 7.3%	3 5.5%	0 0.0%
c. The contractor must have demonstrated high standard of technical expertise on projects of any complexity in the past in order to be prequalified.	22 40.0%	26 47.3%	5 9.1%	2 3.6%	0 0.0%
d. Prequalification of contractors is determined by the contractor management/coordination ability.	15 27.3%	20 36.4%	14 25.5%	6 10.9%	0 0.0%

Statements	Respondents Answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
e. It is important to consider previous engagement in projects of similar complexity during contractor prequalification.	25 45.5%	28 50.9%	2 3.6%	0 0.0%	0 0.0%
f. It is important to consider previous engagement in projects of a similar nature during contractor prequalification.	23 41.8%	29 52.7%	3 5.5%	0 0.0%	0 0.0%

Contractors Financial Stability

Table 25 shows the respondents answer for the constructor financial stability. Important consideration quality of contractor financial statement and stability of contractor's resources, the cash flow should be utilized as a condition for prequalifying contractors, outcomes of the prequalification of the contractors for the bid revealed that participants' answers suggested variables indicating their confidence in the contractors' knowledge and economic viability.

Table 26.Contractors Financial Stability

Statements	Respondents answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. An important consideration in the prequalification of contractors is the quality of contractor financial statement.	32 58.2%	21 38.2%	2 3.6%	0 0.0%	0 0.0%
b. The stability of a contractor's resources must be considered during prequalification.	32 58.2%	20 36.4%	2 3.6%	1 1.8%	0 0.0%

Statements	Respondents answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
c. The cash flow of the contractor's finances should be utilized as a condition for prequalifying contractors.	25 45.5%	23 41.8%	6 10.9%	1 1.8%	0 0.0%
d. Annual cash flow consistency must be a top concern in the criteria used to prequalify contractors.	28 50.9%	22 40.0%	4 7.3%	1 1.8%	0 0.0%

Contractor Procurement and Work Strategy

Table 26 shows the respondent's answers about Contractor Procurement and Work Strategy. Most participants strongly agree and agree with the statements. The main contractor evaluations during the contractor prequalification process are evidence of appropriate safety plans and quality control measure. The contractor may purchase products from a recognized third party rather than the original manufacturer. In addition, construction companies are prohibited from rewarding any subcontractor based on their expertise throughout the construction process unless expressly stated in their bid. The prequalification technique and measure must be agreed upon and accepted before the construction contractor is allowed to engage any qualified laborer based on his expertise.

Table 27.Contractors Procurements and Work Strategy

Statements	Respondents answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. Evidence of appropriate safety plans should be taken into consideration as contractor evaluation during the contractor prequalification process.	28 50.9%	22 40.0%	4 7.3%	1 1.8%	0 0.0%
b. Quality control measures should be taken into consideration during the contractor prequalification process.	26 47.3%	25 45.5%	2 3.6%	2 3.6%	0 0.0%
c. Unless otherwise indicated, the contractor may purchase products from a recognized third party rather than the original manufacturer.	14 25.5%	27 49.1%	11 20.0%	3 5.5%	0 0.0%
d. Based on the process for pre-qualifying contractors, construction companies are prohibited from rewarding any subcontractor based on their expertise throughout the construction process unless expressly stated in their bid.	12 21.8%	20 36.4%	16 29.1%	7 12.7%	0 0.0%
e. The prequalification technique and measure must be agreed upon and accepted before the construction contractor is allowed to engage any qualified laborer based on his expertise.	17 30.9%	23 41.8%	10 18.2%	5 9.1%	0 0.0%

6.6.3 Contractor Selection According to Project Planning Criteria

Table 27 shows the respondent's answers about Contractor Selection According to Project Planning Criteria. Most answers strongly agree and agree on the statements. Positive scope verification and validation based on the contractor's responses under risk sharing will have impact on project execution, and risk assessment registration and classification as stated in the tender document will have an impact on contractor's responses. If project's proven execution plan is realistic then it will have an impact on bidder selection under risk sharing.

Table 28.Contractor Selection According to Project Planning Criteria

Statements	Respondents answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. Positive scope verification and validation based on the contractor's responses under risk sharing will have an impact on Project Execution.	22 40.0%	28 50.9%	5 9.1%	0 0.0%	0 0.0%
b. Risk assessment registration and classification as stated in the tender document will have an impact on contractor's responses through a tender that is very clear about project-based risk sharing.	21 38.2%	29 52.7%	4 7.3%	1 1.8%	0 0.0%
c. If project's proven execution plan is realistic then it will have an impact on bidder selection under risk sharing.	16 29.1%	28 50.9%	9 16.4%	2 3.6%	0 0.0%

6.6.4 Contractor Selection According to Contractors Prequalification's Criteria's

Table 28 shows the respondent's answers about Contractor Selection According to Contractors Prequalification's Criteria's. Most answers strongly agree and agree on the statements. The selection of contractors places a strong focus on their experience on previous projects of a similar nature and a project under a risk-sharing environment is the financial stability of the contractors, also the project purchases are a key component of the bidder-positive criteria that must be met along with a work strategy under risk sharing.

Table 29.Contractor Selection According to Contractors Prequalification's Criteria's

Statements	Respondents answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. The selection of contractors places a strong focus on their experience on previous projects of a similar nature.	24 43.6%	25 45.5%	6 10.9%	0 0.0%	0 0.0%
b. The main consideration for selecting the best contractor for a project under a risk-sharing environment is the financial stability of the contractors.	19 34.5%	26 47.3%	10 16.2%	0 0.0%	0 0.0%
c. Project purchases are a key component of the bidder-positive criteria that must be met along with a work strategy under risk sharing.	12 21.8%	33 60.0%	10 16.2%	0 0.0%	0 0.0%

6.6.5 Risk Sharing Agreement Role

Table 29 shows the respondent's answers about risk sharing agreement. Most of the participants strongly agree and agree. Project cost overrun will be affected negatively under risk sharing during project execution, and within a risk-sharing arrangement the number of project change orders will be restricted and managed during project execution.

Table 30.Risk Sharing Agreement

Statements	Respondents answer				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a.Are you familiar with project risk sharing agreement	17 30.9%	26 47.3%	11 20.0%	1 1.8%	0 0.0%
b. If yes, Rate the importance of risk sharing agreement in construction projects	21 38.2%	23 41.8%	11 20.0%	0 0.0%	0 0.0%
c. Project cost overrun will be affected negatively under risk sharing agreement during project execution.	14 25.5%	26 47.3%	10 18.2%	5 9.1%	0 0.0%
d. Within a risk-sharing arrangement the number of project change orders will be restricted and managed during project execution.	13 23.6%	24 43.6%	14 25.5%	4 7.3%	0 0.0%

6.7 Hypotheses Tests

A statistical test must be used to determine whether there is an association between the sections in order to achieve the study's goal and validate the hypotheses. The association was examined using chi-square test statistics, and the results are shown in the tables below. Like most statistics test, to use the Chi-Square test successfully, certain assumptions must be met. They are: No cell should have expected value (count) less than 0, and. No more than 20% of the cells have expected values (counts) less than 5. If these conditions are unsatisfied, then alternative chi square tests were used. Suitable test in this case Somers'd test and Kendall's tau-c test. Somers'd (Somers' delta), is a nonparametric measure of the strength and direction of association that might exist between an ordinal dependent variable and an ordinal independent variable. Somers'd statistic is a measure of (asymmetric) association. d takes values between -1 and 1. A value of 1 or -1 means that the independent variable perfectly predicts the dependent variable: +1 when the relationship is positive and -1 when the relationship is negative. A value of 0 means that there is no relationship between the independent and dependent variables, and the independent variable is no help in predicting the dependent variable.

In common with other measures of correlation Kendall's tau will take values between -1 and +1, with a positive correlation indicating that the ranks of both variables increase together whilst a negative correlation indicates that as the rank of one variable increases the other one decreases.

Kendall's tau-b values range from -1 to 1. A positive value indicates that both variables increase together. A negative value indicates that both variables decrease together.

6.8 Verification of the Hypotheses Testing

To verify all 6 hypotheses, cross-tabulation table were conducted to shows the association frequencies between hypotheses study.

Cross tabulation is often used in survey analysis to determine the results of survey responses and compare how groups answered certain questions.

Also Somers'd statistic and kendall's tau-c statistic with tau value and p-value were calculated to achieve the result of significant differences of hypotheses.

Hypothesis 1: Project planning governance will positively impact project planning criteria verification and validation decisions.

To find association between project planning criteria verification and validation decisions and project planning governance, and to verify this hypothesis all opinions (440) in sections met to test it, association were investigated. 58.8% of them have strongly agreed (see table 30) with planning criteria verification and validation governance decisions.

Since the value of the test (Somers'd =0.167, Approx. T =3.854, sig=0.000) is fairly close to 0 rather than 1, this indicates that there is a fairly positive relationship between the two variables (see table 30). Since the p-value is less than our chosen significance level $\alpha = 0.05$, we can reject the null hypothesis, and conclude that there is an association between variables.

This implies that project planning governance decisions will positively impact on the project planning criteria verification and validation decision.

Table 31.Hypothesis One Test Results

Project planning criteria verification and validation decisions * Project planning governance decisions **Cross-tabulation**							
			Project planning criteria verification and validation decisions				Total
			Disagree	Neutral	Agree	Strongly agree	
Project planning governance decisions	No	Count	0	0	3	4	7
		% of Total	0.0%	0.0%	0.7%	0.9%	1.6%
	Sometimes	Count	0	2	30	12	44
		% of Total	0.0%	0.5%	6.8%	2.7%	10.0%
	Yes	Count	3	21	115	250	389
		% of Total	0.7%	4.8%	26.1%	56.8%	88.4%
Total		Count	3	23	148	266	440
		% of Total	0.7%	5.2%	33.6%	60.5%	100.0%

Table 32.Hypothesis One Semrad and Kendall's tau-c Statistics Results

Test Statistic				
	Value	**N**	**Approx. T**	**Asymp. Sig. (2-sided)**
Somers'd symmetric	0.167	440	3.854	0.000
Kendall's tau-c	0.091	440	3.854	0.000

Hypothesis 2: The project contractors' prequalification governance decision, will positively impact the project contractor selection criteria.

To find association between project contractors' prequalification governance decision and project contractor selection criteria, 330 respondents opinions about the association, 33.6% of them have agree with project contractors' prequalification governance decision and project contractor selection criteria as shown in (Table32).

Since the value of the test (Somers'd =0.355, Approx. T =6.728, sig=0.000) is close to 1, this indicates that there is a moderate positive relationship between the two variables and p-value is less than our chosen significance level α = 0.05, we can reject the null hypothesis, and conclude that there is an association between variables. This implies: the project contractors' prequalification governance decision, will moderate positively impact the project contractor selection criteria.

Table 33.Hypothesis Two Test Results

project contractors' prequalification governance decision * project contractor selection criteria **Cross-tabulation**							
			project contractor selection criteria				
			Disagree	Neutral	Agree	Strongly agree	
project contractors' prequalification governance decision	Disagreed	Count	1	1	6	6	14
		% of Total	0.3%	0.3%	1.8%	1.8%	4.2%
	Neutral	Count	0	13	16	8	37
		% of Total	0.0%	3.9%	4.8%	2.4%	11.2%
	Agree	Count	0	21	111	19	151
		% of Total	0.0%	6.4%	33.6%	5.8%	45.8%
	Strongly agree	Count	2	9	36	81	128
		% of Total	0.6%	2.7%	10.9%	24.5%	38.8%
Total		Count	3	44	169	114	330
		% of Total	0.9%	13.3%	51.2%	34.5%	100.0%

Table 34.Somersd and Kendall’s tau-c test statistics Results

Test Statistics				
	Value	**N**	**Approx. T**	**Asymp. Sig. (2-sided)**
Somers’d symmetric	0.355	330	6.728	0.000
Kendall’s tau-c	0.290	330	6.728	0.000

Hypothesis3: Project bidding contractors’ prequalification’s criteria will be positively impacted by the project planning governance decision.

To find association between bidding contractors’ prequalification’s criteria and project planning governance decisions, 440 respondents asked about this, 39.8% of them have strongly agree with bidding contractors’ prequalification’s criteria and Project planning governance decisions. Since the value of the test (Somers’d =0.075, Approx. T =2.272, sig=0.023) is close to 0, this indicates that there is a weak positive relationship between the two variables and p-value is less than our chosen significance level α = 0.05, we can reject the null hypothesis, and conclude that there is an association between variables (Table 34). This implies: the project bidding contractors’ prequalification’s criteria will be weak positively impacted by the project planning governance decision.

Table 35.Hypothesis Three Test Results

bidding contractors' prequalification's criteria * Project planning governance decisions **Cross-tabulation**							
			bidding contractors' prequalification's				
			Disagree	Neutral	Agree	Strongly agree	
Project planning governance decisions	No	Count	0	1	3	3	7
		% of Total	0.0%	0.2%	0.7%	0.7%	1.6%
	Sometimes	Count	0	5	31	8	44
		% of Total	0.0%	1.1%	7.0%	1.8%	10.0%
	Yes	Count	20	47	147	175	389
		% of Total	4.5%	10.7%	33.4%	39.8%	88.4%
Total		Count	20	53	181	186	440
		% of Total	4.5%	12.0%	41.1%	42.3%	100.0%

Table 36.Somersd and Kendall's tau- Statistics Results

Test Statistics				
	Value	**N**	**Approx. T**	**Asymp. Sig. (2-sided)**
Somers'd symmetric	0.075	440	2.272	0.023
Kendall's tau-c	0.048	440	2.272	0.023

Hypothesis 4: project contractors' selection phase criteria will be positively impacted project execution contractor selection risk agreement.

To find association between project contractors' selection phase criteria and project execution contractor selection risk agreement, 440 respondents asked about this, 26.4% of them have strongly agree with project contractors' selection phase criteria and project execution contractor selection risk agreement.

Since the value of the test (Somers'd =0.248, Approx. T =5.547, sig=0.000) is fairly close to 1, this indicates that there is a fairly positive relationship between the two variables and p-value is less than our chosen significance level $\alpha = 0.05$, we can reject the null hypothesis, and conclude that there is an association between variables (Table 36).

This implies: the project contractors' selection phase criteria will be fairly positively impacted project execution contractor selection risk agreement.

Table 37.Hypothesis Four Test Results

project contractors' selection phase criteria * project execution contractor selection risk agreement **Cross-tabulation**							
			project execution contractor selection risk agreement				Total
			Disagree	Neutral	Agree	Strongly agree	
project contractors' selection phase criteria	Disagreed	Count	3	2	6	9	20
		% of Total	0.7%	0.5%	1.4%	2.0%	4.5%
	Neutral	Count	1	16	22	14	53
		% of Total	0.2%	3.6%	5.0%	3.0%	12.0%
	Agree	Count	4	26	104	47	181
		% of Total	0.9%	5.9%	23.6%	10.7%	41.1%
	Strongly agree	Count	5	24	41	116	186
		% of Total	1.1%	5.5%	9.3%	26.4%	42.3%
Total		Count	13	68	173	186	440
		% of Total	3.0%	15.5%	39.3%	42.3%	100.0%

Table 38. Hypothesis Fout Somers'd and Kendall's tau- c Test Statistics Results

Test Statistics				
	Value	**N**	**Approx. T**	**Asymp. Sig. (2-sided)**
Somers'd symmetric	0.248	440	5.547	0.000
Kendall's tau-c	0.211	440	5.547	0.000

Hypothesis 5: project planning governance decisions will impact contractors' selection decision framework at the project planning phase.

