



ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

**ANALYTICAL HIERARCHY PROCESS-BASED MULTI-CRITERIA DECISION
ANALYSIS FOR CONTRACTOR SELECTION: A CASE OF ETHIOPIAN ROAD
ADMINISTRATION**

A Thesis submitted to Addis Ababa Institute of Technology, School of Civil and Environmental Engineering in partial fulfillment of the requirement for the award of the degree of Master of Science in Civil Engineering (Construction Technology and Management Option) of the Addis Ababa University

By: Eden Mershaye Tessema

Advisor: Prof. (Dr.-Ing.) Abebe Dinku

November, 2024

Addis Ababa, Ethiopia



SCHOOL OF GRADUATE STUDIES

ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

**ANALYTICAL HIERARCHY PROCESS-BASED MULTI-CRITERIA DECISION
ANALYSIS FOR CONTRACTOR SELECTION: A CASE STUDY OF THE ETHIOPIAN
ROAD ADMINISTRATION**

BY: EDEN MERSHAYE

APPROVED BY BOARD OF EXAMINERS:

<u>ABEBE DINKU (Prof.)</u>	<u>Abebe Dinku</u>	<u>10/01/2025</u>
Advisor	Signature	Date
<u>ABRAHAM ASSEFA (PHD)</u>	<u>Abraham</u>	<u>12/30/24</u>
Internal Examiner	Signature	Date
<u>Fekadu MILESE</u>	<u>Fekadu milese</u>	<u>8/1/2025</u>
External Examiner	Signature	Date
<u>Abraham Gebre (Dr.) Dean, School of Civil & Environmental Engineering</u>	<u>Abraham Gebre</u>	<u> </u>
Chair Person	Signature	Date



DECLARATION

I hereby confirm that this thesis is my original work, with the exception of properly acknowledged citations and quotations. I also certify that it has not been submitted for a degree at any other university.

Eden Mershaye

Author's Name

Signature

Date

ACKNOWLEDGEMENT

First and foremost, I am profoundly grateful to the Almighty God for granting me the strength, and resilience throughout the journey of completing this thesis paper. My sincere gratitude goes out to my advisor, Prof. (Dr.-Ing.) Abebe Dinku for his unwavering support, invaluable guidance, and insightful feedback throughout this academic endeavor. His expertise has shaped this thesis into a comprehensive piece of scholarly work.

I am deeply grateful to Addis Ababa University for the invaluable opportunity provided to me through the female scholarship program.

To my beloved mother, Zewde T. whose unconditional love, encouragement, and sacrifices have been my source of inspiration and motivation, I owe a debt of gratitude beyond words. Her belief in me never wavered, and I am forever thankful for her unwavering support. I also would like to thank my sister Dagmawit M., whose support and tolerance have been a never-ending source of inspiration. Her input has been crucial in assisting me in overcoming the obstacles associated with my academic career.

I would like to give my special thanks to my friend, Nitshit T. For her time, insightful suggestions, support, and comments throughout this academic journey.

Finally, my special gratitude also goes to the Ethiopian Roads Administration and the staff in each management program for giving me relevant data and information, which are valuable for achieving this thesis.

To each of you, I offer my sincerest gratitude. This thesis would not have been possible without your unwavering support, guidance, and love. Thank you for being a crucial part of my journey.

ABBREVIATIONS

AC	Asphalt Concrete
AFDB	African Development Bank
AHP	Analytic Hierarchy Process
ANN	Artificial Neural Network
ANP	Analytic Network Process
BADEA	Bank of Arab for Economic in Africa
BEM	Bid Evaluation Mode
CA	Cluster Analysis
CBR	Case Based Reasoning
COPRAS	Complex Proportional Assessment
CPM	Construction Project Management
CR	Consistency Ratio
CS	Contractor Selection
DBST	Double Bituminous Surface Treatment
DDGs	Deputy Director General
DEA	Data Envelopment Analysis
DG	Engineering Procurement Directorate
DM	Decision Making
DWM	Dimensional Weighting Method
ELECTRE	Elimination & choice translating reality
EPD	Engineering Procurement Directorate
ERA	Ethiopian Road Administration
ERCC	Ethiopian Road Construction Corporation
EU	European Union
FIDIC	Federation Internationale des Ingenieurs Conseils (International Federation of Consulting Engineers)
FPPPA	Federal Public Procurement Property Administration
FSM	Final Selection Model
FST	Fuzzy Set Theory
GA	Genetic Algorithm

GC	General Contractor
GDP	Growth Domestic Product
GIS	Geographic Information System
GOE	Government of Ethiopia
GPAM	Government Procedure Assessment Models
ICB	International Competitive Tendering
ICT	International Competitive Tendering
ICT	Information & Communication Technology
IFPQ	Invitation for Pre-Qualification
IFS	Intuitionistic Fuzzy Set
ISO	International Organization for Standardization
ITB	Invitation to Bid
IT	Information Technology
ITT	Invitation to Tender
MAA	Multi-Attribute Analysis
MCDM	Multi Criteria Decision Making
MP	Mathematical Programming
MR	Multiple Regression
NBE	National Bank of Ethiopia
NCB	National Competitive Bidder
NCT	National Competitive Tendering
NDF	Nordic Development Fund
OFID	Fund for International Development
OSHA	Occupational Safety and Health Administration
PDD	Project Development Directorate
PEC	Procurement Endorsement Committee
PPA	Public Procurement Authority
PPL	Public Procurement Law
PQM	Pre-qualification Model
PQSM	Performance Quality System Management
PROMETHEE	Preference ranking organization method for enrichment evaluation

QA	Quality Assurance
QC	Quality Control
QFD	Quality Function Deployment
RFP	Request for Proposal
RFQ	Request for qualification
RI	Random Consistency Index
RII	Relative Importance Index
RRA	Regional Roads Authorities
RSDP	Road Sector Development Program
SAW	Simple Additive Weighing
SDB	Standard Biding Document
SDF	Saudi Fund for Development
SMART	Simple Multi Attribute Technique
TAC	Technical Analysis Committee
TL	Team Leader
TOPSIS	Technique for Order Preference by Similarity to an Ideal Solution
TST	Triple Surface Treatment
UNDP	United Nation Development Programme
URRAP	Universal Rural Road Access Program
VIKOR	Vlsekriterijumsko Kompromisno Rangiranje
WB	World Bank
WDM	Weight Determination Model
WRO	Woreda Road Offices

ABSTRACT

Selecting a contractor is a crucial task for any client. The success of a project is likely to be compromised in the absence of an appropriate and accurate process for choosing the best contractor. This study looks at the analytical hierarchy process (AHP) as a model for decision-making while choosing a contractor. This methodology can help project management teams choose contractors based on criteria other than the lowest bid; it can help them discover contractors who are most likely to produce good results. Further, the study tests an AHP-based model on a real-world scenario whereby potential contractors are assessed. Primary and secondary data sources are both used in the research. A questionnaire was utilized by the researcher to get primary data, while document reviews and extensive literature reviews were used as secondary data to determine the contractor selection criteria to select contractors for road projects. The Analytical Hierarchy Process (AHP) was used to analyze the collected data, which involved identifying 23 sub-criteria under four major categories: financial competency, past performance competency, technical competency, and management competency. These criteria were evaluated by 87 respondents. The analysis revealed that past performance competency held the highest weight at 38.56%, with a consistency ratio of 0.0880. It was followed by technical competency, weighted at 24.16% and a consistency ratio of 0.0794. Financial competency ranked next with a weight of 20.42% and a consistency ratio of 0.07368, while management competency had the lowest weight at 16.84%, with a consistency ratio of 0.0529. Following the identification of contractor selection criteria and the assessment of each criterion's relative importance, a case study was used to test the model validity. According to the results, the candidates were ranked based on each criterion, and the candidate with the highest overall score was declared as the winner. Selecting contractors solely based on the lowest bid is common practice but may overlook other crucial factors. Incorporating a multi-criteria technique ensures a more balanced decision that considers both the bid price and additional important criteria. The findings of this study benefit owners, stakeholders, and project managers in making well-informed decisions and guaranteeing that the contractors chosen for the projects fulfil their needs and expectations.

Key words: Analytical Hierarchy Process, Multi Criteria Decision Making, Contractor Selection

TABLE OF CONTENTS

DECLARATION	I
ACKNOWLEDGEMENT	III
ABBREVIATIONS	IV
ABSTRACT.....	VII
LIST OF TABLES	XII
LIST OF FIGURES	XIV
CHAPTER ONE: INTRODUCTION.....	1
1.1. Background of the Study.....	1
1.2. Statement of the Problem.....	4
1.3. Objective of the Study.....	6
1.3.1 General objective.....	6
1.3.2. Specific objective	6
1.4. Research Question.....	7
1.5. Significance of the Study	7
1.6. The Scope of the Study	7
1.7. Limitation of the Study	8
1.8. Organization of the Study	8
CHAPTER TWO: LITERATURE REVIEW.....	10
2.1. Introduction	10
2.2. Contextual Background.....	10
2.2.1. Overview of Construction Industry in Ethiopia	10
2.2.2. Overview of Ethiopian Roads Administration (ERA).....	12
2.3. Overview of Tendering and Contractor Selection Process	13
2.3.1. Construction Tendering.....	13

2.3.2. Contractor Selection Criteria	14
2.3.3. Bid Selection Process in Different Countries	16
2.3.4. Tendering Process in Ethiopian Road Administration	24
2.3.4.1. Summary of Bid Evaluation Process in Ethiopian Road Administration	27
2.4. Contractor Selection Criteria Importance and Challenges	29
2.4.1. Contractor Selection Criteria and its Importance	29
2.4.2. Challenges in Contractor Selection	32
2.5. Overview of Contractor Selection Methods	34
2.5.1. Multi-Criteria Decision Making	34
2.5.2. Decision-Making Techniques Applied in Contractor Selection Models	34
2.5.2.1. Types of Contractor Selection Models	35
2.6. Analytic Hierarchy Process (AHP)	40
2.6.1. Application of AHP in Contractor Selection	42
2.6.2. Advantage of AHP	42
2.7. Empirical Review	43
2.8. Research Gap	51
CHAPTER THREE: MATERIALS AND METHODS	55
3.1. Introduction	55
3.2. Study Area	55
3.3. Research Design	58
3.4. Research Methodology	58
3.5. Research Approach	59
3.5.1. Qualitative Approach	59
3.5.2. Quantitative Approach	60
3.6. Target Population	61

3.7. Sampling and Sample Selection Techniques	62
3.7.1. Sample Size Distributions	63
3.8. Source of Data	64
3.9. Data Collection Instruments.....	64
3.9.1. Questionnaires	64
3.9.2. Questionnaire Development	65
3.10. Data Collection Procedure	65
3.11. Data Analysis	66
3.12. Case Study.....	66
3.13. Reliability and Validity of Instruments.....	67
3.13.1 Reliability of Instruments	67
3.13.2. Validity of Instruments.....	68
CHAPTER FOUR: RESULTS AND DISCUSSION	70
4.1. Questionnaire Return Rate	70
4.2. Demographic Information	71
4.3. Identification of Major Contractor Selection Criteria	75
4.3.1. Major Contractors’ Selection Criteria Participating in Road Construction Projects... 77	
4.3.2. Alignment of Proposed Methodology with PPA Contractor Selection Requirements 80	
4.3.3. Grouping the Criteria.....	83
4.4. AHP Model Development.....	85
4.4.1. Structure the Hierarchical Model	85
4.4.2. Methodology and its Implementation.....	88
4.4.3. Pairwise Comparison Questionnaires	89
4.4.4. Combining Experts’ Judgement	92
4.5. AHP Process.....	93

4.5.1. Structure the Hierarchy.....	93
4.5.2. Performing Pairwise Comparisons	94
4.5.2.1. Main criteria comparison	94
4.5.2.2. Sub criteria Comparison	95
4.5.3. Prioritization of Sub criteria	103
4.5.4. Summary of AHP Results.....	105
4.5.5. Applying the Four Criteria to All of the Alternatives	109
4.6. Case Study.....	110
4.6.1. Project Information.....	111
4.6.2. Contractor’s Profiles.....	113
4.6.3. Comparison of Bid Price	115
4.6.4. Contractor Selection Based on AHP Model	116
4.6.5. Applying AHP	117
4.6.6. Summary of the Results on Case Study.....	121
4.6.7. Conclusion of the Case Study.....	122
4.7. Sensitivity Analysis.....	123
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS	127
5.1. Conclusions	127
5.2. Recommendations	129
5.3. Future Research.....	130
REFERENCES	131
APPENDIX A: QUESTIONNAIRE.....	139
APPENDIX B: PAIRWISE QUESTIONNAIRE.....	143
APPENDIX C: AHP MODEL PAIRWISE COMPARISONS JUDGEMENTS	149

LIST OF TABLES

Table 2- 1: Contractor Selection Criteria by Different Researchers.....	15
Table 2- 2: Bidding Process in Different Countries.....	21
Table 2- 3: Tendering Process in ERA	24
Table 2- 4: Technical Evaluation Criteria.....	27
Table 2- 5: Financial Evaluation Criteria.....	29
Table 2- 6: Importance of Contractor Selection Criteria	30
Table 2- 7: Challenges in Contractor Selection Criteria.....	33
Table 2- 8: Advantage and Disadvantage of MCDM Methods	37
Table 2- 9: The scale of each level of importance	41
Table 2- 10: Criteria for Contractor Selection	44
Table 2- 11: Knowledge Gaps Found in Review of Literature.....	51
Table 3- 1: Research Question.....	60
Table 3- 2: Cronbach Alpha Result	67
Table 4- 1: Questionnaire Response Rate.....	70
Table 4- 2: Years of Establishment of the Organization	72
Table 4- 3: Experience of the Organization in the Road Sector	72
Table 4- 4: Educational Qualification.....	72
Table 4 - 5: Field of Specialization.....	73
Table 4 - 6: Respondents Overall Work Experience	73
Table 4 - 7: Respondents Experience with in Their Organization.....	73
Table 4 - 8: Status of Respondents' Organization	74
Table 4- 9: Top Ten Journals Publishing Selected Articles	76
Table 4 - 10: Major Contractors' Selection Criteria in Tender Evaluation	79
Table 4 - 11: Comparison of Contractor Selection Criteria with PPA Requirements	80
Table 4 - 12: Summary of Grouped Criteria.....	83
Table 4 - 13: Kruskal-Walli's Test Results	85
Table 4 - 14: The Saaty Rating Scale	88
Table 4 - 15: Pairwise Comparison Matrix for Financial Competency Criteria.....	90
Table 4 - 16: Pair Wise Comparison for Past Performance Competency.....	90

Table 4- 17: Pairwise Comparison for Technical Competency	91
Table 4 - 18: Pairwise Comparison for Management Competency.....	91
Table 4 - 19: Random consistency index (RI)	93
Table 4 - 20 : Pair Wise Comparison for Major Criteria Comparison	95
Table 4 - 21: Normalization Matrix for Main Criteria.....	95
Table 4 - 22 : Pair Wise Comparison for Sub Criteria Comparison for Financial Competency ..	96
Table 4 - 23: Normalization Matrix for Financial Competency	96
Table 4 - 24: Pair Wise Comparison for Sub Criteria Comparison for Past Performance Competency	97
Table 4 - 25: Normalization Matrix for Past Performance Competency.....	97
Table 4 - 26: Pair Wise Comparison for Sub Criteria Comparison for Technical Competency Criteria	98
Table 4 - 27: Normalization Matrix for Technical Competency	98
Table 4 - 28: Pair Wise Comparison for Sub Criteria Comparison for Technical Competency ..	99
Table 4 - 29: Normalization Matrix for Management Competency	99
Table 4 - 30: Summary of AHP Result.....	100
Table 4 - 31: Result of Sub Criteria.....	104
Table 4 - 32: Overall Ranking	107
Table 4 - 33: Result of contractor evaluation criteria	110
Table 4 - 34: Contractor's profile	114
Table 4 - 35: Contractor's Country of Registration.....	114
Table 4 - 36: Applicants Bid Price	114
Table 4 - 37: Comparison of Bid Price with Engineer's Estimate	115
Table 4 - 38: Final Result of the Selection of the Contractor	116
Table 4 - 39: Contractors Pair Wise Comparison with Respect to Main Criteria	118
Table 4 - 40: Pairwise Comparison and Normalization Matrices for Each Criterion	119
Table 4 - 41: Criteria Weightages with Respect to Contractors	121
Table 4 - 42: Global Score of Contractors	121
Table 4 - 43: Rank of Bidders Based in the Two Methods	122

LIST OF FIGURES

Figure 2- 1GDP Growth Rate of the Construction Industry 10

Figure 2- 2: GDP contributions from Industry, Services, and Agriculture Over the last Ten Years 11

Figure 2- 3: Construction Sector's Contribution to Ethiopia's Domestic Gross Development..... 12