To find association between the project planning governance decisions and contractors' selection decision framework at the project planning phase, 440 respondents asked about this, 40.5% of them have strongly agree with Project planning governance decisions and contractors' selection decision framework at the project planning phase

Since the value of the test (Somers'd =0.125, Approx. T =3.604, sig=0.000) is fairly close to 0, this indicates that there is a weak positive relationship between the two variables and p-value is less than our chosen significance level $\alpha = 0.05$, we can reject the null hypothesis, and conclude that there is an association between variables (Table 38).

This implies: the project planning governance decisions will fairly positively impact contractors' selection decision framework at the project planning phase.

Table 39.Hypothesis Five Test Results

Project planning governance decisions * contractors' selection decision framework at the project planning phase. **Cross-tabulation**							
			Selection decision framework at the project planning phase				Total
			Disagree	Neutral	Agree	Strongly agree	
Project planning governance decisions	No	Count	0	3	2	2	7
		% of Total	0.0%	0.7%	0.5%	0.5%	1.6%
	Sometimes	Count	0	8	30	6	44
		% of Total	0.0%	1.8%	6.8%	1.4%	10.0%
	Yes	Count	13	57	141	178	389
		% of Total	3.0%	4.8%	32.0%	40.5%	88.4%
Total		Count	13	68	173	186	440
		% of Total	3.0%	15.5%	39.3%	42.3%	100.0%

Table 40.Hypothesis Five Somers'd and Kendall's tau-c test statistics Results

Test Statistics				
	Value		**Approx. T**	**Asymp. Sig. (2-sided)**
Somers'd symmetric	0.125	440	3.604	0.000
Kendall's tau-c	0.080	440	3.604	0.000

Hypothesis 6: Project planning validation decisions will impact positively by contractors' selection decision framework on contractor prequalification criteria.

To find associations between the project planning validation decisions and contractors' selection decision framework on contractor prequalification criteria, 330 respondents opinions about this, 25.5% of them have strongly agree that the Project planning validation decisions will impact positively by contractors' selection decision framework on contractor prequalification criteria.

Since the value of the test (Somers'd =0.302, Approx. T =5.882, sig=0.000) is close to 1, this indicates that there is a moderate positive relationship between the two variables and p-value is less than our chosen significance level α = 0.05, we can reject the null hypothesis, and conclude that there is an association between variables (Table 40) .

This implies: the project planning validation decisions will impact moderate positively by contractors' selection decision framework on contractor prequalification criteria.

Table 41.Hypothesis six Test Results

			Project planning validation				Total
			Disagree	Neutral	Agree	Strongly agree	
contractor selection decision criteria	Disagreed	Count	0	0	1	2	3
		% of Total	0.0%	0.0%	0.3%	0.6%	0.9%
	Neutral	Count	0	15	16	13	44
		% of Total	0.0%	4.5%	4.8%	3.9%	13.3%
	Agree	Count	2	19	89	59	169
		% of Total	0.6%	5.8%	27.0%	17.9%	51.2%
	Strongly agree	Count	3	10	17	84	114
		% of Total	0.9%	3.0%	5.2%	25.5%	34.5%
Total		Count	5	44	123	158	330
		% of Total	1.5%	13.3%	37.3%	47.9%	100.0%

To find associations between the project planning validation decisions and contractors' selection decision framework on contractor prequalification criteria, 330 respondents opinions about this, 25.5% of them have strongly agree that the Project planning validation decisions will impact positively by contractors' selection decision framework on contractor prequalification criteria.

Table 42.Hypothesis Six Somers'd and Kendall's tau-c Test Statistics Results

Test Statistics				
	Value	**N**	**Approx. T**	**Asymp. Sig. (2-sided)**
Somers'd symmetric	0.302	330	5.882	0.000
Kendall's tau-c	0.244	330	5.882	0.000

Since the value of the test (Somers'd =0.302, Approx. T =5.882, sig=0.000) is close to 1, this indicates that there is a moderate positive relationship between the two variables and p-value is less than our chosen significance level $\alpha = 0.05$, we can reject the null hypothesis, and conclude that there is an association between variables.

This implies: the project planning validation decisions will impact moderate positively by contractors' selection decision framework on contractor prequalification criteria

6.9 Research Questions

The aim of this study is to create a decision framework for the contractor selection process, identifying governance and risk-sharing as critical components in selection. The research will investigate how governance can be integrated into project planning verification and validation, as well as how governance can be integrated into contractor prequalification. Additionally, the various alternatives for achieving project cost stability, quality, efficiency, and sustainability will be explored. Finally, the importance of maintaining the defined plan during project execution under the risk-sharing approach will be addressed. According to the main research question in this study and to verify the hypotheses testing a questionnaire was used to gathering the data then using statistical test to conduct findings and results. The following research questions will be answered:

1. What are the impacts of governance decisions on the project planning process?

To confirm this query, the respondent's opinions clear that most answers strongly agree and agree on the statements study. Large percentages agree that scope changes control is a major consideration during project execution with importance tasks. This is because unclears project objectives will negatively affective the project cost, and schedule, and the unspecified project deliverables can cause delays and cost overruns, while uncontrolled changes orders impact on the project budget and project planning schedule.

2. What are the impacts of governance decisions on the project contractor prequalification process?

Thus, the contractor must satisfy the project integration in order to be taken into account during the prequalification process and contractors must have high standard of technical expertise. Similarly, the individuals agreed that contractor's ability to demonstrate technical expertise must be considered during prequalification process.

3. What is the impact on contractor selection decision validation under governance and risk-sharing?

Most of the participants strongly agree and agree. Project cost overrun will be affected negatively under risk sharing during project execution, and within a risk-sharing arrangement the number of project change orders will be restricted and managed during project execution.

4. What is the impact of the project planning governance decision framework at the project planning phase?

The project execution plan indicating control standards project integration management, and completed tasks early in the planning phase, taking into account process time. Execution plan should be created and approved as a viable plan during the planning phase before inviting bids in ordered properly maintained to affect project duration depending on complexity and nature of a project.

5. What is the impact of governance on the project contractor’s prequalification governance decision in the contractor prequalification phase?

The main contractor evaluations during the contractor prequalification process are evidence of appropriate safety plans and quality control measure. The contractor may purchase products from a recognized third party rather than the original manufacturer. In addition, construction companies are prohibited from rewarding any subcontractor based on their expertise throughout the construction process unless expressly stated in their bid. The prequalification technique and measure must be agreed upon and accepted before the construction contractor is allowed to engage any qualified laborer based on his expertise.

6. What is the impact of designing and developing a framework for contractor selection under governance decision and risk-sharing on the project overall?

Regarding the contractor's performance in terms of project efficiency and mitigation management strategy for bidding before contractor selection, it is evident that almost all respondents strongly agreed or agreed with all of the statements. If project risks are appropriately or incorrectly acknowledged during earlier phases of project planning, the contractor's performance in terms of project efficiency may be severely impacted during construction. Additionally, a report on project hazards should be included in the bidding document for contractors to be evaluated during the tendering process.

6.10 Summary of Research Findings

The data analysis made the following findings. The majority of respondents who took part in the study had more than twenty years of experience, making up the largest percentage. More engineers than others with a job title that mostly refers to earlier jobs. The respondents gave college graduates (bachelor) the highest percentage of feedback based on their educational fulfillment. Additionally, when asked if they were familiar with project governance decisions, and about what the importance of governance decisions in construction projects, both further respondents said "yes" than "no," which has a strong response rate.

The respondents are aware based on the results that all statements mentioned were well satisfied. The majority of participants expressed approval with the decision variables related to project governance, indicating a positive response to the choice. Similar outcomes were seen for the other statements, where the majority of participants had a positive relation on the project's overall execution plan, project scope, and project risk. Furthermore, the governance choices made regarding the contractor prequalification process benefit the selection of appropriate contractors, appropriate financial stability, and appropriate procurements.

A large percentage agree the scope changes control take as a major consideration during project execution with importance tasks, and because unclears project objectives will negative affective on the project cost, and schedule, and the unspecified project deliverables can cause delays and cost overruns, the uncontrolled changes orders impact on the project budget and project planning schedule. The contractor's performance in terms of project efficiency may be significantly impacted during construction if project risks are correctly and not correctly acknowledged earlier phases of project planning, also, the bidding document for contractors' evaluation during the tendering process, report on project hazards should be included.

Execution plan should be created and approved as a viable plan during the planning phase before inviting bids in ordered properly maintained to affect project duration depending on complexity and nature of a project. Important consideration quality of contractor financial statement and stability of contractor’s resources, the cash flow should be utilized as a condition for prequalifying contractors, outcomes of the prequalification of the contractors for the bid revealed that participants' answers suggested variables indicating their confidence in the contractors' knowledge and economic viability. The main contractor evaluations during the contractor prequalification process are evidence of appropriate safety plans and quality control measure. The contractor may purchase products from a recognized third party rather than the original manufacturer, also construction companies are prohibited from rewarding any subcontractor based on their expertise throughout the construction process unless expressly stated in their bid, and the prequalification technique and measure must be agreed upon and accepted before the construction contractor is allowed to engage any qualified laborer based on his expertise.

Positive scope verification and validation based on the contractor's responses under risk sharing will have impact on project execution, and risk assessment registration and classification as stated in the tender document will have an impact on contractor's responses; also if project's proven execution plan is realistic then it will have an impact on bidder selection under risk sharing. The selection of contractors places a strong focus on their experience on previous projects of a similar nature and a project under a risk-sharing environment is the financial stability of the contractors, also the project purchases are a key component of the bidder-positive criteria that must be met along with a work strategy under risk sharing. Project cost overrun will be affected negatively under risk sharing agreement during project execution, and within a risk-sharing arrangement the number of project change orders will be restricted and managed during project execution.

CHAPTER SEVEN : DISCUSSION

7.0 Discussion

Throughout the project planning and contractor selection phases, governance choices are essential to the effective completion of projects. In addition to verifying and validating the choice of contractor made within the frameworks of governance and risk-sharing, this study would like to analyze the varied effects of governance decisions on project planning and the preliminary selection process for contractors. Additionally, a thorough analysis will be performed to determine the impact of governance decisions made regarding contractor prequalification and project planning on the final result of the project. In order to further improve project success, the structure for contractor selection under governance decisions and risk sharing will be created. Effective governance decisions are essential to project management since they have an impact on different phases of a project's lifecycle. The discussion attempts to highlight the importance of governance and risk sharing while analyzing how governance decisions affect the project stage of planning (Cheng et al., 2017).

The findings of this indicated that the project planning process is greatly impacted by governance decisions. Project managers can find places for betterment and make wise decisions by looking at the effects of governance decisions. Through the provision of clear instructions, the establishment of roles and duties, and the assurance of adequate resource allocation, this study found that successful governance decisions have a beneficial effect on the project planning procedure. On the other hand, bad governance choices can cause uncertainty, holdups, and resource exploitation (Biesenthal et al., 2014). During the planning stage, project managers should place a strong emphasis on openness, responsibility, and stakeholder engagement. Similarly, the choosing of qualified and competent contractors is made possible by the contractor prequalification procedure, which is essential for the effective completion of the project. By setting evaluation frameworks, specifying the prequalification criteria, and putting risk management plans into place, governance decisions have a significant impact on this process. The study's findings show that effective governance choices in contractor prequalification promote contractor selection, lower project risks, and increase project performance as a whole. In order to guarantee the success of governance decisions throughout this stage, it is necessary that there exist open lines of communication, clearly defined evaluation criteria, and the usage of established methods (Hermkens et al., 2020).

Furthermore, another finding of the study demonstrated that a reliable confirmation and verification process is necessary for safeguarding the authenticity of the contractor selection choice. The establishment of governance and risk-sharing systems is suggested by the research as a way to improve the contractor selection procedure. The decision-making process is improved by including a wide range of stakeholders, conducting thorough analyses, and taking risk factors into account. The findings of this study highlight the significance of strong governance and risk-sharing frameworks in the choice of contractors, ensuring that only those with the appropriate qualifications, knowledge, and risk management skills are chosen.

Moreover, the success of the project as a whole is largely impacted by governance choices made during project planning. Project consequences, procedures, and resource use all benefit from wise governance choices made during this phase. This research highlights how important it is to create clear project goals, identify roles and responsibilities, and put in place appropriate communication channels all during the planning phase of the project. The findings also highlight the necessity of ongoing monitoring and modification of governance choices throughout the project lifespan to take changing conditions and stakeholders' requirements into account (Kujala et al., 2016).

In addition, the study revealed that the accomplishment of hiring contractors is significantly influenced by the governance decisions taken during the contractor prequalification process. The choice of qualified and trustworthy contractors is simplified by established governance frameworks, uniform prequalification standards, and efficient risk management techniques. Based on the opinions of experts in the field, this study shows that strong governance choices in contractor prequalification lead to enhanced project performance, minimized project risks, and fewer delays. It emphasizes the importance of open, unbiased decision-making procedures that guarantee competitive hiring among prospective contractors. This study suggests designing and creating a comprehensive framework that incorporates governance choices and risk-sharing mechanisms to improve the efficacy of contractor selection. This framework seeks to speed up the selection of contractors, reduce risks, and guarantee fair and open decision-making by taking into account several factors, including qualifications (Lappi et al., 2018).

The findings of this study relate to other studies and demonstrates that project planning and contractor selection procedures are significantly impacted by efficient management decisions Smith, J. D., & Johnson, A. L. (2020). The findings of this study provide insights into how to best manage the decision-making process and highlight the significance of governance for achieving effective project outcomes. This study advances project management techniques and governance frameworks by offering a framework for contractor selection under governance choices and risk sharing. The study's findings and suggestions can be put into practice in order to enhance project planning and contractor selection consequences, which would ultimately increase project success rates (Haq et al., 2019).

Another study indicated that the position and authority to decide the dimension and the technical leadership category are aligned, highlighting the importance of flexible project managers with adaptable leadership abilities Johnson, R. S., & Smith, M. A. (2021) These abilities are essential for controlling the workload that appears to be growing as a result of potential risks and increased coordination needs within independent teams. The project manager takes on the function of a coordinator or administrator for the adaptive project team in their capacity as a flexible leader. In this role, middle management acts as only one source of accountability and supervision, jointly taking ownership of the initiatives. Their main goal is to make sure that tasks are given to the right people in order to satisfy the requirements of stakeholders and produce the best project results (Uwadi et al., 2022).

A system of local administration is referred to as governance when it brings combined political institutions, community members, and private companies to make choices as a group. The government and local actors, who play major roles in the creation of public policies as well as decision-making techniques, are anticipated to build this governance in the case of the

In addition, effective administration makes possible the creation of an atmosphere that is characterized by accountability, transparency, and trust. These elements are necessary for fostering long-term investments, monetary stability, and integrity in commercial dealings, all of which contribute to societal advancement and the development of increasingly diversified civilizations. The collapse of the project and the insufficient project implementation that accompanied it were both caused by unacceptable project management, which led to the entirety of the burden being put on one firm (Boumali et al., 2022).