Figure 2- 4: Suitability and Problems of MCDM Applied in CS Model's..... 36

Figure 2- 5: Hierarchical Tree 41

Figure 3- 1-: ERA Revised Organizational Structure; Source: (ERA)..... 57

Figure 3- 2: Research Methodology 59

Figure 3- 3: Target Population..... 62

Figure 3- 4: Graphical Presentation of Cronbach Alpha Values 68

Figure 3- 5: Study Methodological Flowchart..... 69

Figure 4- 1: Percentage for Valid Returned Questionnaire 71

Figure 4- 2: Details of the Experts; Education, Qualification, Experience, Status 75

Figure 4- 3: Number of Selected Articles According to Publication Year..... 76

Figure 4- 4: Decision Making Process..... 77

Figure 4- 5: AHP Model; Source: (Super decision software)..... 87

Figure 4- 6: A Hierarchical Representation of the AHP Model. 94

Figure 4 - 7: Major Criteria and its Relative Weight 102

Figure 4- 8: Financial Competency and its Relative Weight 102

Figure 4- 9: Past Performance Competency and its Relative Weight 103

Figure 4- 10: Technical Competency & its Relative Weight 103

Figure 4- 11: Management Competency& its Relative Weight 103

Figure 4- 12: Over all Ranking..... 108

Figure 4- 13: Hierarchical Structure of the Case Study..... 117

Figure 4- 14: Sensitivity Analysis With Respect to Financial and Past Performance Competency 124

Figure 4- 15: Sensitivity Analysis with Respect to Technical & Management Competency; ... 125

Figure 4- 16: Sensitivity Analysis for Various Percentages 126

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

The construction industry is a fundamental economic sector that influences the majority of other sectors. It covers every stage of the physical infrastructure's design, planning, manufacturing, alterations, maintenance, repair, and demolition. The effectiveness and productivity of other industry sectors are significantly impacted by the construction industry. Without completed facilities, it is impossible to imagine significant investment in the manufacturing, agricultural, or service sectors (Suliman, 2017).

According to the National Bank of Ethiopia (NBE) 2022/2023 report, the Ethiopian economy grew by 7.1% in the 2022/23 fiscal year, up from 6.4% in 2021/22. This growth was driven by a 7.9% increase in the services sector, which accounts for 40% of GDP, 6.3% growth in agriculture, contributing 32.1% to GDP, and 6.9% growth in the industrial sector, which represents 28.8% of GDP. The growth rate of Ethiopia's construction industry has shown fluctuations in recent years due to varying economic and political conditions. In the 2022/23 fiscal year, the sector recorded a 7.1% growth rate, reflecting its resilience and continued importance to the country's economic development.

One of the most important public projects is construction of roads, which act as a crucial infrastructure for the economic development of the country and helps to connect to other forms of transportation including railways, ships, and airplanes. The Ethiopian government has been allocating multiple billion ETB for road projects in order to accomplish its goal of expanding the road network across the nation in an effort to provide access to energy, irrigation, markets, healthcare, and educational facilities that in turn were assumed to play a significant role in the development of the country. Despite the government's efforts, there are still obstacles to implementing the plan as intended (Suliman, 2017).

Careful risk management is necessary for construction projects. The procedure of choosing the most competitive tender offer and selecting the best contractor to meet project objectives is crucial due to the intricacy and risk associated with construction work (Olatunji, 2017). Consequently, a key factor in selecting the winning bidder is risk preference (Liu J, 2018). One of the most challenging jobs in a client is to choose the best contractor from the bids submitted to the tender committee. This kind of work can get more difficult when there are several bidders or when there

is a deadline and the task needs to get done right away. While selecting a contractor based solely on the lowest bid is not the only factor contributing to poor construction performance, it is a significant one among other factors such as inadequate contractor expertise, lack of financial stability, and insufficient project management skills (Liu J, 2018). Consequently, during the tendering process, consideration should be given to minimizing risk from selecting the wrong contractor.

The choice of contractor, among other factors, plays a significant role in determining the implementation and success of construction projects. This implies that low quality, schedule overruns, and low cost performance will be experienced by the project if an unsuitable contractor is chosen, (Ayettey, 2018) and (Khosro A. Y., 2021). With the help of simplified guidelines, clients will be able to precisely define their needs and choose the contractor most suited to finish the job to their satisfaction.

Open tendering, in which the lowest bidder is given the contract, has grown to be the most widely used method of choosing contractors among different systems (Olatunji, 2017). Theoretically, it helps choose the contractor who can build the facility for the least amount of money and with the most creative and economical solution. However, in order to stay in business during a period of low activity, contractors will fully quote a low bid price, hoping that this will be countered by claims (Birjandi, 2019). Computational models that can be utilized to choose the best contractor based on the project specifications and the applicant's facts are required in order to eliminate such elements from the results of contractor selection. Therefore, when selecting a contractor for a construction project, a number of factors including those unrelated to cost should be taken into account.

To select the best contractor, a variety of quantitative and qualitative considerations need to be taken, given the frequently intricate and unstructured nature of the decision-making process involved in contractor selection. For qualitative criteria, the scoring procedure must be explained. This typically entails creating discrete scales with spoken explanations, which may include ranges of potential levels. The majority of the suggested models for contractor selection follow a straightforward decision-making procedure. The chaotic and varied character of the existing contractor selection process in the context of MCDM doesn't seem to be taken into consideration (Bishaw, 2019). It is clear that a variety of parameters are considered when choosing a contractor,

and most of these are qualitative in nature, requiring human experts to evaluate them subjectively (Rahimdel, 2014). According to (Rahimdel, 2014), MCDM is a useful method for ranking based on a set number of choices while taking into account other factors. The Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Fuzzy Set Theory (FST), Data Envelopment Analysis (DEA), Mathematical Programming (MP), Case Based Reasoning (CBR), Genetic Algorithm (GA), and Simple Multi Attribute Technique (SMART) are just a few of the numerous MCDM approaches that have been proposed for contractor selection.

Determining the most effective method for assessing and choosing contractors and employing organizations is challenging. A methodical, efficient process or approach should be used to pick the best contractor. Analytic Hierarchy Process (AHP) is one of the most widely used MCDM techniques. It was developed by Saaty in 1980 (Rahimdel, 2014). It is a theory of measurement that is developed by pairwise comparison, and the priority scales are created using expert judgement (Rahimdel, 2014). It is a successful method of making decisions that is based on the multi-criteria decision-making methodology (MCDM).

This study is conducted at Ethiopian Road Administration, an organization established in 1951 and engaged in construction activities that include the construction of motorways, new link roads, rural and Woreda roads, rural and urban road rehabilitation and upgrading, and federal and regional road maintenance in conjunction with regional road authorities to meet the sector's goals (ERA, 2011(a)). Further, the administration also goes through the process of selecting contractors in order to construct various road projects. This procedure helps to weed out incompetent bidders and produces a list of qualified contractors and organizations that are able to deliver the project as per the defined goals. In ERA, construction contracts are typically awarded using the low bid technique, where the contract is granted to the firm that submits the lowest bid and meets the minimum qualification requirements.

The primary disadvantage of the low-bid approach is the potential for a contractor to be awarded a construction contract if they purposefully or unintentionally submit an extremely low bid price (Fekadu, 2013). The most important task for a construction project is choosing the right contractor for the right project, and numerous research findings have shown that rate rivalry alone is not sufficient to guarantee the use of cost-effective and respectable quality yields. Several and frequently contradictory objectives and substitutes, need to be taken into consideration.

Consequently, this research aims to help the client select the best contractor using the AHP method so that the administration selects the best contractor.

Accordingly, the researcher believes that the client will have a better understanding of the key factors that need to be considered before choosing a contractor. Since the industry is a significant force behind creative approaches, by reducing performance concerns early in the project life cycle, the study's results, if implemented effectively, might help improve project performance and contractor profits.

1.2. Statement of the Problem

Construction work is done under a legally binding contract. Selecting the right contractor is an essential prerequisite to complete the construction project successfully. The likelihood that a construction project will be successfully completed is increased when the right construction contractor is chosen (Prolay, 2021). It is imperative that the client makes an objective and transparent decision in order to choose the best contractor. In addition to thorough evaluation criteria, advanced decision-making processes should be used to support the conclusion, when selecting construction contractors. (Hasemi, 2018) Suggests that multi-criteria decision methods (MCDM) approach is a helpful method, when choosing a contractor.

Throughout the last ten years, a variety of decision-making approaches have been utilized for the purpose of choosing contractors. These include TOPSIS (Alptekin, 2017), simple additive weighting, Complex Proportional Assessment, fuzzy set theory methods (Alhumaidi, 2015), fuzzy logic (Akçay, 2018), Data Envelopment Analysis (DEA), (Yang, 2016), neural networks, integral programming, multi-attributed utility theory, fuzzy-excellent order method, and analytic network process. In a similar vein, researchers like (Al-Harbi, 2001), (Wang W-C, 2013) , and (Yang I-T, 2012) employed AHP to choose contractors.

Analyzing a technique's applicability and adaptability is necessary before applying it, especially when trying to tackle a specific problem that depends on the situation and the surrounding conditions. The requirements may speak to the kind of decision that is made for a certain domain and how simple it is to analyze and evaluate, both of which are crucial for that particular area. In light of this, it is crucial to apply caution when choosing contractors for construction projects, as it is one of the key factors that contribute better project performance. The lowest bidder method is

one of the most widely used procedures used by ERA to choose contractors (Fekadu, 2013). The competitive low bid price method has been criticized since most contractors winning through this bidding system go to negative impact on contractor's profit, dispute by finding incomplete clauses rather than doing their work which in turn leads to time and cost overrun in the construction project (Shumie, 2019).

In addition, (Demesew, 2019), argues that awarding tenders based on the lowest price often leads to various challenges. The study, which analyzed 25 projects, identified several critical factors contributing to poor construction performance, including financial shortages on the client's part, lack of initiative among staff, selecting unqualified bidder, inaccurate contract duration estimates, changes in project scope, insufficient cooperation from clients, ineffective bidding techniques, poor communication, and delayed or insufficient advance payments. Among these, selecting unqualified bidders was identified as the primary cause of poor performance, accounting for the highest percentage of issues impacting project outcomes. According to the study, 15 out of the 25 projects were awarded using the lowest bid technique. These projects experienced significant delays, with time overruns ranging from 34.8% to 400%, work scope variations ranged from 5.71% to 21.64%, and in one extreme case, a project was even canceled. This demonstrates that selecting contractors based on the lowest bid often results in the choice of unqualified contractors, leading to time overruns, cost overruns, and even project termination.

For the fiscal year 2023–2024, the FDRE House of Representatives approved a budget of 802 billion birr, of which 68.4 billion birr was allocated to the Ethiopian Roads Administration (ERA), comprising about 12% of the country's total annual budget. In a 2024 report, ERA noted that it oversees and funds numerous road construction projects, with 231 being handled by various contractors. Despite the industry's economic significance, 57% of contractors who successfully pass the bidding process fail to complete their projects within the specified budget and timeline. Performance reviews by the project committee and management team indicate that some contractors receive low performance ratings, as they are evaluated based on their fulfillment of contractual obligations.

The Ethiopian Roads Administration (ERA) selects its contractors using the least bid technique, a method in line with government policies designed to ensure transparency and cost-effectiveness

in public project procurement. While this approach prioritizes financial efficiency, researchers argue that the low-bid technique has both advantages and disadvantages. It ensures cost control, but challenges can arise in terms of project performance. Most research on poor project performance tends to focus on issues that arise during construction, but it is important to recognize that decisions made in the pre-construction phase, such as contractor selection, can influence project outcomes.

Since the Ethiopian Roads Administration (ERA) employs the low-bid method to select contractors, various researchers have suggested refining this approach to mitigate potential risks while retaining its benefits. To address these challenges, Multi-Criteria Decision-Making (MCDM) methods, particularly the Analytical Hierarchy Process (AHP), have been proposed to enhance decision-making and optimize contractor selection without undermining the value of the low-bid method. This study aims to advance the contractor selection process by analyzing and assessing the criteria used for evaluating contractors bidding for ERA projects. By incorporating a multi-criteria decision-making model, the study assists evaluators and decision-makers in weighing and ranking participating contractors. This approach supports fair competition and ensures that selected contractors can meet the project's requirements and the company's expectations. Given the group-based and uncertain nature of decision-making in this context, the use of an AHP model provides a systematic and reliable method to improve project delivery and mitigate the limitations of awarding contracts solely to the lowest bidder.

1.3. Objective of the Study

1.3.1 General objective

The primary objective of the study is to use the Analytical Hierarchy Process (AHP) to create a multi-criteria decision-making model for contractor selection.

1.3.2. Specific objective

1. To reevaluate the major contractor selection criteria during tender evaluation
2. To assess the level of significance and weight of each evaluation criteria using Analytical Hierarchy Process
3. To develop theoretical model that represent the suitable contractor selection based on Analytical Hierarchy process

1.4. Research Question

1. What are the major contractor selection criteria during tender evaluation?
2. What are the weights of the selection criteria?
3. How to develop a theoretical model that represent the suitable contractor selection?

1.5. Significance of the Study

Conducting a study on contractor selection criteria by applying the MCDM approach is useful, in order to comprehend industry best practices, identify challenges and offer suggestions for improvement. Additionally, it can assist owners, stakeholders, and project managers in making well-informed decisions and ensuring that the contractors chosen for the projects fulfil their needs and expectations. Moreover, it will provide the administration's decision-making body with information regarding the key contractor selection variables considered in tender evaluation. Therefore, the major stakeholders who would benefit from the outcomes of this research would be the Ethiopian Road Administration and road construction contractors participating in federal road construction projects.

1.6. The Scope of the Study

The scope of this research has been limited to the determination of contractors' selection criteria and the development of an AHP decision-making model in the Ethiopian Road Administration. The study looks at the organization's current contractor selection practices and suggests improvements through the application of AHP. The conceptual scope of this research covers the contractor selection procedures and standards used in road projects that are overseen by the administration. The main selection criteria used in the study include financial competency, past performance competency, technical competency and management competency. The study aims to explore how these selection criteria can be used by incorporating them with AHP. Methodologically, this study employed a survey research design, using a questionnaire as the primary data collection tool. The data were collected from stakeholders that are currently involved in the administration. The findings and recommendations are specifically tailored to this organization and may not be directly applicable to other organizations without further adaptation.

1.7. Limitation of the Study

The study's limitations are multifaceted and may impact the reliability and generalizability of its findings. The availability and accessibility of comprehensive and reliable data on contractors and project outcomes posed a significant challenge, potentially impacting the thoroughness of the analysis. The analytical hierarchy process (AHP) involves assigning weights to different criteria, which can be subjective and may introduce bias in to the decision-making process. Difference in opinions among experts providing input for the AHP could affect the consistency and reliability of the results, as expert judgement is a critical component of this methodology. The implementation of AHP can be complex and time consuming, particularly when dealing with large number of criteria and alternatives, which may limit its practicality in some settings. Hence the study lacks consideration of other contractor selection criteria for instance reputation, current work load, experience in similar structure, ongoing judicial disputes, method of payment and others. The study's findings, based on specific case study within ERA may not be easily generalizable to other contexts or regions. Moreover, stakeholders may exhibit resistance to adopting new decision-making methodologies, preferring conventional approaches, which could limit the implementation of the study's recommendations.

1.8. Organization of the Study

The study was divided into five chapters, each of which is briefly covered below:

Chapter One (Introduction): includes the introduction, the study's background, which explains all of the variables, the research problem, the study's aim, its objectives, its research questions, its relevance, its assumptions, its limitations, and its delimitation.

Chapter Two (Literature Review): tries to overview the different literatures including journals, articles, previous thesis, books, different manuals and guidelines related to the scope of this research. It encompasses theoretical review followed by empirical review and finally summarizes the gap identified.

Chapter Three (Methodology and Materials): explains the research area, the sample size and procedures, the target population, the study design, the methodology, and the methodologies for gathering and analyzing the data.

Chapter four (Analysis of Data and Discussion): encapsulates the discussion, interpretation, presentation, and analysis of data.

Chapter five (Conclusion and Recommendation): is the final one and provides an overview of the study's conclusions, recommendations, contribution to the body of information already in existence, and areas in need of additional research.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This section reviews contextual and empirical literature that is relevant to the current investigation. For the compilation of this portion of the research, several books, journals, articles, thesis, manuals, and guidelines are examined. The conceptual background is presented first, and then an analysis of the empirical literature is discussed later. The present study's theoretical foundation was developed based on these ideas and theories. Additionally, it attempts to provide an overview of the gaps that this study will fill.

2.2. Contextual Background

2.2.1. Overview of Construction Industry in Ethiopia

The construction industry is growing in most African countries. In Ethiopia the industry has experienced a decline in recent years due to a combination of interrelated factors. Political instability has disrupted economic activities, delayed infrastructure projects and reducing both local and foreign investment in the sector. Conflicts in various regions have further strained the construction industry. The COVID-19 pandemic has also had a profound impact, with restrictions on movement, labor shortages, and increased costs of materials due to global supply chain disruptions. Figure 2-1 shows the growth rate of the industry for the last fifteen years.