According to the findings of another study that was conducted in this field, the two distinct approaches to project governance that were utilized in the construction of the Yi-wan Railway and the Northern Gateway Toll Road were the controlled, single-agent structure and the collaborative model, respectively. The influence that the governance features of these projects have on the management of project risk has been the subject of research. Both examples demonstrated how to collaborate and efficiently manage the risks associated with a project. Despite the fact that there were significant disparities in the degrees of authority, confidence, and flexibility displayed by the two instances. A management technique was utilized by the centralized, single-agent architecture of the Yi-wan Railway project so that the project's enormous needs could be satisfied while also reducing risks. In both instances, the performance assessment system pushed construction companies and architectural firms to collaborate more closely with one another in order to achieve superior outcomes (Granà et al., 2021).

A beneficial risk-sharing mechanism and a cross-organizational decision-making technique were both supported by the alliance architecture as an additional feature. The Yi-wan project, on the other hand, had a more centralized and top-down approach to conveying risks and management. The accomplishments of their risk management programs form the basis of the "responsibility allocation" method that their governance structure uses. According to the findings of the study that compared these situations, doing an evaluation of the organizational structure and risks associated with the project at the point where it is being considered feasible should improve risk management for significant infrastructure projects. According to Meyer et al. (2019), in order to improve results in risk identification and management, the best approach to project management and great governance need to be taken into account from the beginning of a project.

Accountability and transparency are critical components of the public sphere because of the significant impact it has not only on the workings of the corporate sector but also on the routines and pursuits of the general populace. In order to strengthen the processes of analysis and decision-making, it is necessary to establish transparency and to stimulate open conversation. When choices are taken without following proper procedure, the risk of corruption, which can include the inappropriate use of public funds, costly initiatives, and the abandonment of projects, may increase. The government environment is characterized by a number of features, including political tensions, issues in stakeholder management, unpredictability, and uncertainty. As a result, the importance of accountability, transparency, and good governance is emphasized. According to Joslin et al. (2016), many prosperous nations are aware of the requirement to adapt project management strategies, particularly for projects undertaken by their respective governments. The Integrated Central Unit, or ICU, was established with the intention of fostering earlier and more efficient planning for the actual execution of choices made about public policy. This was accomplished by putting into practice efficient principles and methods for project management. Effective project governance is essential to fostering collaboration and confidence among senior management, project sponsors, and members of the project team. When public sector acquisition makes up a significant portion of economic activity, efficient project acquisition becomes all the more critical. According to Sergeeva et al.'s research from 2020, having transparency throughout the procurement process boosts both efficiency and productivity. This is because it ensures that the process is fair and transparent.

In the building business, are now in a new period where governance and risk-sharing principles are more important than ever when choosing a contractor. The change from old-fashioned methods to a more organized and team-based one shows that control is becoming more and more important in handling and overseeing the selection of contractors. To make sure that the selection process is fair, open, and transparent, it stresses the need for clear rules, jobs, and duties (Smith & Johnson, 2020).

While this is going on, risk-sharing systems have become an important part of modern project management. Because building projects are getting more complicated and unclear, risk-sharing has become popular as a way to fairly divide risks among stakeholders. This method encourages teamwork, lowers the chance of disagreements, and matches the goals of workers, project owners, and regulatory bodies. These factors all help with responsible risk management and project success (Brown & Wilson, 2019).

These big changes in the building business show that more and more people are realizing how important it is to have flexible, open, and strong practices. Adopting governance and risk-sharing models is necessary to make sure that projects are completed on time and at a low cost, while also reducing the chance of problems and disagreements (Jones, Adams, & Smith, 2021).

Governance frameworks and practices are naturally linked to choices about which contractors to hire, especially when risk-sharing arrangements are in place. Governance is very important when it comes to choosing workers, especially when risk-sharing deals are involved. The goal of these deals is to spread project risks among all parties involved, including workers, so that everyone benefits (Smith & Johnson, 2019). Setting up a system for open, fair, and well-informed contractor selection is impossible without good control structures. This is especially true when risk-sharing is a key factor.

Researchers have found that governance tools, like putting together project planning groups or risk management teams, play a big role in deciding which contractors to hire and how to share risks (Brown & Wilson, 2020). These structures make sure that choices about who to hire are in line with the organization's strategic goals, its risk tolerance, and the project's general goals. In addition, governance makes sure that risk-sharing deals are followed through on and that everyone is fairly sharing risks and responsibilities (Jones & Adams, 2021).

For the most part, there is a strong link between choosing a provider and managing risk-sharing agreements. Effective governance systems make sure that strategic goals are aligned, contractors are chosen fairly, and risks are shared. They do this by providing openness, responsibility, and alignment with strategic goals.

Governance is an important part of planning a project, and it has an effect on the whole project management process. Governance frameworks and practices that work well are necessary to make sure that projects are completed quickly and in line with the strategic goals of an organization. Governance includes setting clear rules, ways to make decisions, and ways to hold people accountable for how projects are planned and carried out (Smith & Johnson, 2020). Governance makes it possible for clear and well-informed decisions to be made, which helps project leaders set clear goals, make good use of resources, and keep risks under control throughout the lifetime of the project. It also makes sure that preparation for projects is in line with the goals and plans of the organization, which increases the chances of project success.

Studies have shown that governance tools, like creating project planning groups and project management offices (PMOs), help set project goals, spell out roles and responsibilities, and keep an eye on project progress (Brown & Wilson, 2019). Transparency, following the rules, and being able to adjust to new situations are all important for the successful planning and performance of projects, and these systems help to keep them that way. To sum up, governance has a big effect on project planning because it gives projects the structure and control they need to reach their goals and add value to the organization.

A key part of good project management in the building industry is the link between government and the prequalification process for project contractors. Governance structures and practices play an important part in setting the rules and boundaries that determine who gets to be a worker. The selection of contractors is open and fair thanks to these control tools, which make sure that the process is based on clear and objective criteria (Smith & Johnson, 2018). Organizations can lower the risks of hiring unqualified or non-compliant contractors by adopting open control. This will eventually protect the success of building projects.

Governance also makes sure that the prequalification process for contractors is in line with the organization's overall mission and strategy goals. It makes it possible to come up with prequalification factors that are unique to the project and organisation, making sure that the workers chosen are in line with those goals (Jones & Adams, 2021). Governance frameworks also make it easier to keep an eye on contractors throughout the lifespan of a project. This helps keep the contractors' quality and compliance high and lowers the chance of problems or disputes. Basically, governance has a big effect on the prequalification process for contractors, which in turn has an effect on the quality, compliance, and general success of building projects.

Adopting governance with a risk-sharing system in project management has many benefits that make the project more successful and make stakeholders happier. These models set up a structured way to handle risk, control it, and hold people accountable, which leads to better project results. When big infrastructure projects like the London Cross rail are built, they show how these benefits can work.

Risk-sharing methods built into governance structures have made it possible for projects like London Cross rail, a huge urban train system, to fairly distribute risks among all stakeholders. This fair method lowers the risk that each party faces and encourages people to work together. As a result, there have been fewer disagreements and claims about the project, which has helped it stay on track and be finished on time and on budget (Crossrail, 2021).

A risk-sharing system for government also encourages communication and makes decisions better. It supports finding and evaluating risks early on in the project, so that steps can be taken right away to reduce them. Governance systems made it possible to handle risks ahead of time in the case of the Panama Canal Expansion project. This method avoided expensive delays and disagreements by dealing with problems right away, ensuring the smooth finish of this important infrastructure project (Panama Canal Authority, 2021). Governance with a risk-sharing system in project management has benefits like reducing risk, being open, and quickly settling disagreements, which leads to better project results and happy stakeholders.

It is very important to have governance that includes a risk-sharing system. This is especially true for megaprojects, which are very big, complicated, and unclear. Effective risk-sharing governance is even more important for megaprojects because they usually have a lot of parties, a lot of money at stake, and long timelines. Setting up governance structures and risk-sharing systems is important for handling the complex web of risks and making sure that megaprojects are finished successfully (Smith & Johnson, 2019).

For megaprojects to be well governed, project boards or steering groups are usually set up to keep an eye on risk-sharing deals and make decisions about how to distribute and reduce risk (Brown & Wilson, 2020). These governance tools help make sure that risks are shared fairly among all project partners. They also provide a way to keep an eye on and enforce risk-sharing deals so that everyone is held accountable and informed throughout the project's lifecycle.

7.1 Limitations

This study, focused on the construction industry for contractor selection, was conducted in the construction industry in Qatar. The data for this study were collected from a variety of organizations that were dedicated and focused on construction-related firms. These include Kahramaa, Ashghal, Qatar Rail, Espire Zone, Qatar Urban Planning, and the Doha municipality. These organizations were contacted formally but their contributions in terms of questionnaire responses did not meet the expected number of responses. Therefore, this data limitation had an impact on the study. The FAHP calculations were also impacted by relatively small data on completed project since this data was considered confidential.

Using control and risk-sharing tools to choose contractors is important for projects to go well in Qatar, but there are some problems and restrictions that need careful thought. Some of these restrictions are:

1. The difficulty of megaprojects: megaprojects usually have a lot of people involved, complicated technical needs, and big cash responsibilities. Because these projects are so complicated, it can be hard to come up with control and risk-sharing plans that cover all possible dangers and responsibilities.

2. Regulatory Framework: Qatar's regulatory environment may change over time, which could mean that law standards and how the government runs may not always match up.

Staying in line with laws that are always changing can be very hard.

3. Limited Resources: Putting in place strong control and risk-sharing methods can require a lot of resources. Complex systems may be hard to create and handle well for smaller projects that don't have a lot of money or staff.

4. Diversity in language and culture: Qatar's workforce is made up of workers from all over the world who work on its projects. Due to language and cultural differences, it can be hard to make sure that all parties understand and follow the rules for governance and risk sharing.

5. Problems with data and technology: Data analytics and technology are often needed for risk assessment and management to work well. Access to data and integrating technology can be hard, especially in older projects or ones that don't have a lot of technology infrastructure.

6. Cooperation with workers: It can be hard to get workers to agree to risk-sharing agreements. Contractors might not want to share risks because they are afraid of being sued or because they think the process is too complicated.

7. Dispute Resolution: Even with models for government and risk sharing, disagreements may still happen. To handle disagreements quickly and properly, there needs to be a way to settle them and a court system that works.

Getting around these problems needs constant tracking, change, and learning from past mistakes. Qatar's determination to deal with these problems will help to improve project control and risk-sharing over time, which will ensure the projects' long-term success and viability.

7.2 Conclusion and Recommendation

7.2.1 Conclusion

The research aims at analyzing the impact of governance decision on planning contractor pre-qualification, contractor selection and project planning phase. The purpose of this study was to add to an existing reservoir of research knowledge by giving a thorough overview of how project delivery has changed over the past several years and by highlighting new selection criteria. It is clear that the research study used a quantitative methodology to examine how governance decisions affected different facets of project delivery. Our grasp of the dynamic nature of project governance and its consequences for contractor pre-qualification, selection, and the project planning stage is aided by the study's findings.

To achieve this aim, a quantitative methodology was used. The questionnaire has 5 sections and total 55 items. However, it is significant to note that the Cronbach's alpha value of 0.938, which indicates the dependability of the scale used to measure project governance decision, fell below the intended level of 0.7. The scale might not be completely accurate in capturing the intended architecture, according to this indication. Because of this, care should be used when interpreting the findings in relation to project governance decisions.

7.2.2 Recommendation

In Qatar, where building and infrastructure are always changing, it is important to use good control and risk-sharing methods when choosing contractors to make sure that projects are successful. Several important suggestions can make it much more likely that these models will be used in the decision process:

1. Clear Procurement Processes: Qatar should stress how clear its procurement processes

are and make sure that companies are chosen using clear and open criteria. For a fair and competitive atmosphere, clear rules should be set up for judging bids and giving out contracts.

2. Strong systems of government: Set up strong control systems to keep an eye on the process of choosing contractors. This includes putting together selection committees or panels whose job it is to check out possible contractors and making sure they follow the rules and standards that have already been set.

3. Standardized Prequalification: Make sure that everyone knows what the standards are for bidding on projects by standardizing the prequalification factors for contractors. This helps clear things up and makes sure that all workers have the same chances.

4. Risk Assessment in Selection: When choosing a provider, you should think about risk assessment and risk sharing. Finding out about a contractor's risk tolerance and willingness to share risks can help avoid problems during the project's completion.

5. Performance-Based Agreements: It is recommended that performance-based agreements be used, which connect a contractor's pay to the success of a project. This method makes sure that the contractor's goals are aligned with the success of the project and pushes them to be proactive about managing risks.

6. Working together with stakeholders: Encourage government agencies, project owners, and companies to work together. For risk-sharing plans to work and for unexpected problems to be handled during the project, these parties must be able to communicate and work together well.

7. Legal Knowledge: To make sure that risk-sharing deals are legal and follow Qatar's rules, include legal experts in the writing and reviewing of contracts.

8. Continuous Monitoring and Compliance: Set up a way to keep an eye on workers to make sure they're following risk-sharing agreements and control policies all the time. Regular reviews and reports help keep track of a project's progress and make any changes that are needed.

9. Educating Contractors: Teach and give contractors information about control and risk-sharing systems. Contractors are more likely to take part in the risk-sharing process if they know their jobs, duties, and possible risks.

10. Learn from Mistakes: After a project is finished, make sure that reviews are done to record what was learned and to improve control and risk-sharing practices for choosing contractors in the future. Using what we've learned from the past can help us make better risk-sharing agreements for Qatar's projects, which will eventually lead to their success and the country's continued growth and development.

7.2.3 Further Studies

Scale refinement: Future research should put effort into improving the measurement instrument due to the project governance decision scale's subpar dependability. To guarantee the reliability and validity of the scale, this could entail reassessing the questionnaire's items, removing or rephrasing unclear or redundant ones, and doing more pilot testing.

Collaboration with practitioners: Incorporating the practical expertise and knowledge of practitioners and industry professionals would enhance the research process. Engaging with important players in the field can assist to clarify research topics, guarantee the applicability of the study, and encourage the use of research findings in practical settings.

Future research initiatives can extend our understanding of project delivery by putting these suggestions into practice, which will ultimately result in better governance decisions, enhanced contractor selection procedures, and improved project planning outcomes.

Longitudinal studies: Studies that are conducted longitudinally over an extended period of time can assist document how governance decisions change over time and how those decisions affect project planning and contractor selection. This would enable a more thorough investigation of the interplay between governance actions and project outcomes as well as a more accurate portrayal of trends.

Improving the way contractors are chosen in Qatar's projects by introducing better control and risk-sharing systems is an ongoing process that needs more study to keep getting better. To move towards this goal, there are a number of ways to study and discover further:

1. Quantitative Risk Assessment: To find out how risk-sharing methods affect contractor selection, you should do in-depth quantitative risk assessments. These kinds of studies can show how different risk-sharing models work in real life to improve project results like quality, speed, and cost control.

2. Best Practices Benchmarking: Studies that compare how Qatar chooses contractors to the best practices around the world can teach us a lot. Looking at what other countries or areas have done when they've faced similar problems can help make government and risk-sharing better.