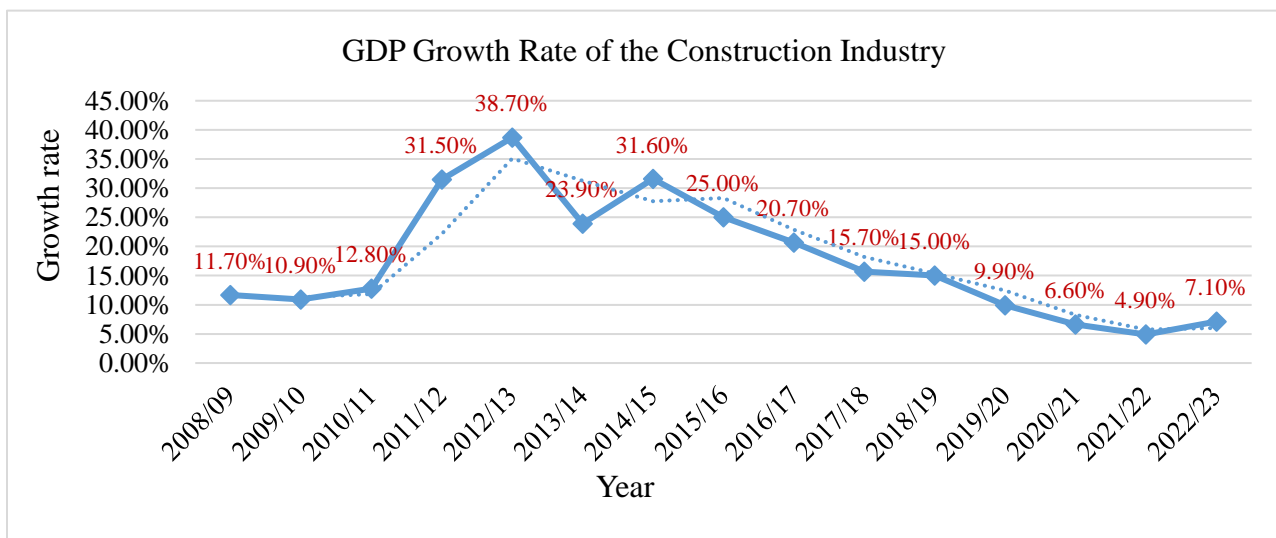


Figure 2- 1: GDP Growth Rate of the Construction Industry; Source: (*NBE Yearly Annual Report*)

The government of Ethiopia spends a great share of its budget on mega public construction projects aiming to end extreme poverty that play a tremendous role in the development process of the country. A report by Planning and Development Commission of Ethiopia for the year 2022/2023 indicated that, the agriculture sector, on average, contributed 32.1% to the GDP growth, where the crops sub-sector contributed 66.1%. Similarly, the industry contributed 28.8% of which the construction and manufacturing sub-sectors respectively contributed 72.2% and 23.4% to the overall industry sector. This shows that the major source of Gross Value Additions (GVA) registered in the industry sector has been the construction sub-industry. On the other hand, the service sub-sector has contributed 40.3% to the GDP growth. The wholesale and retail trade sub-sector had the share of 36.3% within the services sector. Figure 2-2 shows sectors that contributed to the Gross Domestic Product (GDP) include Agriculture, Industry and Services.

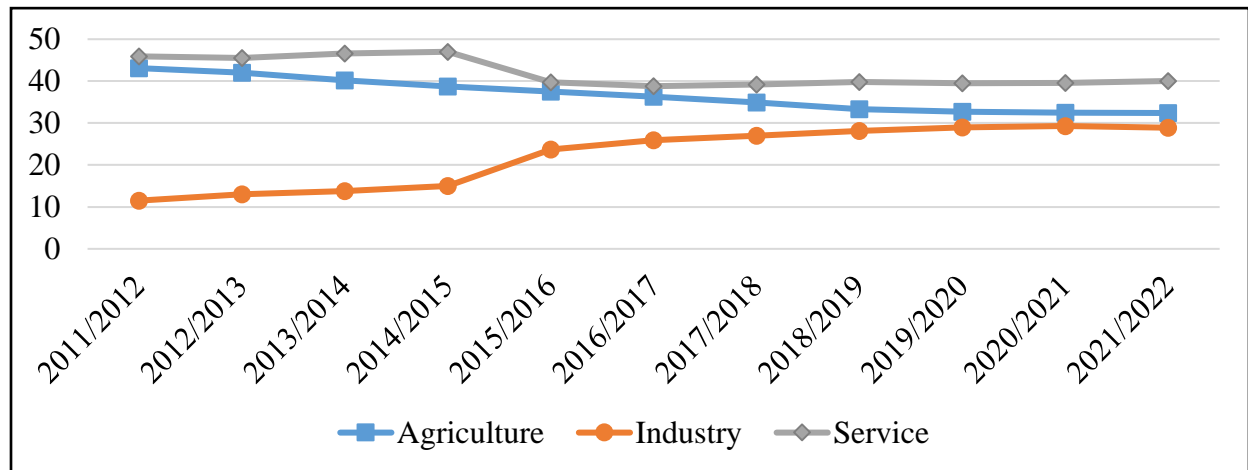


Figure 2- 2: GDP contributions from Industry, Services, and Agriculture Over the last Ten Years; Source: *(NBE Yearly Annual Report)*

From various subsectors, construction is one of the industries that contribute to the country's economy. Its major role in industrial production was indicated by its 72.2 percent share in the industrial sector and a 7.1% GDP growth rate, which came from investments in the building of roads, trains, dams, and residential buildings. Meanwhile, mining and quarrying, along with electricity and water, contributed 1.6% and 2.9% to the industrial sector, respectively. The share in industry of the construction industry and other industry sectors is shown in Figure 2-3.

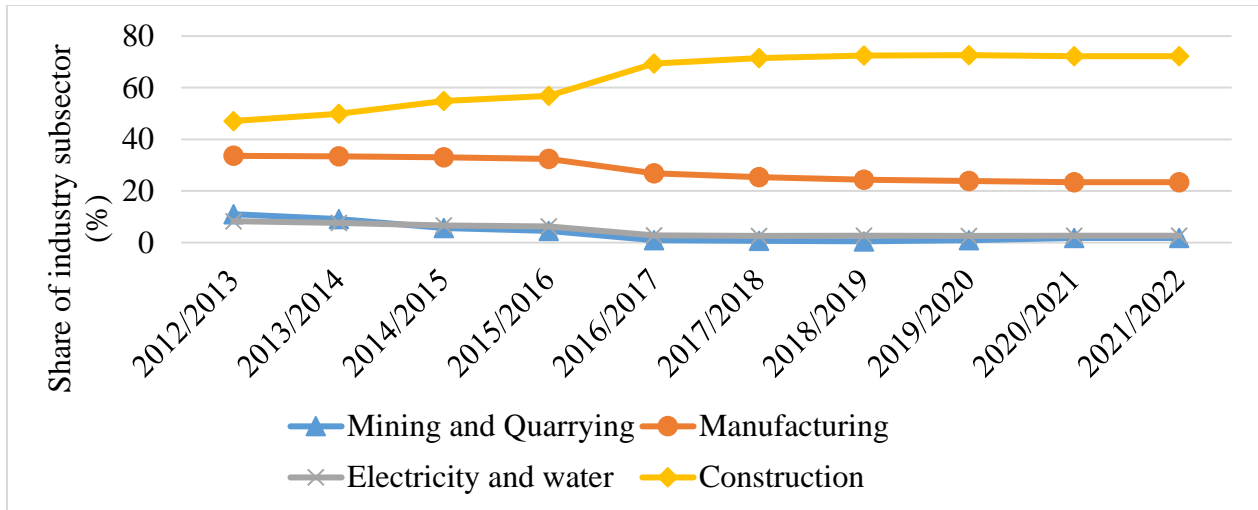


Figure 2- 3: Construction Sector's Contribution to Ethiopia's Domestic Gross Development;

Source: (NBE Yearly Annual Report)

The nature of the construction industry necessitates domestic manufacturing, the importation of specialists and raw materials, as well as high labor and material intensity, which helps to explain why the sector should be primarily focused in the economic development of the countries. The construction industry creates a diverse range of services, from single to large-scale infrastructure, including highways, power plants, and other complex outputs.

Roads are one of the construction sectors that facilitate the region's economic growth and transition through the transport industry. By offering the physical networks and services that the economy and society depend on for the movement of people and goods, it promotes economic diversification and regional integration, makes markets and services more accessible to businesses and consumers, and supports the expansion of the overall economy. From a social standpoint, transportation promotes individual mobility so that everyone can take advantage of access to vital public services like health and education, as well as access to the labor market, which can have significant repercussions for economic inclusion and gender equality.