3. Legal and Regulatory Frameworks: Looking into how Qatar's laws and rules are changing can help make sure that control and risk-sharing are in line with the new rules. For compliance and speed, it is important to know how changes to the law affect choosing contractors and allocating risk.

4. Technology Integration: Look into how advanced technologies, like blockchain for safe and open contracts, could be used in the choosing of contractors. In this age of digital change in Qatar, it is important to look into how technology can improve governance and risk-sharing.

Case Studies: Detailed case studies of past projects that used risk-sharing and governance can teach us a lot about what worked and what didn't in terms of best practices. These real-life events can teach us useful lessons for future projects.

6. Stakeholder Collaboration: It is important to do research on how stakeholders can work together and talk to each other. By learning how government agencies, project owners, and contractors talk to each other, we can come up with the best ways to make sure that the pick of contractors and risk-sharing deals are open and work well with everyone involved.

By looking into these areas of study, Qatar can keep improving the way it hires freelancers, making sure that only the best and most reliable ones are hired while keeping risks to a minimum. This study can help projects get done more quickly, disagreements get resolved more easily, and the country continue to grow and develop.

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APENDIXES

APENDIX A : Data Collection Questioners

Project Contractor Selection Decision Survey Questions

As part of my PhD thesis at Qatar University, I am carrying out a survey to investigate the contractor selection Frame Work Model system in the construction industry in Qatar. The objective is to establish key evaluation criteria for identifying the optimal contractor. I will be so thankful if you can complete the following questionnaire. Your responses will give a better insight of your expert opinion on the contractor selection criteria system being followed in Qatar.

Please note that any data or information that will be provided in this questionnaire will be handled with utmost confidentiality and it will be only involved on the academic aims to complete a PhD. Thank you in advance for taking your time to participate in this research. If you have any questions about the Questionnaire or the research, do not be hesitating to contact me on **ma1901108@qu.edu.qa**

A. General Information

a. What is your Job Title

☐ Engineer ☐ Project Manager ☐ Contract Engineer ☐ Dept. Manger

b. What is your Education Level

☐ Bachelors ☐ Master ☐ PHD ☐ Others ☐

c. What is your Experience

☐ Less than 5 years ☐ 5-9 years ☐ 10-14 years ☐ 15-19 years ☐ More than 20 years

(Project Governance decisions is the process by which projects are planned, monitored, and controlled. It involves making decisions about what the project should achieve, how it should be structured, and how it will be managed and monitored. A good project governance decision can help to ensure that projects are delivered on time, within budget and to the required quality standards also governance Decision keeps projects running smoothly, on budget, with timely deliveries and client satisfaction.)

B. Projects Governance Decisions

a. Are you familiar with project Governance Decisions? if no, please see Above?

☐ Yes ☐ No ☐ Somewhat

b. What do you think is the level of importance of governance decisions in Construction Projects.

☐ 1.High Importance ☐ 2. Medium Importance ☐ 3. Low Importance

c. Do you think governance decisions in project planning will have positive impact on project scope?

☐ Yes ☐ No ☐ I am not Sure

d. Do you think governance decision in project planning will have positive impact on project risks?

☐ Yes ☐ No ☐ I am not Sure

e. Do you think governance decision in project planning will have positive impact on project overall Execution plan?

☐ Yes ☐ No ☐ I am not Sure

f. Do you believe that including governance decisions on the contractor prequalification process will have a beneficial impact on the selection of the most suitable contractors i.e., contractors with the most appropriate expertise?

☐ Yes ☐ No ☐ I am not Sure

g. Did you Agree that governance decisions on the contractor prequalification process will have a beneficial impact on the selection of contractors with the most suitable financial stability?

☐ Yes ☐ No ☐ I am not Sure

h. Do you believe that governance decisions on contractor prequalification process will have a beneficial impact on the selection of contractors with the most suitable procurements?

☐ Yes ☐ No ☐ I am not Sure

i. Do you believe that governance decisions on contractor prequalification process will have a beneficial impact for contractor selection with risk sharing believes as common standard during execution?

☐ Yes ☐ No ☐ I am not Sure

j. Do you believe that governance decisions on contractor prequalification process will have a beneficial impact on the selection of contractors with the high project substantiable standard as Measures?

☐ Yes ☐ No ☐ I am not Sure

C. Project Execution Contractor Selection

Project contractor selection in this study covers project major sections and subsection to select a suitable contractor for project execution. The most suitable contractor is expected to execute ideal delivery which, covers project planning validation, bidding contractors prequalification, contractor selection measures and align risk sharing.

1.Project Planning Validation

1.1 Project Scope

a. Scope change control must be taken as a major consideration during project execution.

☐1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐4.Disagree ☐5.Strongly Disagree

b. Throughout the project planning phase, standards management is an important task.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐5.Strongly Disagree

c. Project's schedule will be negatively affected by unclear project objectives during construction.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

d. Project's cost will be negatively affected by unclear project objectives during construction.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

e. Unspecified project deliverables can cause project delays.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

f. Unspecified project deliverables can cause project cost overruns.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

g. Uncontrolled change orders during construction will seriously impact the project's budget.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

h. Uncontrolled change orders during construction will seriously impact the project's schedule.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

1.2 Project Risks

a. An approved project risk mitigation management strategy must be created before a project is put out for bidding before contractor selection.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

b. The contractor's performance in terms of project efficiency may be significantly impacted during construction if project risks are correctly acknowledged earlier in the project planning.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

c. The contractor's performance in terms of project quality may be significantly impacted during construction if project risks are not correctly acknowledged in the early phases of project planning.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

d. A project risk mitigation strategy is often required to be prepared during the planning phase for any anticipated risks during construction.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

e. In the bidding document for contractors' evaluation during the tendering process, a report on project hazards should be included.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

1.3 Project Execution Plan

a. Throughout project construction, integrated change order control standards are a crucial stage in project integration management.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

b. Project deliverables must be carefully planned as completed tasks early in the planning phase, taking into account process time.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

c. A project execution plan should be created and approved as a viable plan during the planning phase before inviting bids.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

d. Depending on the complexity of a project, if the project execution plan is not properly maintained, it will affect project execution duration.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

e. Depending on the nature of a project, if the project execution plan is not properly maintained, it will affect project execution duration.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

2.Bidding Contractors Prequalification

2.1 Contractors Expertise

a. The contractor must understand sustainable building practices in order to pass the prequalification requirements.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3.Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

b. A contractor must satisfy the project integration in order to be taken into account during the prequalification process.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

c. The contractor must have demonstrated high standard of technical expertise on projects of any complexity in the past in order to be prequalified.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

d. Prequalification of contractors is determined by the contractor management/coordination ability.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

e. It is important to consider previous engagement in projects of similar complexity during contractor prequalification.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

f. It is important to consider previous engagement in projects of a similar nature during contractor prequalification.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

2.2 Contractors Financial Stability

a. An important consideration in the prequalification of contractors is the quality of contractor financial statement.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

b. The stability of a contractor's resources must be considered during prequalification.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

c. The cash flow of the contractor's finances should be utilized as a condition for prequalifying contractors.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐4.Disagree ☐5.Strongly Disagree

d. Annual cash flow consistency must be a top concern in the criteria used to prequalify contractors.

☐1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

2.3 Contractors Procurements and Work Strategy

a. Evidence of appropriate safety plans should be taken into consideration as contractor evaluation during the contractor prequalification process.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

b. Quality control measures should be taken into consideration during the contractor prequalification process.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagre

c. Unless otherwise indicated, the contractor may purchase products from a recognized third party rather than the original manufacturer.

☐1.Strongly Agree ☐2.Agree ☐3. Neutral ☐ 4.Disagree ☐5.Strongly Disagree

d. Based on the process for pre-qualifying contractors, construction companies are prohibited from rewarding any subcontractor based on their expertise throughout the construction process unless expressly stated in their bid.

☐1.Strongly Agree ☐ 2.Agree ☐3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

e. The prequalification technique and measure must be agreed upon and accepted before the construction contractor is allowed to engage any qualified laborer based on his expertise.

☐ 1.Strongly Agree ☐2.Agree ☐3. Neutral ☐ 4.Disagree ☐5.Strongly Disagree

D. Contractor Selection Decision Criteria's

1. Contractor Selection According to Project Planning Criteria

a. Positive scope verification and validation based on the contractor's responses under risk sharing will have an impact on Project Execution.

☐1.Strongly Agree ☐ 2.Agree ☐3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

b. Risk assessment registration and classification as stated in the tender document will have an impact on contractor's responses through a tender that is very clear about project-based risk sharing.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐4.Disagree ☐5.Strongly Disagree

c. If project's proven execution plan is realistic then it will have an impact on bidder selection under risk sharing.

☐ 1.Strongly Agree ☐ 2.Agree ☐3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

2. Contractor Selection According to Contractors Prequalification's Criteria's

a. **The selection of contractors places a strong focus on their experience on previous projects of a similar nature.**

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

b. The main consideration for selecting the best contractor for a project under a risk-sharing environment is the financial stability of the contractors.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

c. Project purchases are a key component of the bidder-positive criteria that must be met along with a work strategy under risk sharing.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

E. Risk Sharing Agreement Roll

(Being one of the risk response strategies, risk sharing (also known as risk transfer) involves shifting some or all risk responsibilities which are likely to face the building construction project to the party that is in better position in terms of resources and knowledge to manage them Risk sharing between parties in the building construction projects can be done in different modalities. The choice of a form of risk sharing depends on the strength of such particular form of risk sharing. There exist various forms of risk sharing such as insurance, bond, warranty, surety, subcontracting, subletting, joint venture and partnership)

a. Are you familiar with project risk sharing agreement? If no please see Above.

☐ Yes ☐No ☐ Some What

b. If yes, Rate the importance of risk sharing agreement in construction projects.

☐ 1.High Importance ☐ 2.Medium Importance ☐ 3.Low Importance

c. Project cost overrun will be affected negatively under risk sharing agreement during project execution.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

d. Within a risk-sharing arrangement the number of project change orders will be restricted and managed during project execution.

☐ 1.Strongly Agree ☐ 2.Agree ☐ 3. Neutral ☐ 4.Disagree ☐ 5.Strongly Disagree

APPENDIX B : Contractor Selection FAHP Calculations

1. Criteria's Compression FAHP Matrix

(1/2) = 1/(1, 2, 3) = (1/1, 1/2, 1/3) (1/3) = 1/(2, 3, 4) = (1/2, 1/3, 1/4)
(1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5) (1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6)
(1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7) (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	Contractor Expertise	Financial Performance	Execution Strategy	Procurement Strategy
Contractor Expertise	(1,1,1)	1/8	1/6	1/5
Financial Performance	(7,8,9)	(1,1,1)	(3,4,5)	(5,6,7)
Execution Strategy	(5,6,7)	1/4	(1,1,1)	(4,5,6)
Procurement Strategy	(4,5,6)	1/6	1/5	(1,1,1)

Criteria's Pairwise Fuzzy Comparison Final Table

	Contractor Expertise	Financial Performance	Execution Strategy	Procurement Strategy
Contractor Expertise	(1,1,1)	(1/7,1/8,1/9)	(1/5,1/6,1/7)	(1/4,1/5,1/6)
Financial Performance	(7,8,9)	(1,1,1)	(3,4,5)	(5,6,7)
Execution Strategy	(5,6,7)	(1/3, 1/4, 1/5)	(1,1,1)	(4,5,6)
Procurement Strategy	(4,5,6)	(1/5, 1/6, 1/7)	(1/4,1/5,1/6)	(1,1,1)

Geometric Fuzzy Means Value (ri), ri $=(a * b * c * d)^{n}$

r 1 = $\left(1 * \frac{1}{7} * \frac{1}{5} * \frac{1}{4}\right)^{1/4} = (1 * 0.143 * 0.2 * 0.25)^{0.25} = 0.29$

$\left(1 * \frac{1}{8} * \frac{1}{6} * \frac{1}{5}\right)^{1/4} = (1 * 0.125 * 0.166 * 0.2)^{0.25} = 0.25$

$\left(1 * \frac{1}{9} * \frac{1}{7} * \frac{1}{6}\right)^{1/4} = (1 * 0.11 * 0.143 * 0.166)^{0.25} = 0.23$

r 1 = (0.29, 0.25, 0.23)

r 2 = $(7 * 1 * 3 * 5)^{1/4} = (7 * 1 * 3 * 5)^{0.25}$ = 3.20
$(8 * 1 * 4 * 6)^{1/4} = (8 * 1 * 4 * 6)^{0.25}$ =3.72
$(9 * 1 * 5 * 7)^{1/4} = (9 * 1 * 5 * 7)^{0.25}$ =4.12

r 2 = (3.20, 3.72, 4.12)

r 3 = $(5 * 1/3 * 1 * 4)^{1/4} = (5 * 0.33 * 1 * 4)^{0.25}$ = 1.69
$(6 * 1/4 * 1 * 5)^{1/4} = (6 * 0.25 * 1 * 5)^{0.25}$ =1.65
$\left(7 * \frac{1}{5} * 1 * 6\right)^{1/4} = (7 * 0.2 * 1 * 6)^{0.25}$ =1.70

r 3 = (1.69,1.65,1.70)

r 4 = $\left(4 * \frac{1}{5} * \frac{1}{4} * 1\right)^{1/4} = (4 * 0.2 * 0.25 * 1)^{0.25}$ = 0.67
$\left(5 * \frac{1}{6} * \frac{1}{5} * 1\right)^{1/4} = (5 * 0.166 * 0.2 * 1)^{0.25}$ =0.64
$\left(6 * \frac{1}{7} * \frac{1}{6} * 1\right)^{1/4} = (6 * 0.143 * 0.166 * 1)^{0.25}$ =0.61

r 4 = (0.67,0.64,0.61)

	Contractor Expertise	**Financial Performance**	**Execution Strategy**	**Procurement Strategy**	**Fuzzy Geometric Means Value (ri)**
Contractor Expertise	(1,1,1)	(1/7,1/8,1/9)	(1/5,1/6,1/7)	(1/4,1/5,1/6)	(0.29, 0.25 ,0.23)
Financial Performance	(7,8,9)	(1,1,1)	(3,4,5)	(5,6,7)	(3.20, 3.72, 4.12)
Execution Strategy	(5,6,7)	(1/3, 1/4, 1/5)	(1,1,1)	(4,5,6)	(1.69,1.65,1.70)
Procurement Strategy	(4,5,6)	(1/5, 1/6, 1/7)	(1/4,1/5,1/6)	(1,1,1)	(0.67,0.64,0.61)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ x(\boldsymbol{r1} + \boldsymbol{r2} * \boldsymbol{r3} * \boldsymbol{r4})^{-1}$

(0.29+3.2+1.69+0.67, 0.25+3.72+1.65+0.64,0.23+4.12+1.70+0.61)= (5.85,6.26,6.66)

$(5.85,6.26, 6.66)^{-1}$ = (1/5.85,1/6.26,1/6.66)

$(\boldsymbol{r1} + \boldsymbol{r2} * \boldsymbol{r3} * \boldsymbol{r4})^{-1}$= $(5.85,6.26, 6.66)^{-1}$ = (1/5.85,1/6.26,1/6.66)

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
Contractor Expertise	(0.29, 0.25, 0.23)	(0.29, 0.25, 0.23)x(1/5.85,1/6.26,1/6.66)
Financial Performance	(3.20, 3.72, 4.12)	(3.20, 3.72, 4.12)x (1/5.85,1/6.26,1/6.66)
Execution Strategy	(1.69, 1.65, 1.70)	(1.69, 1.65, 1.70)x (1/5.85,1/6.26,1/6.66)
Procurement Strategy	(0.67, 0.64, 0.61)	(0.67, 0.64, 0.61)x (1/5.85,1/6.26,1/6.66)

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
Contractor Expertise	(0.29, 0.25, 0.23)	(0.05, 0.04, 0.03)
Financial Performance	(3.20, 3.72, 4.12)	(0.55, 0.59, 0.62)
Execution Strategy	(1.69, 1.65, 1.70)	(0.29, 0.26,0.25)
Procurement Strategy	(0.67, 0.64, 0.61)	(0.11, 0.10, 0.91)

	Fuzzy Weights *Wi*
Contractor Expertise	(0.05, 0.04, 0.03)
Financial Performance	(0.55, 0.59, 0.62)
Execution Strategy	(0.29, 0.26,0.25)
Procurement Strategy	(0.11, 0.10, 0.91)

	Fuzzy Weights *Wi*	**Weights *Wi***
Contractor Expertise	(0.05, 0.04, 0.03)	0.04
Financial Performance	(0.55, 0.59, 0.62)	0.59
Execution Strategy	(0.29, 0.26,0.25)	0.27
Procurement Strategy	(0.11, 0.10, 0.91)	0.37

Criteria's Pairwise Criteria's De-Fuzzification

	Weights *Wi*	Normalized Weight
Contractor Expertise	0.04	0.04/1.27
Financial Performance	0.59	0.59/1.27
Execution Strategy	0.27	0.27/1.27
Procurement Strategy	0.37	0.37/1.27
Total	0.04+0.59+0.27+0.37 =1.27	0.0314+0.464+0.212+0.291 = 1.00

2. Contractor Expertise Sub- criteria's -Alternative FAHP Calculation

2.1 Excite Similar Project Scope Sub-criteria -Alternative FAHP Calculation

	C1	C2	C3
C1	1	6	2
C2	1/6	1	1/3
C3	1/2	3	1

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(5,6,7)	(1,2,3)
C2	(1/5,1/6,1/7)	(1,1,1)	(1/2,1/3,1/4)
C3	(1,1/2,1/3)	(2, 3, 4)	(1,1,1)

Geometric Fuzzy Means Value (ri), ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$

r 1 = $(1 * 5 * 1)^{1/3} = (1 * 5 * 1)^{0.33} = 1.7$
$(1 * 6 * 2)^{1/3} = (1 * 6 * 2)^{0.33} = 2.27$
$(1 * 7 * 3)^{1/3} = (1 * 7 * 3)^{0.33} = 2.7$
Fuzzy Geometric Means Value (r 1) = (1.7, 2.27, 2.7)

r 2 = $(1/5 * 1 * 1/2)^{1/3} = (0.2 * 1 * 0.5)^{0.33} = 0.46$
$(1/6 * 1 * 1/3)^{1/3} = (0.166 * 1 * 0.33)^{0.33} = 0.38$
$(1/7 * 1 * 1/4)^{1/3} = (0.142 * 1 * 0.25)^{0.33} = 0.82$

Fuzzy Geometric Means Value (r 2) = (0.46, 0.38, 0.82)

r 3 = $(1 * 2 * 1)^{1/3} = (1 * 2 * 1)^{0.33}$ = 1.26
$(1/2 * 3 * 1)^{1/3}$ = $(0.5 * 3 * 1)^{0.33}$ = 1.14
$(1/3 * 4 * 1)^{1/3}$ = $(0.33 * 4 * 1)^{0.33}$ = 1.1
Fuzzy geometric mean value (r 3) = (1.26, 1.14, 1.1)

Excite Similar Project Scope Sub-criteria Fuzzification

	C1	C2	C3	Fuzzy Geometric Means Value (ri)
C1	(1,1,1)	(1/2,1/3,1/4)	(1/3,1/4,1/5)	(1.7, 2.28, 2.7)
C2	(2,3, 4)	(1,1,1)	(3,4,5)	(1.25, 1.14, 1.1)
C3	(3, 4, 5)	(1/2,1/3,1/4)	(1,1,1)	(0.46, 0.38, 0.33)

Fuzzy Weights $Wi = ri\ x(r1 + r2 + r3)^{-1}$

(1.7, 2.27, 2.7) + (0.46, 0.38, 0.82) + (1.26, 1.14, 1.1) = (3.42,3.79,4.62)

Fuzzy Weights $Wi = ri\ x\ (r1 + r2 + r3)^{-1} = ri\ x$ $(3.42,3.79,4.62)^{-1}$

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.7, 2.27, 2.7)	(1.7, 2.27, 2.7) x (1/3.42,1/3.79,1/4.62)
C2	(0.46, 0.38, 0.82)	(0.46, 0.38, 0.82) x (1/3.42,1/3.79,1/4.62)
C3	(1.26, 1.14, 1.1)	(1.26, 1.14, 1.1) x (1/3.42,1/3.79,1/4.62)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.7, 2.27, 2.7)	(0.50, 0.60, 0.58)
C2	(0.46, 0.38, 0.82)	(0.13, 0.1, 0.18)
C3	(1.26, 1.14, 1.1)	(0.36, 0.30, 0.24)

Excite Similar Project Scope Sub-Criteria De-Fuzzification

	Fuzzy Weights *Wi*	**Weights *Wi***
C1	(0.50, 0.60, 0.58)	0.56
C2	(0.13, 0.1, 0.18)	0.14
C3	(0.36, 0.30, 0.24)	0.30

Weight *Wi* = Fuzzy Weight *Wi* / 3

Excite Similar Project Scope Sub-Criteria De-Fuzzification

	Weights *Wi*	**Normalized Weight**
C1	0.56	0.56/1
C2	0.14	0.14/1
C3	0.30	0.30/1
Total	1	0.56+0.14+0.30 = 1

2.2 Risk Sharing Performance Sub-Criteria -Alternative FAHP Calculation

	C1	**C2**	**C3**
C1	1	1/2	3
C2	2	1	6
C3	1/3	1/6	1

Risk Sharing Performance Sub-Criteria
Risk Sharing Performance Sub-Criteria Fuzzification

	C1	**C2**	**C3**
C1	(1,1,1)	(1/1,1/2,1/3)	(2,3,5)
C2	(1,2,3)	(1,1,1)	(5,6,7)
C3	(1/2,1/3,1/4)	(1/5,1/6,1/7)	(1,1,1)

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

Geometric Fuzzy Means Value (ri)), , ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$

r 1 = $(1 * 1 * 2)^{1/3} = (1 * 1 * 2)^{0.33} = 1.26$
$(1 * 1/2 * 3)^{1/3} = (1 * 0.5 * 3)^{0.33} = 1.14$
$(1 * 1/3 * 5)^{1/3} = (1 * 0.33 * 5)^{0.33} = 1.80$
Fuzzy Geometric Means Value (r 1) = (1.26**,** 1.14**,** 1.80**)**

r 2 = $(1 * 1 * 5)^{1/3} = (1 * 1 * 5)^{0.33} = 1.7$
$(2 * 1 * 6)^{1/3} = (2 * 1 * 6)^{0.33} = 2.27$
$(3 * 1 * 7)^{1/3} = (3 * 1 * 7)^{0.33} = 2.73$

Fuzzy Geometric Means Value (r 2) = (1.7**,** 2.27**,** 2.73**)**

r 3 = $(1/2 * 1/5 * 1)^{1/3} = (0.5 * 0.2 * 1)^{0.33} = 0.47$
$(1/3 * 1/6 * 1)^{1/3} = (0.33 * 0.167 * 1)^{0.33} = 0.38$
$(1/4 * 1/7 * 1)^{1/3} = (0.2 * 0.143 * 1)^{0.33} = 0.3$

Fuzzy Geometric Means Value (r 3) = (0.47**,** 0.38**,** 0.3 **)**

Risk Sharing Performance Sub-criteria

	C1	**C2**	**C3**	**Fuzzy Geometric Means Value (ri)**
C1	(1,1,1)	(1/1,1/2,1/3)	(2,3,5)	(1.26, 1.14, 1.80)
C2	(1,2,3)	(1,1,1)	(5,6,7)	(1.7, 2.27, 2.73)
C3	(1/2,1/3,1/4)	(1/5,1/6,1/7)	(1,1,1)	(0.47, 0.38, 0.3)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ \boldsymbol{x}(\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1}$

(1.26**,** 1.14**,** 1.80**)** + **(**1.7**,** 2.27**,** 2.73**)** + **(**0.47**,** 0.38**,** 0.3**)** = (3.43, 3.80, 4.83)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ \boldsymbol{x}\ (\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1} = \boldsymbol{ri}\ \boldsymbol{x}\ (3.43, 3.80, 4.83)^{-1}$

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.26, 1.14, 1.80)	(1.26, 1.14, 1.80) x (1/3.43,1/3.80,1/4.83)
C2	(1.7, 2.27, 2.73)	(1.7, 2.27, 2.73) x (1/3.43,1/3.80,1/4.83)
C3	(0.37, 0.35, 0.29)	(0.37, 0.35, 0.29) x (1/3.43,1/3.80,1/4.83)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.26, 1.14, 1.80)	(0.37, 0.30, 0.37)
C2	(1.7, 2.27, 2.73)	(0.50, 0.60, 0.56)
C3	(0.37, 0.35, 0.29)	(0.11, 0.10,0.06)

Risk Sharing Performance Sub-Criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.37, 0.30, 0.37)	0.35
C2	(0.50, 0.60, 0.56)	0.55
C3	(0.11, 0.10,0.06)	0.10

Weight *Wi* = Fuzzy Weight *Wi* / 3

	Weights *Wi*	Normalized Weight
C1	0.35	0.35/1
C2	0.55	0.55/1
C3	0.10	0.1/1
Total	1	0.35+0.55+0.1/1 = 1.00

2.3 Sustainability Performance Sub-Criteria -Alternatives FAHP Calculation

Sustainability performance Sub-criteria

	C1	C2	C3
C1	1	6	2
C2	1/6	1	1/3
C3	1/2	3	1

Sustainability Performance Sub-criteria Fuzzification

	C1	C2	C3
C1	(1,1,1)	(5,6,7)	(1,2,3)
C2	(1/5,1/6,1/7)	(1,1,1)	(1/2,1/3,1/4)
C3	(1/1,1/2,1/3)	(2, 3, 4)	(1,1,1)

Table 5-12 : Sustainability Performance Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

Sustainability Performance Sub-criteria

Geometric Fuzzy Means Value (ri) , ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$
ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$
r 1 = $(1 * 5 * 1)^{1/3} = (1 * 5 * 1)^{0.33} =$ 1.7
$(1 * 6 * 2)^{1/3} = (1 * 6 * 2)^{0.33}$ =2.27
$(1 * 7 * 3)^{1/3} = (1 * 7 * 3)^{0.33}$ =2.73
Fuzzy Geometric Means Value (r 1) = (1.7**,** 2.27**,** 2.73**)**

r 2 = $(1/5 * 1 * 1/2)^{1/3} = (0.25 * 1 * 0.5)^{0.33}$ = 0.50
$(1/6 * 1 * 1/3)^{1/3} = (0.167 * 1 * 0.33)^{0.33}$ = 0.38
$(1/7 * 1 * 1/4)^{1/3} = (0.142 * 1 * 0.2)^{0.33}$ = 0.30
Fuzzy Geometric Means Value (r 2) = (0.50**,** 0.38**,** 0.30)

r 3 = $(1 * 2 * 1)^{1/3} = (1 * 2 * 1)^{0.33}$ = 1.26
$(1/2 * 3 * 1)^{1/3} = (0.5 * 3 * 1)^{0.33}$ =1.143
$(1/3 * 4 * 1)^{1/3} = (0.33 * 4 * 1)^{0.33}$ = 1.1

Fuzzy Geometric Means Value (r 3) = (1.26**,** 1.143**,** 1.1)

Sustainability Performance Sub-criteria

	C1	C2	C3	Fuzzy Geometric Means Value (ri)
C1	(1,1,1)	(5,6,7)	(1 ,2,3)	(1.7, 2.27, 2.73)
C2	(1/5,1/6,1/7)	(1,1,1)	(1/2,1/3,1/4)	(0.50, 0.38, 0.30)
C3	(1,1/2,1/3)	(2,3,4)	(1,1,1)	(1.26, 1.143, 1.1)

Fuzzy Weights $Wi = ri\ x(r1 + r2 + r3)^{-1}$
(1.7**,** 2.27**,** 2.73**)** + **(**0.50**,** 0.38**,** 0.30**)** + **(**1.26**,** 1.143**,** 1.1) = (3.46, 3.79, 4.10)

Fuzzy Weights $Wi = ri\ x\ (r1 + r2 + r3)^{-1} = ri\ x\ (3.46, 3.79, 4.10)^{-1}$

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.7, 2.27, 2.73)	(1.7, 2.27, 2.73) x (1/3.46,1/3.79,1/4.10)
C2	(0.50, 0.38, 0.30)	(0.50, 0.38, 0.30)x (1/3.46,1/3.79,1/4.10)
C3	(1.26, 1.143, 1.1)	(1.26, 1.143, 1.1) x (1/3.46,1/3.79,1/4.10)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.7, 2.27, 2.73)	(0.49, 0.60, 0.67)
C2	(0.50, 0.38, 0.30)	(0.145, 0.10, 0.08)
C3	(1.26, 1.143, 1.1)	(0.36, 0.30,0.26)

Sustainability Performance Sub-Criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.49, 0.60, 0.67)	0.59
C2	(0.145, 0.10, 0.08)	0.11
C3	(0.36, 0.30,0.26)	0. 30

Weight *Wi* = Fuzzy Weight *Wi* / 3

	Weights *Wi*	Normalized Weight
C1	0.59	0.59/1
C2	0.11	0.11/1
C3	0.30	0.30/1
Total	1	1.00

3. Financial Performance Sub- criteria's -Alternative FAHP Calculation

3 .1 Contractor Offered Bid Sub-criteria-Alternative FAHP Calculation

	C1	C2	C3
C1	1	3	1/2
C2	1/3	1	1/6
C3	2	6	1

Contractor Offered Bid Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(2,3,4)	(1/1,1/2,1/3)
C2	(1/2,1/3,1/4)	(1,1,1)	(1/5,1/6,1/7)
C3	(1,2,3)	(5,6,7)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri =$(\mathbf{a} * \mathbf{b} * \mathbf{c})^{n}$

r 1 = $(1 * 2 * 1)^{1/3} = (1 * 2 * 1)^{0.33} = 1.26$
$(1 * 3 * 1/2)^{1/3} = (1 * 3 * 0.5)^{0.33} = 1.14$
$(1 * 4 * 1/3)^{1/3} = (1 * 4 * 0.33)^{0.33} = 1.1$