2.2.2. Overview of Ethiopian Roads Administration (ERA)

In order to accomplish the sector's goals, the Ethiopian Roads Administration (ERA), a federal organization founded on January 26, 1951, is currently in charge of building federal road construction projects nationwide in coordination with regional road administrations. (ERA, 2011(a)). Road design and construction are contracted out to various national and international

contracting companies by the Ethiopian Road Administration. The director general of ERA answers to the board of directors. Being a legally independent organization, ERA has undergone numerous structural modifications. The most recent of them was brought about in July 2011 by Council of Ministers Regulation No. 247/2011. This rule validates the division of the regulatory and operational branches into two separate organizations, allowing ERA to concentrate on asset management and road network growth instead of building and maintaining the same. Thus, Ethiopian Road Construction Corporation (ERCC) was established as an independent public contractor, replacing ERA's operations department, which was in charge of performing heavy and routine maintenance on federal roads and building road projects involving over 10,000 workers. The organization's primary duty, the creation and supervision of roads, has not changed significantly despite multiple reestablishments. ERCC had functioned as a profitable public company. Road projects that would be too costly to grant to private contractors due to factors like remoteness and severe terrain were given to ERCC by ERA.

Through direct negotiation, ERA also granted ERCC the majority of the heavy and regular maintenance of federal roads. ERCC's 70 years of expertise building asphalt and gravel roads as an ERA force account would increase its bidding competitiveness. As a government agency, ERCC is essential to maintaining the industry's average cost of road building. ERA demanded the restoration of maintenance districts in order to address the issue of contractors being disinclined to bid on maintenance projects due to their reduced cost. The maintenance wing of the ERCC and the council of ministers have, of course, approved this proposal; hence, the districts are returned to ERA in 2019/20. In response to the government's reform of government organizations and their accountability offices, ERA recently changed its organizational structure, notably on the building project management regions, to become a project administration program unit.

2.3. Overview of Tendering and Contractor Selection Process

2.3.1. Construction Tendering

In the construction industry, requesting and accepting a price for a specific scope of work is known as tendering. The tendering system guarantees genuine competition based on predetermined selection criteria. FIDIC (1987) defines tender as "*the contractor's priced offer to the employer for the execution and completion of the works and the remedying of any defects therein in accordance with the provision of the contract, as accepted by the letter of acceptance*".

The term "tender" and "bid" are used interchangeably in most contract documents. FIDIC 2010 article 1.2, which was cited by (Dametachew, 2015), states that the terms "tender" and "bid" are synonymous. The term "tender" is also used in the ISO 6707-2:2014 interchangeably for bid, which defines it as written offer to perform at a specified price or rate and order for the provision of goods or services or the execution of works under provided consideration.

The invitation to tender (ITT), also known as an invitation to bid (ITB), request for qualifications (RFQ), or request for proposal (RFP), is the initial stage of the construction tendering process. The tender document includes all the necessary details to furnish a cost estimate for the proposed scope of work, and contractors furnish the owner with a quote based on the information supplied. Once the contractors prepare and submit their bids based on the tender documentation the owner or other relevant parties review the tenders and select the best one that meets their needs. Following the selection of the project delivery method, the project owners must decide how to proceed with the purchase of construction services. In general, the tendering process ensures transparency, competition and fairness in awarding construction contracts. Further, it helps clients identify the best contractors for their projects, while contractors have a structured way to compete for business.

According to (Bedasso, 2020), the Ethiopian Federal Government's procurement and property administration proclamation now governs the contractor selection procedure for public construction projects. Six categories of procurement procedures are listed in this proclamation document: direct procurement, two-stage tendering, restricted tendering, open bidding, request for offers, and request for quotation. Additionally, it specifies that, until the proclamation's requirements for adopting a different approach are satisfied, open bidding will be the preferred form of procurement for public organizations.

2.3.2. Contractor Selection Criteria

A construction project's success, among other factors, depends on its contractor, and selecting the best contractor is a crucial step for the client company. The client's decisions play a major role in determining whether a construction project succeeds or fails (Fekadu, 2013) . The method of contractor prequalification is frequently employed to find a competent, trustworthy, and reputable contractor. The creation of suitable and necessary criteria is a prerequisite for the qualification procedure. The qualification process looks into and evaluates a contractor's ability to complete a

task. This is the method that is currently most popular in many nations, and it considers a wide range of characteristics to assess a contractor's overall suitability. A screening process based on a set of requirements established by each individual owner is part of the contractor qualifying process. According to (Afolayan, 2018) clients typically prefer contractor prequalification in order to lower risks and failures and improve the performance levels of selected contractors by using specified minimum capacities under which contractors would not be considered.

Numerous studies have established a number of elements and standards for the proper evaluation and choice of contractors for construction projects. Clients that choose the lowest bidder frequently allocate construction contracts to unqualified, unskilled, underfunded, and incompetent contractors (Morkfinate, 2017). Similarly, choosing the wrong contractors could result in significant additional expenses for rework that arises from a variety of issues, including low-quality work, disputes, claims, desertion, and insolvency (Polat, 2016).

Before selecting a contractor for any construction project, it is essential to evaluate several key criteria that ensure the chosen contractor is capable of delivering the project successfully. Various researchers have studied the factors that influence contractor selection, each highlighting specific aspects depending on the nature of the project and the region in which it is conducted. This research aims to review and summarize these contractor selection criteria as identified by different scholars. Table 2-1 below provides a concise summary of the major contractor selection criteria identified in multiple studies, offering a comprehensive view of the factors that are considered crucial by different researchers in different contexts.

Table 2- 1: Contractor Selection Criteria by Different Researchers

Researcher	Contractor Selection Criteria
(Khosro Y., 2020)	Prior experience, employee performance and ability, financial stability, safety, reputation, quality, equipment capability, technology, local information, workload, accessibility, time and cost performance
(Maqsoom A. B., 2020)	Proper planning, creditworthiness, plant and equipment holding, financial stability and past performance
(Alptekin, 2017)	Completion of work, technical staff experience, financial strength and credibility, lowest bid, safety plan and record, work quality, time

Researcher	Contractor Selection Criteria
	in industry, similar work experience, number of technical staff, materials and equipment and work experience document
(Araujo, 2015)	Cost, health and safety, past project performance, experience in similar jobs and quality
(Nasab, 2015)	Technical proficiency, management aptitude, prior performance history, financial stability, health and safety performance
(Rashid i. M., 2017)	Management capability, financial capability, experience, resources, technical capability, environment, health and safety and timeliness
(ASK-EHS., 2018)	Safety performance records, worker compensation, documented injury rate, safety programs, staff safety competency

2.3.3. Bid Selection Process in Different Countries

One of the most difficult aspects of reviewing bids in the road construction sector is determining the optimum way of analyzing bids. Here below the research discuss different countries bidding experience.

I. Bidding Process in U.S

The price of the bidder determines which bids are chosen in the road construction sector in the United States. Under the closed bidding mechanism, the bid was awarded to or won by the bidder who offered the lowest bid price. This method is fair, very transparent, and appropriate for the degree of competition at the government level. However, because the bid price was the primary consideration in deciding who would receive a construction contract under this approach, many major and medium-sized road building projects were abandoned. This was caused by the winning bidder's extremely low offer price, which they intended to raise once they had purposefully reached an agreement (Hasnain M. M., 2017).

II. Bidding Process in France

France stopped using its outdated system of public or large-scale project procurement and bidding. Currently, the government is switching from the previous, price-based bidding method to one that selects bids based on the most favorable economic conditions. However, the government typically has personnel who are knowledgeable in the field to select a good bid in the road construction

sector. Reforms to the bidding process have been assessed recently to enhance both life and the quality of the road (Hasnain M. M., 2017).

III. Bidding Process in Germany

In Germany, bids are assessed, and contractors are chosen depending on whether they are financially favorable to the government. The majority of German bidders, meanwhile, are small and medium-sized businesses, and they lack the resources to build high-quality roads that adhere to EU laws and regulations. Therefore, the German government declared that any company from the EU can engage in the bid in order to improve the quality of the roads by bringing on board major and highly qualified infrastructure organizations (Hasnain M. M., 2017).

IV. Bidding Process in Australia

The construction and maintenance of roads in Victoria, Australia, are essential to the state's economy, the development of key commercial and infrastructure projects, and the growth of the employment sector. The civil construction and maintenance industry in Victoria is dedicated to setting an example of excellence in the development and maintenance of other infrastructure projects in the region while keeping the environment and community requirements in mind. To meet this objective, it is imperative that best practices for managing contracts and tenders pertaining to road building expand. For this reason, the government of Victoria has set a minimum standard for contracts pertaining to the construction and upkeep of public roadways (Alliance, 2008).