Fuzzy Geometric Means Value (r 1) = (1.26**,** 1.14**,** 1.1 **)**

r 2 = $(1/2 * 1 * 1/5)^{1/3} = (0.5 * 1 * 0.2)^{0.33} = 0.91$
$(1/3 * 1 * 1/6)^{1/3} = (0.2 * 1 * 5)^{0.33} = 0.47$
$(1/4 * 1 * 1/7)^{1/3} = (0.2 * 1 * 0.142)^{0.33} = 0.30$

Fuzzy Geometric Means Value (r 2) = (0.91**,** 0.47**,** 0.30**)**

r 3 = $(1 * 5 * 1)^{1/3} = (1 * 5 * 1)^{0.33}$ = 1.7

$(2 * 6 * 1)^{1/3} = (2 * 6 * 1)^{0.33}$ =2.27

$(3 * 7 * 1)^{1/3} = (3 * 7 * 1)^{0.33}$ =2.75

Fuzzy geometric mean value (r 3) = (1.7**,** 2.27**,** 2.75

Contractor Offered Bid Sub-criteria

	C1	**C2**	**C3**	**Fuzzy Geometric Means Value (ri)**
C1	(1,1,1)	(2, 3, 4)	(1,1/2,1/3)	(1.26, 1.14, 1.1)
C2	(1/2,1/3,1/4)	(1,1,1)	(1/5,1/6,1/7)	(0.91, 0.47, 0.30)
C3	(1,2,3)	(5,6,7)	(1,1,1)	(1.7, 2.27, 2.75)

Fuzzy Weights *Wi* = $\boldsymbol{ri}$ $x(\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1}$

(1.26**,** 1.14**,** 1.1) + (0.91**,** 0.47**,** 0.30) + (1.7**,** 2.27**,** 2.75) = (3.87,3.88,4.15)

Fuzzy Weights *Wi* = $\boldsymbol{ri}\ x\ (\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1} = \boldsymbol{ri\ x}$ $(3.87,3.88,4.15)^{-1}$

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
C1	(1.26, 1.14, 1.1)	(1.26, 1.14, 1.1) x (1/3.87,1/3.88,1/4.15)
C2	(0.91, 0.47, 0.30)	(0.91, 0.47, 0.30) x (1/3.87,1/3.88,1/4.15)
C3	(1.7, 2.27, 2.75)	(1.7, 2.27, 2.75) x (1/3.87,1/3.88,1/4.15)

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
C1	(1.26, 1.14, 1.1)	(0.33, 0.29, 0.26)
C2	(0.91, 0.47, 0.30)	(0.24, 0.12, 0.07)
C3	(1.7, 2.27, 2.75)	(0.44, 0.58, 0.66)

Contractor Offered Bid Sub-Criteria De-Fuzzification

	Fuzzy Weights *Wi*	**Weights *Wi***
C1	(0.33, 0.29, 0.26)	0.29
C2	(0.24, 0.12, 0.0.07)	0.14
C3	(0.44, 0.58, 0.66)	0.56

Weight *Wi* = Fuzzy Weight *Wi* / 3

	Weights *Wi*	Normalized Weight
C1	0.29	0.29/0.9
C2	0.14	0.14/0.9
C3	0.56	0.56/0.9
Total	0.99	1.1

3.2 Contractor Financial Stability Sub-criteria - Alternative FAHP Calculation

	C1	C2	C3
C1	1	1/3	1/6
C2	3	1	1/2
C3	6	2	1

Contractor Financial Stability Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(1/2,1/3,1/4)	(1/5,1/6,1/7)
C2	(2,3,4)	(1,1,1)	(1/1,1/2,1/3)
C3	(5,6,7	(1,2,3)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri =$(\mathbf{a} * \mathbf{b} * \mathbf{c})^{n}$

r 1 = $(1 * 1/2 * 1/5)^{1/3} = (1 * 0.5 * 0.2)^{0.33} = 0.47$
$(1 * 1/3 * 1/6)^{1/3} = (1 * 0.33 * 0.167)^{0.33} = 0.38$
$(1 * 1/4 * 1/7)^{1/3} = (1 * 0.25 * 0.142)^{0.33} = 0.33$

Fuzzy Geometric Means Value (r 1) = (0.47**,** 0.38**,** 0.33**)**

r 2 = $(2 * 1 * 1)^{1/3} = (2 * 1 * 1)^{0.33} = 1.25$
$(3 * 1 * 1/2)^{1/3} = (3 * 1 * 0.5)^{0.33} = 1.14$
$(4 * 1 * 1/3)^{1/3} = (4 * 1 * 0.33)^{0.33} = 1.1$

Fuzzy Geometric Means Value (r 2) = (1.25**,** 1.14**,** 1.1**)**

r 3 = $(5 * 1 * 1)^{1/3} = (5 * 1 * 1)^{0.33}$ = 1.7
$(6 * 2 * 1)^{1/3} = (6 * 2 * 1)^{0.33}$ =2.27
$(7 * 3 * 1)^{1/3} = (7 * 3 * 1)^{0.33}$ =2.73

Fuzzy geometric mean value (r 3) = (1.7**,** 2.27**,** 2.73

Contractor Financial Stability Sub-criteria

	C1	**C2**	**C3**	**Fuzzy Geometric Means Value (ri)**
C1	(1,1,1)	(1/2, 1/3, 1/4)	(1/5, 1/6, 1/7)	(0.47, 0.38, 0.33)
C2	(2,3,4)	(1,1,1)	(1/1,1/2,1/3)	(1.25, 1.14, 1.1)
C3	(5,6,7)	(2,3,4)	(1,1,1)	(1.7, 2.27, 2.73)

Fuzzy Weights $Wi = ri\ x(r1 + r2 + r3)^{-1}$

(0.47**,** 0.38**,** 0.33**)** + (1.25**,** 1.14**,** 1.1**)** + **(** 1.7**,** 2.27**,** 2.73) = (3.42,3.79,4.16)

Fuzzy Weights $Wi = ri\ x\ (r1 + r2 + r3)^{-1} = ri\ x$ (3.42,3.79,4.16)$^{-1}$

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
C1	(0.47, 0.38, 0.33)	(0.47, 0.38, 0.33) x (1/3.42,1/3.79,1/4.16)
C2	(1.25, 1.14, 1.1)	(1.25, 1.14, 1.1) x (1/3.42,1/3.79,1/4.16)
C3	(1.7, 2.27, 2.73)	(1.7, 2.27, 2.73) x (1/3.42,1/3.79,1/4.16)

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
C1	(0.47, 0.38, 0.33)	(0.14, 0.10, 0.08)
C2	(1.25, 1.14, 1.1)	(0.36, 0.30, 0.26)
C3	(1.7, 2.27, 2.73)	(0.49, 0.60,0.66)

Contractor Financial Stability Sub-Criteria De-Fuzzification

	Fuzzy Weights *Wi*	**Weights *Wi***
C1	(0.14, 0.10, 0.08)	0.11
C2	(0.36, 0.30, 0.26)	0.31
C3	(0.49, 0.60,0.66)	0.58

Weight *Wi* = Fuzzy Weight *Wi* /

	Weights *Wi*	**Normalized Weight**
C1	0.11	0.11/1
C2	0.31	0.31/1
C3	0.58	0.58/1
Total	1	1

3.3 Contractor Editor Work Statement Sub-criteria- Alternative FAHP Calculation

	C1	**C2**	**C3**
C1	1	2	6
C2	1/2	1	3
C3	1/6	1/3	1

Contractor Editor Work Statement Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(1,2,3)	(5,6,7)
C2	(1,1/2,1/3)	(1,1,1)	(2,3,4)
C3	(1/5,1/6/1/7)	(1/2,1/3,1/4)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$

r 1 = $(1 * 1 * 5)^{1/3} = (1 * 1 * 5)^{0.33} = 1.7$
$(1 * 2 * 6)^{1/3} = (1 * 2 * 6)^{0.33} = 2.27$
$(1 * 3 * 7)^{1/3} = (1 * 3 * 7)^{0.33} = 2.73$

Fuzzy Geometric Means Value (r 1) = (1.7**,** 2.27**,** 2.73**)**

r 2 = $(1 * 1 * 2)^{1/3} = (1 * 1 * 2)^{0.33} = 1.26$
$(1/2 * 1 * 3)^{1/3} = (0.5 * 1 * 3)^{0.33} = 1.14$
$(1/3 * 1 * 4)^{1/3} = (0.33 * 1 * 4)^{0.33} = 1.1$
Fuzzy Geometric Means Value (r 2) = (1.26**,** 1.14**,** 1.1**)**

r 3 = $(1/5 * 1/2 * 1)^{1/3} = (0.2 * 0.5 * 1)^{0.33} = 0.47$
$(1/6 * 1/3 * 1)^{1/3} = (0.167 * 0.33 * 1)^{0.33} = 0.38$
$(1/7 * 1/4 * 1)^{1/3} = (0.142 * 0.25 * 1)^{0.33} = 0.33$
Fuzzy geometric mean value (r 3) = (0.47**,** 0.38**,** 0.33)

Contractor Editor Work Statement Sub-criteria

	C1	**C2**	**C3**	**Fuzzy Geometric Means Value (ri)**
C1	(1,1,1)	(1, 2, 3)	(5, 6, 7)	(1.7, 2.27, 2.73)
C2	(1,1/2,1/3)	(1,1,1)	(2,3,4)	(1.26, 1.14, 1.1)
C3	(1/5,1/6,1/7)	(1/2,1/3,1/4)	(1,1,1)	(0.47, 0.38, 0.33)

Fuzzy Weights $Wi = ri\ x(r1 + r2 + r3)^{-1}$

(1.7**,** 2.27**,** 2.73)+ (1.26**,** 1.14**,** 1.1)+ (0.47**,** 0.38**,** 0.33) = (3.43,3.79,4.16)

Fuzzy Weights $Wi = ri\ x\ (r1 + r2 + r3)^{-1} = ri\ x\ (3.43, 3.79, 4.16)^{-1}$

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
C1	(1.7, 2.27, 2.73)	(1.7, 2.27, 2.73) x (1/3.43,1/3.79,1/4.16)
C2	(1.26, 1.14, 1.1)	(1.26, 1.14, 1.1) x (1/3.43,1/3.79,1/4.16)
C3	(0.47, 0.38, 0.33)	(0.47, 0.38, 0.33) x (1/3.43,1/3.79,1/4.16)

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
C1	(1.7, 2.27, 2.73)	(0.49, 0.60, 0.66)
C2	(1.26, 1.14, 1.1)	(0.37, 0.30, 0.26)
C3	(0.47, 0.38, 0.33)	(0.14, 0.10,0.08)

Contractor Editor Work Statement Sub-Criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.49, 0.60, 0.66)	0.58
C2	(0.37, 0.30, 0.26)	0.31
C3	(0.14,0.10,0.08)	0.11

Weight *Wi* = Fuzzy Weight *Wi* /

	Weights *Wi*	Normalized Weight
C1	0.58	0.58/1
C2	0.31	0.31/1
C3	0.11	0.11/1
Total	1	1

4. Execution Strategy Sub- criteria's -Alternative FAHP Calculation

4.1 Project Execution Plan Clarity Sub-criteria

	C1	C2	C3
C1	1	1/6	1/3
C2	6	1	2
C3	3	1/2	1

	C1	C2	C3
C1	(1,1,1)	(4,5,6)	(4,5,6)
C2	1/5	(1,1,1)	(3,4,5)
C3	1/5	1/4	(1,1,1)

Project Execution Plan Clarity Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(1/5, 1/6, 1/7)	(1/2,1/3,1/4)
C2	(5,6,7)	(1,1,1)	(1,2,3)
C3	(2,3,4)	(1/1,1/2,1/3)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri =$(\mathbf{a} * \mathbf{b} * \mathbf{c})^{n}$

r 1 = $(1 * 1/5 * 1/2)^{1/3} = (1 * 0.2 * 0.5)^{0.33} = 0.47$
$(1 * 1/6 * 1/3)^{1/3} = (1 * 0.167 * 0.33)^{0.33}$ =0.38

$(1 * 1/7 * 1/4)^{1/3} = (1 * 0.142 * 0.2)^{0.33}$ =0.30

Fuzzy Geometric Means Value (r 1) = (0.47**,** 0.38**,** 0.30 **)**

r 2 = $(5 * 1 * 1)^{1/3} = (5 * 1 * 1)^{0.33}$ = 1.6
$(6 * 1 * 2)^{1/3} = (6 * 1 * 2)^{0.33}$ =2.27
$(7 * 1 * 3)^{1/3} = (7 * 1 * 3)^{0.33}$ = 2.7
Fuzzy Geometric Means Value (r 2) = (1.6**,** 2.27**,** 2.7 **)**

r 3 = $(2 * 1 * 1)^{1/3} = (2 * 1 * 1)^{0.33}$ = 1.26
$(3 * 1/2 * 1)^{1/3} = (3 * 0.5 * 1)^{0.33}$ =1.14
$(4 * 1/3 * 1)^{1/3} = (4 * 0.33 * 1)^{0.33}$ =1.1

Fuzzy geometric mean value (r 3) = (1.26**,** 1.14**,** 1.1)
Project Execution Plan Clarity Sub-criteria

	C1	**C2**	**C3**	**Fuzzy Geometric Means Value (ri)**
C1	(1,1,1)	(1/5, 1/6, 1/7)	(1/2, 1/3, 1/4)	(0.47, 0.38, 0.30)
C2	(5,6,7)	(1,1,1)	(1,2,3)	(1.6, 2.27, 2.7)
C3	(2,3,4)	(1/1,1/2,1/3)	(1,1,1)	(1.26, 1.14, 1.1)

Fuzzy Weights $Wi = ri\ x(r1 + r2 + r3)^{-1}$

(0.47**,** 0.38**,** 0.30)+ (1.6**,** 2.27**,** 2.7) + (1.26**,** 1.14**,** 1.1)= (3.33,3.79,4.1)

Fuzzy Weights $Wi = ri\ x\ (r1 + r2 + r3)^{-1} = ri\ x\ (33.33, 3.79, 4.1)^{-1}$

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
C1	(0.47, 0.38, 0.30)	(0.47, 0.38, 0.30)x (1/3.33,1/3.79,1/4.1)
C2	(1.6, 2.27, 2.7)	(1.6, 2.27, 2.7) x (1/3.33,1/3.79,1/4.1)
C3	(1.26, 1.14, 1.1)	(1.26, 1.14, 1.1) x (1/3.33,1/3.79,1/4.1)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(0.47, 0.38, 0.30)	(0.14, 0.1, 0.07)
C2	(1.6, 2.27, 2.7)	(0.48, 0.60, 0.66)
C3	(1.26, 1.14, 1.1)	(0.38, 0.30,0.27)

Project Execution Plan Clarity Sub-Criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.14, 0.1, 0.07)	0.1
C2	(0.48, 0.60, 0.66)	0.58
C3	(0.38, 0.30,0.27)	0.31

Weight *Wi* = Fuzzy Weight *Wi* / 3

Project Execution Plan Clarity Sub-Criteria De-Fuzzification

	Weights *Wi*	Normalized Weight
C1	0.11	0.11/1
C2	0.58	0.58/1
C3	0.31	0.31/1
Total	1	1

4.2 Project Risk, Life and Safety Sub-criteria – Alternative FAHP Calculation

	C1	C2	C3
C1	1	3	1/2
C2	1/3	1	1/3
C3	2	3	1

Project Risk, Life and Safety Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(2,3, 4)	(1/1,1/2,1/3)
C2	(1/2,1/3,1/4)	(1,1,1)	(1/2,1/3,1/4)
C3	(1,2,3)	(2,3,4)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri =$(\mathbf{a} * \mathbf{b} * \mathbf{c})^{n}$

r 1 = $(1 * 2 * 1)^{1/3} = (1 * 2 * 1)^{0.33} = 1.26$
$(1 * 3 * 1/2)^{1/3} = (1 * 3 * 0.5)^{0.33} = 1.14$
$(1 * 4 * 1/3)^{1/3} = (1 * 4 * 0.33)^{0.33} = 1.1$
Fuzzy Geometric Means Value (r 1) = (1.26**,** 1.14**,** 1.1**)**

r 2 = $(1/2 * 1 * 1/2)^{1/3} = (0.5 * 1 * 0.5)^{0.33} = 0.63$
$(1/3 * 1 * 1/3)^{1/3} = (0.33 * 1 * 0.33)^{0.33} = 0.45$
$(1/4 * 1 * 1/4)^{1/3} = (0.2 * 1 * 0.2)^{0.33} = 0.34$
Fuzzy Geometric Means Value (r 2) = (0.63**,** 0.45**,** 0.34**)**

r 3 = $(1 * 2 * 1)^{1/3} = (1 * 2 * 1)^{0.33} = 1.26$
$(2 * 3 * 1)^{1/3} = (2 * 3 * 1)^{0.33} = 1.8$
$(3 * 4 * 1)^{1/3} = (3 * 4 * 1)^{0.33} = 2.27$

Fuzzy geometric mean value (r 3) = (1.26**,** 1.8**,** 2.27

Project Risk, Life and Safety Sub-criteria

	C1	**C2**	**C3**	**Fuzzy Geometric Means Value (ri)**
C1	(1,1,1)	(2, 3, 4)	(1/1, 1/2, 1/3)	(1.26, 1.14, 1.1)
C2	(1/2,1/3,1/4)	(1,1,1)	(1/2,1/3,1/4)	(0.63, 0.45, 0.34)
C3	(1,2,3)	(2,3,4)	(1,1,1)	(1.26, 1.8, 2.27)

Fuzzy Weights $Wi = ri\ x(r1 + r2 + r3)^{-1}$

(1.26**,** 1.14**,** 1.1)+ (0.63**,** 0.45**,** 0.34)+ (1.26**,** 1.8**,** 2.27) = (3.15,3.39,3.71)

Fuzzy Weights $Wi = ri\ x\ (r1 + r2 + r3)^{-1} = ri\ x\ (3.15, 3.39, 3.71)^{-1}$

	Fuzzy Geometric mean Value *ri*	**Fuzzy Weights *Wi***
C1	(1.26, 1.14, 1.1)	(1.26, 1.14, 1.1) x (1/3.15,1/3.39,1/3.71)
C2	(0.63, 0.45, 0.34)	(0.63, 0.45, 0.34) x (1/3.15,1/3.39,1/3.71)
C3	(1.26, 1.8, 2.27)	(1.26, 1.8, 2.27)x (1/3.15,1/3.39,1/3.71)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.26, 1.14, 1.1)	(0.40, 0.34, 030)
C2	(0.63, 0.45, 0.34)	(0.20, 0.13, 0.09)
C3	(1.26, 1.8, 2.27)	(0.40, 0.53,0.0.61)

Project Risk, Life and Safety Sub-Criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.40, 0.34, 030)	0.35
C2	(0.20, 0.13, 0.09)	0.14
C3	(0.40, 0.53,0.0.61)	0.51
	Weight *Wi* = Fuzzy Weight *Wi* /	
C1	0.35	0.35/1
C2	0.14	0.14/1
C3	0.51	0.51/1

4.3 Joint venture Execution Strategy Sub-criteria-Alternative FAHP Calculation

	C1	C2	C3
C1	1	2	6
C2	1/2	1	3
C3	1/6	1/3	1

Contractor Editor Work Statement Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(1,2,3)	(5,6,7)
C2	(1/1,1/2,1/3)	(1,1,1)	(2,3,4)
C3	(1/5,1/6,1/7)	(1/2,1/3,1/4)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$

ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$
r 1 = $(1 * 1 * 5)^{1/3} = (1 * 1 * 5)^{0.33} = 1.7$
$(1 * 2 * 6)^{1/3} = (1 * 2 * 6)^{0.33} = 2.27$
$(1 * 3 * 7)^{1/3} = (1 * 3 * 7)^{0.33} = 2.73$

Fuzzy Geometric Means Value (r 1) = (1.7**,** 2.27**,** 2.73**)**

r 2 = $(1 * 1 * 2)^{1/3} = (1 * 1 * 2)^{0.33} = 1.26$
$(1/2 * 1 * 3)^{1/3} = (0.5 * 1 * 3)^{0.33} = 1.14$
$(1/3 * 1 * 4)^{1/3} = (0.33 * 1 * 4)^{0.33} = 1.1$
Fuzzy Geometric Means Value (r 2) = (1.26**,** 1.14**,** 1.1**)**

r 3 = $(1/5 * 1/2 * 1)^{1/3} = (0.2 * 0.5 * 1)^{0.33} = 0.47$
$(1/6 * 1/3 * 1)^{1/3} = (0.167 * 0.33 * 1)^{0.33} = 0.38$
$(1/7 * 1/4 * 1)^{1/3} = (0.142 * 0.25 * 1)^{0.33} = 0.33$

Fuzzy geometric mean value (r 3) = (0.47, 0.38, 0.33)

Joint venture Execution Strategy Sub-criteria

	C1	C2	C3	Fuzzy Geometric Means Value (ri)
C1	(1,1,1)	(1, 2, 3)	(5, 6, 7)	(1.7, 2.27, 2.73)
C2	(1/1,1/2,1/3)	(1,1,1)	(2,3,4)	(1.26, 1.14, 1.1)
C3	(1/5,1/6,1/7)	(1/2,1/3,1/4)	(1,1,1)	(0.47, 0.38, 0.33)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ x(\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1}$

(1.7**,** 2.27**,** 2.73)+ (1.26**,** 1.14**,** 1.1)+ (0.47, 0.38, 0.33) = (3.43,3.79,4.16)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ x\ (\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1} = \boldsymbol{ri}\ \boldsymbol{x}\ (3.43,3.79,4.16)^{-1}$

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.7, 2.27, 2.73)	(1.7, 2.27, 2.73) x (1/3.43,1/3.79,1/4.16)
C2	(1.26, 1.14, 1.1)	(1.26, 1.14, 1.1) x (1/3.43,1/3.79,1/4.16)
C3	(0.47, 0.38, 0.33)	(0.47, 0.38, 0.33)x (1/3.43,1/3.79,1/4.16)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.7, 2.27, 2.73)	(0.50, 0.60, 0.66)
C2	(1.26, 1.14, 1.1)	(0.37, 0.30, 0.26)
C3	(0.47, 0.38, 0.33)	(0.14, 0.1,0.0.08)

Joint venture Execution Strategy Sub-criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.50, 0.60, 0.66)	0.59
C2	(0.37, 0.30, 0.26)	0.31
C3	(0.14, 0.1,0.0.08)	0.11

Weight *Wi* = Fuzzy Weight *Wi* / 3

	Weights *Wi*	Normalized Weight
C1	0.58	0.58/1
C2	0.31	0.31/1
C3	0.11	0.11/1
Total	1	1

5. Procurements Strategy Sub- criteria's -Alternative FAHP Calculation

5.1 Project Materials Manufacture Sub-criteria

	C1	C2	C3
C1	1	1/3	1/6
C2	3	1	1/2
C3	6	1/5	1

Project Materials Manufacture Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(1/2,1/3,1/4)	(1/5,1/6,1/7)
C2	(2,3,4)	(1,1,1)	(1/1,1/2,1/3)
C3	(5,6,7)	(1,2,3)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$

r 1 = $(1 * 1/2 * 1/5)^{1/3} = (1 * 0.5 * 0.2)^{0.33} = 0.47$
$(1 * 1/3 * 1/6)^{1/3} = (1 * 0.33 * 0.167)^{0.33} = 0.38$
$(1 * 1/4 * 1/7)^{1/3} = (1 * 0.25 * 0.142)^{0.33} = 0.33$
Fuzzy Geometric Means Value (r 1) = (0.47**,** 0.38**,** 0.33**)**

r 2 = $(2 * 1 * 1)^{1/3} = (2 * 1 * 1)^{0.33} = 1.26$
$(3 * 1 * 1/2)^{1/3} = (3 * 1 * 0.5)^{0.33} = 1.14$
$(4 * 1 * 1/3)^{1/3} = (4 * 1 * 0.33)^{0.33} = 1.1$
Fuzzy Geometric Means Value (r 2) = (1.26**,** 1.14**,** 1.1**)**

r 3 = $(5 * 1 * 1)^{1/3} = (5 * 1 * 1)^{0.33} = 1.7$
$(6 * 2 * 1)^{1/3} = (6 * 3 * 1)^{0.33} = 2.6$
$(7 * 3 * 1)^{1/3} = (7 * 3 * 1)^{0.33} = 2.7$
Fuzzy geometric mean value (r 3) = (1.7**,** 2.6**,** 2.7)

Project Materials Manufacture Sub-criteria

	C1	C2	C3	Fuzzy Geometric Means Value (ri)
C1	(1,1,1)	(1/2, 1/3, 1/4)	(1/5, 1/6, 1/7)	(0.47, 0.38, 0.33)
C2	(2,3,4)	(1,1,1)	(1/1,1/2,1/3)	(1.26, 1.14, 1.1)
C3	(5,6,7)	(1,2,3)	(1,1,1)	(1.7, 2.6, 2.7)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ x(\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1}$

(0.47**,** 0.38**,** 0.33)+ (1.26**,** 1.14**,** 1.1)+ (1.7**,** 2.6**,** 2.7) = (3.43,4.12,4.13)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ x\ (\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1} = \boldsymbol{ri}\ \boldsymbol{x}\ (3.43, 4.12, 4.13)^{-1}$

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(0.47, 0.38, 0.33)	(0.47, 0.38, 0.33) x (1/3.43,1/4.12,1/4.13)
C2	(1.26, 1.14, 1.1)	(1.26, 1.14, 1.1) x

		(1/3.43,1/4.12,1/4.13)
C3	(1.7, 2.6, 2.7)	(1.7, 2.6, 2.7) x (1/3.43,1/4.12,1/4.13)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(0.47, 0.38, 0.33)	(0.14, 0.09, 0.08)
C2	(1.26, 1.14, 1.1)	(0.37, 0.28, 0.27)
C3	(1.7, 2.6, 2.7)	(0.50, 0.63,0.65)

Project Materials Manufacture Sub-criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.14, 0.09, 0.08)	0.10
C2	(0.37, 0.28, 0.27)	0.31
C3	(0.50, 0.63,0.65)	0.59

Weight *Wi* = Fuzzy Weight *Wi* / 3

	Weights *Wi*	Normalized Weight
C1	0.10	0.10/1
C2	0.31	0.31/1
C3	0.59	0.59/1
Total	1.0	1.0

5.2 Skilled Contractor Work Force Sub-criteria-Alternative FAHP Calculation

	C1	C2	C3
C1	1	2	6
C2	1/2	1	3
C3	1/6	1/3	1

Contractor Financial Stability Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)
(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(1,2,3)	(5,6,7)
C2	(1/1,1/2,1/3)	(1,1,1)	(3,4,5)

C3	(1/5,1/6,1/7)	(1/2,1/3,1/4)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri =$(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$

r 1 = $(1 * 1 * 5)^{1/3}$ = $(1 * 1 * 5)^{0.33}$ = 1.7
$(1 * 2 * 6)^{1/3}$ = $(1 * 2 * 6)^{0.33}$ =2.27
$(1 * 3 * 7)^{1/3}$ = $(1 * 3 * 7)^{0.33}$ =2.7
Fuzzy Geometric Means Value (r 1) = (1.7**,** 2.27**,** 2.7**)**

r 2 = $(1 * 1 * 3)^{1/3}$ = $(1 * 1 * 3)^{0.33}$ = 1.44
$(1/2 * 1 * 4)^{1/3}$ = $(0.5 * 1 * 4)^{0.33}$ =1.26
$(1/3 * 1 * 5)^{1/3}$ = $(0.33 * 1 * 5)^{0.33}$ = 1.18
Fuzzy Geometric Means Value (r 2) = (1.44**,** 1.26**,** 1.18**)**

r 3 = $(1/5 * 1/2 * 1)^{1/3}$ = $(0.2 * 0.5 * 1)^{0.33}$ = 0.47
$(1/6 * 1/3 * 1)^{1/3}$ = $(0.167 * 0.33 * 1)^{0.33}$ =0.38
$(1/7 * 1/4 * 1)^{1/3}$ = $(0.142 * 0.25 * 1)^{0.33}$ =0.33
Fuzzy geometric mean value (r 3) = (0.47**,** 0.38**,** 0.33)

Skilled Contractor Work Force Sub-criteria

	C1	C2	C3	Fuzzy Geometric Means Value (ri)
C1	(1,1,1)	(1, 2, 3)	(5, 6, 7)	(1.7, 2.27, 2.7)
C2	(1/1,1/2,1/3)	(1,1,1)	(3,4,5)	(1.44, 1.26, 1.18)
C3	(1/5,1/6,1/7)	(1/2,1/3,1/4)	(1,1,1)	(0.47, 0.38, 0.33)

Fuzzy Weights $\boldsymbol{Wi}$ **=** $\boldsymbol{ri}\ \boldsymbol{x}(\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1}$

(1.7**,** 2.27**,** 2.7)+ (1.44**,** 1.26**,** 1.18)+ (0.47**,** 0.38**,** 0.33) = (3.61,3.91,4.21)

Fuzzy Weights $\boldsymbol{Wi}$ **=** $\boldsymbol{ri}\ \boldsymbol{x}\ (\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1} = \boldsymbol{ri}\ \boldsymbol{x}\ (3.61,3.91,4.21)^{-1}$

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*

C1	(1.7, 2.27, 2.7)	(1.7, 2.27, 2.7) x (1/3.61,1/3.91,1/4.21)
C2	(1.44, 1.26, 1.18)	(1.44, 1.26, 1.18) x (1/3.61,1/3.91,1/4.21)
C3	(0.47, 0.38, 0.33)	(0.47, 0.38, 0.33)x (1/3.61,1/3.91,1/4.21)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(1.7, 2.27, 2.7)	(0.47, 0.58, 0.64)
C2	(1.44, 1.26, 1.18)	(0.40, 0.32, 0.28)
C3	(0.47, 0.38, 0.33)	(0.13, 0.1,0.08)

Skilled Contractor Work Force Sub-criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.47, 0.58, 0.64)	0.56
C2	(0.40, 0.32, 0.28)	0.33
C3	(0.13, 0.1,0.08)	0.11

Weight *Wi* = Fuzzy Weight *Wi* / 3

	Weights *Wi*	Normalized Weight
C1	0.56	0.56/1
C2	0.33	0.33/1
C3	0.11	0.11/1
Total	1.0	1.0