In Victoria, open tenders, selected tenders, and preregistered (selective) bids are the most often used tendering procedures. A few steps need to be taken in order to hold an open tender: publishing the "Invitation to Tender" in an appropriate newspaper, sending out important project details, inviting contractors, and informing them of the deadline. "Selected tendering" follows the same rules as "open tendering," with the caveat that contractors may only apply if they have previously worked on projects similar to this one. Two primary stages comprise pre-registered (selected) tendering: requesting expressions of interest from contractors and publicizing tenders (Alliance, 2008).

For the three procedures of tendering Victoria apply the following principles;

- Value for money: the government of the country prioritizes performance requirements and accepts goods and services at the best pricing.
- open and fair competition: Increases the likelihood that businesses and independent contractors will participate in the marketplace
- Accountability: Assignment of responsibility for adhering to rules and embracing best practices
- Risk Management: Implementing directives from management to reduce risk in tendering and contract administration
- Probity and transparency: Ensure fairness, independence, dependability, and transparency at all stages of the procurement process
- Participation of local industry: Utilizing local vendors if they are the cheapest is one way to support local business. Costs associated with the tendering process are kept to a minimum by ensuring that the lowest-priced bids will also be taken into account as long as they guarantee quality services.

V. Bidding Process in Middle East

The popularity of Saudi development advertising and the administration's plan to re-fabricate the Kingdom's framework have pushed the sharp recent expansion of the Saudi Arabian construction industry. These development projects include building new roadways, bridges, sports offices, private housing and administrative buildings. These duties can be classified as real activities and by far the majority of them are funded by the administration. There are also substantial requirements for the private development sector, and the main factors driving these requests are, in large part, changes in the social and financial aspects of Saudi society. These perspectives take into account Saudis' shifting lifestyles from rural to urban areas, increases in job opportunities, and increases in monthly salaries (Walker, 2016).

Accordingly, there have been numerous changes in the nation's government as a result of the administrative process and changes in the socio-financial aspects of Saudi society. As a result of this enormous number of open activities, Saudi Arabia's construction industry has attracted a sizable number of temporary workers from across the country, province, and globe. As a result,

choosing temporary workers is a significant barrier for Saudi open task owners due to the impact of project success on public interest as well as the difficulty in finding qualified candidates (Park, 2017). In Saudi Arabia, the pre-determination procedure for temporary workers primarily relies on a vague list of requirements created by the administration, which is then filled out by the temporary workers themselves. This framework fails to meet the needs of the project's clients and has grown so strong that the same number of contractors have failed to achieve the project's requirements and their own performance commitments. The main step in the current selection process is for the temporary worker to complete an evaluation form, but knowledge of the Saudi construction market has revealed that the contractual workers are unreliable when it comes to evaluating their own performance, the number of projects they have completed, or their own financial performance as a group. Regarding the temporary workers' evaluation of their own execution, there is a lack of assurance (Elik, 2017).

VI. Bidding Process in Turkey

In Turkey, public construction tenders are conducted in accordance with Public Procurement Law 4734, Article 40. Consequently, the bidder who offers the best financial package keeps the tender. In Article 67 of the Implementing Regulation for Construction Business Laws, which is organized in parallel with the tender law, the "lowest price tender" is defined as the most financially viable tender; extra considerations are given to cost, cost efficiency, productivity, quality, and technical value of the tender when price and lowest price are insufficient to determine the most economically beneficial tender. PPL 4734 is a mandatory law in Turkey that restricts the use of the conventional project delivery method for public building acquisition by public entities. PPL 4734 states that the contractor selection method has to employ the tender to predefined bidders' procedure.

. This contractor selection process consists of three main phases:

1. Pre-qualification stage and bid invitation
2. Commissioning a tender and the bidding stage and
3. Request to enter into a contract and contract signing

VII. Bidding Process in Ghana

When it is desirable for only local suppliers or contractors to submit tenders, national competitive tendering (NCT) and international competitive tendering (ICT) procedures are followed, in

accordance with Ghana's Public Procurement Act (PPA) (Act 663, 2003). Three processes are usually included in the evaluation of accepted tenders. These consist of post-qualification evaluations, comprehensive tests, and initial screenings. For a bid to be considered, it must meet all of the requirements specified in the tender document. The lowest-rated tender is chosen and advised to receive the contract, in accordance with Public Procurement Act 663 of 2003.

After selecting the lowest evaluated price, (Acquaye, 2011) suggests that the tenderer's competence and resources for the job should be verified again. To ascertain whether the tenderer with the lowest evaluated tender price have the resources or abilities required to successfully execute the contract, the evaluation panel's assessment process is employed. The memo stated that the tender evaluation procedures are divided into two parts: confirming the information the tenderer submitted in accordance to the tender document is part of the review of the information submitted. The second step is the Tender Review Report, which provides a brief summary of the whole tendering process, from the advertisement to the submission and evaluation of the tender, and lists all the considerations that went into recommending the contract award. The Ghanaian tender evaluation process generally consists of six steps: tender submission, opening, examination, responsiveness, evaluation, and tender evaluation report.

VIII. Bidding Process in Ethiopia

Before being able to bid on a project in Ethiopia, contractors have to meet a number of requirements. One of these is being registered with the Ministry of Construction and Urban Development. Every year, the Minister registers the three categories of contractors general, building, and road according to their areas of expertise that are relevant to the project. Eight groups based on each group's capacity are then created, the first having a larger capacity than the others. A contractor's license is awarded based on their qualifications, including capital, equipment ownership, full-time staff, and office space availability. Next, each customer sets criteria according to the specifics of their own project.

The Federal Government of Ethiopia has legislation requiring the submission of competitive bids for construction projects. This law mandates that public organizations give such contracts to the bidder who receives the lowest evaluation and is judged responsive; responsiveness is defined as the bidder's capacity to satisfy the minimal standards specified in the bid document. Such minimum qualifying criteria include;

- Annual construction turnover (average annual volume of construction work)

- Experience serving as a prime contractor on similar contracts,
- Proposal for timely acquisition of equipment (own, rent, hire, etc.)
- Personnel having a specific expertise and qualification
- Liquid assets and/or credit facilities excluding any potential advance payments made under the Contract and after deducting any other contractual commitments.

The tender document outlines these as the primary qualifying elements. A contractor's non-performance or a history of litigation or arbitration rulings against the applicant or its joint venture partners may also lead to disqualification. The nature of the construction project dictates the specifics. Proclamation Article 43(3) states that a bid is only deemed responsive by the public body if it meets all of the important requirements listed in the bidding document. The Federal Public Procurement Directive states that the evaluation criteria must be unbiased and, to the greatest extent feasible, quantifiable in order to obtain the best value for the money; vague requirements are unacceptable and the employer should refrain from using them; and the criteria cannot unjustly discriminate against any group of people.

Table 2- 2: Bidding Process in Different Countries

Bidding criteria	Bidding Process in different countries						
	U. S	France	Germany	Australia	Middle East	Ghana	Ethiopia
Bid price	✓	✓	✓	✓	✓	✓	✓
Bidder details	✓	✓	✓	✓	✓	✓	✓
Scope of the work	✓	✓	✓	✓	✓	✓	✓
Bidder experience	✓	✓	✓	✓	✓	✓	✓
Technical resources	✓	✓	✓	✓	✓	✓	✓
Related work quality	✓	✓	✓	✓	✓	✓	✓
Health and safety	✓	✓	✓	✓	✓	x	✓
Taxation details	✓	✓	✓	✓	x	✓	✓
Financial information	✓	✓	✓	✓	✓	✓	✓
Infrastructure	✓	✓	✓	✓	x	✓	✓

Bidding criteria	Bidding Process in different countries						
	U. S	France	Germany	Australia	Middle East	Ghana	Ethiopia
Team skills	✓	✓	✓	✓	x	x	x
Plant and tools	✓	✓	✓	✓	✓	✓	✓
Innovation	x	x	x	x	x	x	x

Source: (Hasnain M. M., 2017)

The criteria utilized in various countries for the bidding process provide valuable insights when compared to the additional evaluation frameworks. They highlight the importance of financial stability and prior experience, among other criteria, as key factors in assessing contractor qualifications. The bidding criteria among different countries focus on specific elements such as bid price, bidder details, and technical resources, indicating a practical approach to evaluating bidders based on tangible requirements; these criteria are also suggested by different researchers that are discussed here in this study (Alptekin, 2017), (Rashid i. M., 2017), (Khosro Y., 2020) and (Nasab, 2015). This shared focus underscores a broad consensus on the importance of these factors in selecting a contractor who can meet project demands. For instance, bid price is universally recognized across countries and aligns with different researchers, which considers cost a critical but not exclusive factor, suggesting that it should be balanced with other attributes like quality and past performance.