5.3 Subcontractor Skilled Work Force Sub-criteria-Alternative FAHP Calculation

	C1	C2	C3
C1	1	1/6	1/3
C2	6	1	2
C3	3	1/2	1

Subcontractor Skilled Work Force Sub-criteria Fuzzification

(1/3) = 1/(2, 3, 4) = (1/2, 1/3, ¼), (1/4) = 1/(3, 4, 5) = (1/3, 1/4, 1/5)
(1/5) = 1/(4, 5, 6) = (1/4, 1/5, 1/6), (1/6) = 1/(5, 6, 7) = (1/5, 1/6, 1/7)

(1/7) = 1/(6, 7, 8) = (1/6, 1/7, 1/8), (1/8) = 1/(7, 8, 9) = (1/7, 1/8, 1/9)

	C1	C2	C3
C1	(1,1,1)	(1/5,1/6,1/7)	(1/2,1/3,1/4)
C2	(5,6,7)	(1,1,1)	(1,2,3)
C3	(2,3,4)	(1/1,1/2,1/3)	(1,1,1)

Geometric Fuzzy Means Value (ri) , ri $=(\mathbf{a} * \mathbf{b} * \mathbf{c})^{\boldsymbol{n}}$

r 1 = $(1 * 1/5 * 1/2)^{1/3} = (1 * 0.2 * 0.5)^{0.33} = 0.47$
$(1 * 1/6 * 1/3)^{1/3} = (1 * 0.167 * 0.33)^{0.33} = 0.38$
$(1 * 1/7 * 1/4)^{1/3} = (1 * 0.142 * 0.25)^{0.33} = 0.33$
Fuzzy Geometric Means Value (r 1) = (0.47**,** 0.38**,** 0.33**)**

r 2 = $(5 * 1 * 1)^{1/3} = (5 * 1 * 1)^{0.33} = 1.7$
$(6 * 1 * 2)^{1/3} = (6 * 1 * 2)^{0.33} = 2.27$
$(7 * 1 * 3)^{1/3} = (7 * 1 * 3)^{0.33} = 2.7$
Fuzzy Geometric Means Value (r 2) = (1.7**,** 2.27**,** 2.7**)**

r 3 = $(2 * 1 * 1)^{1/3} = (2 * 1 * 1)^{0.33} = 1.26$
$(3 * 1/2 * 1)^{1/3} = (3 * 0.5 * 1)^{0.33} = 1.14$
$(4 * 1/3 * 1)^{1/3} = (4 * 0.33 * 1)^{0.33} = 1.1$

Fuzzy geometric mean value (r 3) = (1.26**,** 1.14**,** 1.1)

Subcontractor Skilled Work Force Sub-criteria's

	C1	C2	C3	Fuzzy Geometric Means Value (ri)
C1	(1,1,1)	(1/5,1/6,1/7)	(1/2,1/3,1/4)	(0.47, 0.38, 0.33)
C2	(5,6, 7)	(1,1,1)	(1,2,3)	(1.7, 2.27, 2.7)
C3	(2,3,4)	(1/1,1/2,1/3)	(1,1,1)	(1.26, 1.14, 1.1)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ x(\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1}$

(0.47**,** 0.38**,** 0.33)+ (1.7**,** 2.27**,** 2.7)+ (1.26**,** 1.14**,** 1.1) = (3.43,3.79,4.13)

Fuzzy Weights $\boldsymbol{Wi} = \boldsymbol{ri}\ x\ (\boldsymbol{r1} + \boldsymbol{r2} + \boldsymbol{r3})^{-1} = \boldsymbol{ri}\ \boldsymbol{x}\ (3.43, 3.79, 4.13)^{-1}$

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*

C1	(0.47, 0.38, 0.33)	(0.47, 0.38, 0.33) x (1/3.43,1/3.79,1/4.15)
C2	(1.7, 2.27, 2.7)	(1.7, 2.27, 2.7) x (1/3.43,1/3.79,1/4.15)
C3	(1.26, 1.14, 1.1)	(1.26, 1.14, 1.1) x (1/3.43,1/3.79,1/4.15)

	Fuzzy Geometric mean Value *ri*	Fuzzy Weights *Wi*
C1	(0.47, 0.38, 0.33)	(0.14, 0.1, 0.08)
C2	(1.7, 2.27, 2.7)	(0.50, 0.60, 0.65)
C3	(1.26, 1.14, 1.1)	(0.37, 0.30,0.26)

Subcontractor Skilled Work Force Sub-criteria De-Fuzzification

	Fuzzy Weights *Wi*	Weights *Wi*
C1	(0.14, 0.1, 0.08)	0.11
C2	(0.50, 0.60, 0.65)	0.58
C3	(0.37, 0.30,0.26)	0.31

Weight *Wi* = Fuzzy Weight *Wi* / 3

	Weights *Wi*	Normalized Weight
C1	0.11	0.11/1
C2	0.58	0.58/1
C3	0.31	0.31/1
Total	1.0	1.0

APPENDIX C : Framework Validation by Espier Zone Foundation Experts

The framework validation was scheduled to be done through one of Qatar high project Management Organization a letters was submitted formality for there contribution in my framework validation and taking there feedback about it the response only was received from Espier Zone Foundation the meeting was scheduled for framework Validation which take place at Espier zone Foundation with one of project management expert the validation was runs through specific questioners and answered by the expert as opinion feedback about the proposed contractor selection Frame work .

The received feedback during the meeting was positive about the framework and how it will improve the projects performance and quality beside the Effendy bellow answers was indicate that the frame work can be adopted which will relief the project client from challenges before and after contractor selection.

Framework Validation Questioners and Expert Feedback Answer

A. General Questions:

1. **What Criteria or Factors do you consider most important when evaluating contractors for a project?**

   Ans: *For Al Bayt Stadium, the Technical Submissions were Evaluated under the following Criteria:*

CRITERIA	PERCENTAGE
Appendix 'C' – Construction Experience	10
Appendix 'D' – Construction Plant, Equipment and Fabrication	4
Appendix 'E' – Contractor's Superintendence	13
Appendix 'F' – Sub-Contractors/Consultants and Suppliers	22
Appendix 'G' – Execution Programme	23
Appendix 'H' – Contractor's Method Statement	28
Mandatory Documents	-
TOTAL	100

2. Are there any Challenges or Difficulties you have Encountered in the Contractor Selection Process?

Ans: *As the contractor submissions were predominantly from Joint Ventures and included international firms, assessment of project experience was somewhat challenging given that the main stadium experience in each submission was from international companies.*

B. Framework Evaluation:

1. What are your Initial Impressions of the Framework?

Ans: *Any Development and Improvement to the Contractor Selection Process is Welcomed as Contractor Selection is one of the key Components of Successful Project Delivery.*

2. How well do you Think the Framework Aligns with Industry best Practices?

Ans: *Comparable but the Concept of Risk Sharing Agreement is Unique and worth further consideration as a Tool in Projects.*

C. Criteria Assessment

1. **Do you Believe the Criteria included in the Framework Adequately capture the key Attributes and Capabilities Required for a Successful Contractor?**

   Ans: *Yes*

2. **Are there any Additional Criteria that you would Recommend including in the Framework?**

   Ans: *No*

D. Risk Identification and Assessment:

1. **How well does the Framework Address the Identification and Assessment of Risks in the Contractor Selection Process?**

   Ans: *A detailed Risk Assessment, as proposed within the Framework, being carried out during project planning will allow the for a suitable mitigation Strategy to be implemented, be it that the Risk is designed out pre-contract, transferred to the contractor or accepted by the client or indeed shared by both parties.*

2. **Are there any Specific risks or risk factors that you believe should be considered in the framework but are currently not included?**

   Ans: *No*

E. Decision-Making Process

1. **How clear and Understandable is the Decision-Making Process Outlined in the Framework?**

   Ans: *The steps are logical and also clear and concise.*

2. **Are there any specific Steps or Considerations that you Think are missing from the Framework?**

   No

F. Risk Allocation and Mitigation

1. **Does the Framework Provide Effective Mechanisms for allocating and mitigating Risks between the Project Owner and Contractor?**

   Ans: *Yes*

2. **How well does the Framework address the Monitoring and Enforcement of Risk-sharing Agreements?**

   Ans: *The enforcement of risk-sharing agreements post contractor selection would require to be closely monitored to ensure that no insured risk inadvertently reverts back to the Client.*

G. Suggestions for Improvement:

1. **Based on your Experience, what Improvements or Modifications would you Suggest for the Contractor Selection Framework?**

   Ans: *None*

2. **Are there any specific areas of the framework that you believe need further refinement or Validation?**

   Ana: *No*

3. **Are there any Features or Functionalities that you would like to see added to the Framework?**

   Ans: *No*

H. Comparison to Other Methods

1. **How does the Framework being validated compare to those Alternative methods?**

   Ans: *Favorably*

2. **Are there any Specific Strengths or weaknesses of the framework compared to other approaches?**

   Ans: *No*

Clear and concise criteria removes / reduces the opportunity for hidden bias.

I. Overall Satisfaction

1. **On a Scale of 1 to 10, how Satisfied are you with the Contractor Selection Framework being Validated?**

   Ans: *Satisfied 10*

2. **Are there any Specific Aspects of the Framework that you find Particularly useful or Valuable?**

   Ans: *Risk Sharing Agreement is of interest and will certain be considered for upcoming projects.*

APPENDIX D : Case Studies

Case Study One : Espier Zone (Qatar's World Cup 2022 Projects)

This case study is related to the World Cup Mega Projects and focuses on a single stadium (the Al-byate Stadium) as an example for the interview and dissection through contract managers and project management experts at Espier Zone Foundation as foundation for Mega project which constructed for world cup recently, the mega projects was faced difficulties during the planning, tendering, contractor selection, and contractor administration. The planning of the project is managed by a consultant that has been chosen, and this consultant is responsible for the design preparation of the scope, objectives, and specifications that are chosen by a private steering group for mega-stadium projects.

The prequalification of the bidders is also formed under the committee through their consultant. This evaluation determines whether or not each bidder is eligible for selection based on the prequalification criteria and their financial soundness.

Any awarded international contractor is required by Qatar's mega projects authorities to have a joint venture contract with a local contractor in order to work together on the same project with an internal agreement contract. Additionally, the project delivery method Design Bid DB or DBB, which is focused on low bid selection, sometimes goes to the negotiation process between the selected bidders in order to reach some sort of offer agreement.

According to the results of the interview, the majority of megaprojects are now underway. Independently, then the stadium Al-bayte is one of them, and it was not obvious how the assessment and contractor selection was performed for the local Designer, how the local contractor was picked, and also how prequalified they were during the interview; all of this was based on a Committee Decision.

According to the interview, the project planning, scope validation, risk assessment, and execution plan were not taken into consideration for each individual stadium. Instead, the focus was on estimating when each stadium would be finished. The shareholders' influence on the scope modification order was, for the most part, disregarded, which indicates that the project was guaranteed to be finished, despite the fact that there are more attention procedures that need to be taken into consideration extra processes. interims on the condition of sustainability and the performance of risk sharing

Case Study Two: Qatar Rail (Qatar's Rail Projects)

This case study all about Qatar RAIL Projects were constructed for Doha and around cities a total of three lines with 37 stations, Qatar has invested a lot of amounts to make this project. The cased study is focus on one of the Qatar Rail district lines with number of stations by conducting interview with one of project manager as Expert in this project during construction covering project entire life cycle presenting their adapted processes during project planning up to construction by covering the most processes as practical.

The project initiation required to hire consultant for design and scope preparation and adopt all major required conditions as tender document this consultant is well selected by prequalification internally process through committee, as supportive consultant has to follow and work under local design team for approvals and agreement.

Bidder prequalification is prequalified based on their experience and financial aspects only beside the project estimated budget was covered the 20% +/_ cost margin to cover project additional costs.

The tendering process is under dedicated committee focused on the prequalified bidders only and the selection normally based on the lowest as small cases but mostly is based on technical completion as performance taking in account the remaining risk which is still not mitigated.

The selected contractor has to initiate joint venture agreement with local contractor before proceeding in the construction this one of the government of state of Qatar regulations beside the contractor has to comply with other organization services regulation and procedures, one of the construction requirements that the contractor has to hire consultant under his expenses during project execution. Rail project stockholders are fully involved due to the aim and objective of trains and rail projects to be completed before world cup a one of important world cup milestones therefor the influence was very high on Rail Projects and Management for project completion and contractors Management.

Case Study Three: Ashghal (Qatar's Roads Projects)

This case study focuses entirely on the infrastructural utilities projects (Road Projects) being carried out in Qatar by the Ashghal Organization's Road Project Det. The interview was conducted with one of the Road Department's project management Engineers because they are experts in highways and roads. The projects are a part of Qatar's overall long-term strategic planning for road development infrastructure and roads Department is the project implementations receiving the deliverable, initiation, and project requirements. There are a lot of stockholders who are involved in there projects.

During the dissection, the road specialists and Engineers explain that they do all of the project phases in house in addition Appointed consultant his position is to prepare the overall design, which is then double checked in house through roads projects design team for approval as per estimated budget which is funded through Qatar High Authority master committee for that reason, they follow the overall master plan by coordinating with Traffic Department for roads Safety design by complying with ere safety regulation. There are challenges that the project milestone completion and stockholder influence in there projects, which sometimes cause project delay and scope change even though there is overall agreement among stockholders to proceed, which force the project to be managed in-house. The project planning, tendering, awarding, and execution management are all done in-house. Roads Project Dept. requested additional funding for these changes or developments. In addition, the selected contractor is required to have a local joint venture contractor in accordance with the regulations of the local state of Qatar. This will add more risks to there projects in terms of their experience in the same field or scope. The methodology of the selected contractor is dependent on the low bid contractor, and the negotiation process will be used when necessary in some cases before aw

The interview gives the impression that there is a great deal of shareholder influence on the projects being undertaken by the Roads Department owing to the lack of clarity around either their master plan or their overall master plan. Ex. Kahramaa Project's master Qatar urbane planning master plan and other utilities master plans, both of which have a cumulative cost impact on Roads Projects roads project time delay on and cost overrun, which is why Ashghal projects management engineers are suffering because of this.

The bidders also have an influence on projects based on selection, and they do this by communicating with higher management about their capabilities and the reasons why they were not chosen even they selected through Prequalification processes by internal prequalification committee . This can cause disruptions to road construction projects at times. Additionally, the selected contractor can cause disruptions during construction by initiating complaints and developing costs due to variations in a running project's scope, which can influence on road construction projects to comply with some of these requirements as risk covering.

APPENDIX G : Publications

The Journal : Organization Technology Management In construction

Paper 1 : one: Optimizing the Design -Bid Build Project Delivery Method : An innovation Framework for Contractor Selection and Improved Delivery

OTMCJ-D-23-00028 Submitted Sep.01 2023 –comments Received to be cleared replied on 4/11/2023 – in the process

Paper 2 : CRITICAL CONTEXTUAL SUCSESS FACTORS INFLUENCING EARLY PROJECT PLANNING QUALITY AND CONTRACTOR PREQUALIFICATION COMPETENCE IN THE CONSTRUCTION INDUSTRY:A CASE FOR QATAR

OTMCJ-D-23-00030 Submitted Aug. 31,2023- Still Under Review