A notable distinction in contractor selection criteria arises with the emphasis on regulatory and compliance aspects, such as health and safety standards and taxation requirements, which are prioritized differently across countries. This focus on adherence to local regulations reflects the necessity of maintaining project integrity and safety. In contrast, researchers like; (Nasab, 2015), (Araujo, 2015), (Alptekin, 2017) and (Khosro Y., 2020) explore qualitative elements such as management capability, reputation, and technical proficiency, emphasizing the importance of a contractor's operational effectiveness and resource management for successful project execution. These researchers also advocate for innovation and research capabilities criteria that often receive limited attention in national bidding processes arguing that factors like technological advancement, strategic planning, and local knowledge contribute significantly to adaptability and added value.

Overall, this combined perspective is useful for developing a comprehensive contractor selection process. Incorporating the established practices widely used across countries and the additional criteria recommended by researchers allows for a more robust approach. This balanced method ensures that essential criteria are covered while also addressing advanced elements like safety, management skills, and environmental considerations, which support informed and well-rounded contractor selection.

The application of methodologies such as the Multi-Criteria Decision Making (MCDM) can further enhance the evaluation process by allowing decision-makers to systematically prioritize these criteria based on their relative importance. AHP, for instance, can help in breaking down complex decision-making into a structured format, enabling stakeholders to rank criteria according to their significance in a specific context. By integrating these methodologies, organizations can ensure a more comprehensive assessment that balances compliance with local regulations and the contractor's overall operational capabilities.

2.3.4. Tendering Process in Ethiopian Road Administration

The Government of Ethiopia (GOE) views road construction projects as an essential part of its strategy, given its impact on all sectors of the economy. ERA, acting on behalf of the GOE, is heavily involved in the selection and organizing of road initiatives, the procurement of work and service contracts, contract administration, and the preservation of completed projects.

Table 2- 3: Tendering Process in ERA

SI .No	Activity	Description
1	Planning & Bid Preparation	1.1. Receive annual construction plan and data from Plan and Program Directorate, prepare procurement plan, and allocate tasks. 1.2. Determine scope of work with relevant directorates and obtain necessary documents. 1.3. Prepare project work schedule. 1.4. Invite prequalification (IFPQ) for complex/high-value projects or turnkey contracts. 1.5. Assign unique tender numbers. 1.6. Review received Prequalification Documents (where applicable) and bidding document for completeness and correctness against standard documents in compliance with the following, as applicable: <ul style="list-style-type: none"> • Standard Bidding Document for Procurement of Works for ICB • Standard Bidding Document for Procurement of Works for NCB • Standard Pre- qualification Document from Funding organizations, as applicable 1.7. Finalize bid/prequalification documents. 1.8. Decide document pricing, obtain approvals, set floating periods and bid security requirements. 1.9. Obtain "No Objection" for tender documents from funding organizations (if applicable).

SI .No	Activity	Description
2	Invitation for Pre-Qualification	<p>2.1. Prepare IFPQ notice, obtain approvals, and advertise through various channels (ERA website, PPA website, and external websites).</p> <p>2.2. Respond to requests/clarifications within the prescribed period.</p> <p>2.3. Extend deadlines if necessary, ensuring approvals.</p> <p>2.4. Receive prequalification applications securely and submit them for evaluation.</p> <p>2.5. Assess applications using evaluation standards and prepare a Pre-qualification Evaluation Report.</p> <p>2.6. Notify applicants of their status and issue bidding documents to qualified applicants.</p>
3	Invitation and Receipt of Bids	<p>3.1. Prepare and advertise Invitation to Bid, ensuring compliance with directives.</p> <p>3.2. Get the invitation posted on PPA website, External websites i.e. Funding banks</p> <p>3.2. Issue tender documents to authorized representatives upon verification and payment.</p> <p>3.3. Maintain a record of issued documents with bidder details (reference number, full contact details).</p> <p>3.4. Arrange visits, resolve bidder queries, and issue addenda if required.</p> <p>3.5. Extend bidding deadlines for major modifications or upon request with proper approvals.</p> <p>3.6. Secure received bids in locked boxes, providing receipts.</p>

SI .No	Activity	Description
4	Bid Evaluation	<p>4.1. Open bids publicly and verify compliance using a checklist.</p> <p>4.2. Nominate trained members for technical evaluation and evaluate bids confidentially.</p> <p>4.3. Consider contractor performance, litigation history, financial stability, and experience.</p> <p>4.4. Prepare evaluation reports and address clarifications or complaints.</p> <p>4.5. Verify qualification of technically successful bidders.</p> <p>4.6. Communicate decisions to bidders, including reasons for disqualification.</p> <p>4.7. Conduct financial evaluation and recommend actions (e.g., re-advertisement or award).</p> <p>4.8. Obtain approvals for evaluation results from ERA Board and funding organizations (if applicable).</p>
5	Award of Contract	<p>5.1. Conduct pre-award negotiations with the successful bidder and clarify required documents.</p> <p>5.2. Notify unsuccessful bidders of reasons for rejection.</p> <p>5.3. Issue Letter of Acceptance to the successful bidder upon document verification.</p> <p>5.4. Prepare and sign the contract, ensuring a performance security of at least 10% of the contract value.</p> <p>5.5. Distribute signed contracts to relevant parties (e.g., finance, legal, CPM directorate).</p> <p>5.6. Publish information regarding award of contract within 5 days of signing the contract on ERA website and in case of funded project, publish as per the guide lines of the funding organization.</p>

2.3.4.1. Summary of Bid Evaluation Process in Ethiopian Road Administration

The Ethiopian Roads Administration (ERA) follows a two-stage evaluation process **Post Qualification** and **Financial Evaluation** in line with Public Procurement Agency (PPA) requirements, using a pass/fail approach for the technical evaluation and focusing on the lowest bid for the financial evaluation.

1. Technical Evaluation (Post Qualification) – Pass/Fail Approach

The **Technical Analysis Committee (TAC)** conducts the post-qualification evaluation to determine whether contractors meet the minimum requirements outlined in the bidding documents. This evaluation uses a pass/fail approach, meaning that only contractors who meet all minimum requirements can proceed to financial evaluation.

Table 2- 4: Technical Evaluation Criteria

Category	Evaluation criteria
Preliminary Examination of Bids	<p style="text-align: center;">Verification and Completeness of Applications:</p> <ul style="list-style-type: none"> • Compliance with Legal Requirements: <ul style="list-style-type: none"> * For Ethiopian Bidders: Valid Certificate of Registration with Ministry of Construction (Category GC-1 or RC-1, renewed for 2012 EFY). Trading License, Tax Clearance, VAT Registration, and Supplier Registration with the Public Procurement and Property Administration Agency (PPPAA). * For Foreign Bidders: Business Registration or Trade License from the country of origin, Tax Clearance Certificate (if the bidder has an ongoing or completed project in Ethiopia). • Submission of acceptable Power of Attorney. • Submission of acceptable Bid Security. • Validity of bids for the specified period • Information on current work commitments • Compliance with bid format: Language, Copies, Sealing, and Addressing requirements.

Category	Evaluation criteria
	<ul style="list-style-type: none"> • Eligibility of the bidder, including no conflict of interest. • Availability of critical equipment and key personnel • Submission of Work Method and Schedule • Completion of all required forms and confirmation of subcontracting if applicable • Submission of notarized and authenticated company documents for foreign bidders <p style="text-align: center;">Substantial Responsiveness</p> <ul style="list-style-type: none"> - Compliance with all issued Bid Addenda. - Consistency between original and copies of the bid. - No unacceptable material deviation or reservation.
Detailed Examination of Qualification Application	<ul style="list-style-type: none"> - Non-performance history and pending litigation. - Financial performance history. - General and specific experience. - Key personnel and required equipment. - Work methodology and schedule.

If a bidder meets all criteria in the post-qualification phase, the Technical Analysis Committee (TAC) recommends them for financial evaluation. Before the Director General endorses the TAC's post-qualification evaluation, the procurement endorsement committee must first approve the TAC's results. Following this approval, the Director General provides final endorsement.

2. Financial Evaluation

Once bidders pass the technical evaluation, they proceed to financial evaluation, which includes both a preliminary examination and detailed evaluation to determine the lowest evaluated bidder.

Table 2- 5: Financial Evaluation Criteria

Category	Evaluation Criteria
Preliminary Examination	<p style="text-align: center;">Completeness of Bid</p> <ul style="list-style-type: none"> - Form of Bid is properly signed. - Priced Bills of Quantity are presented. - Base Indices table is completed and quotations are documented. - Bid is submitted in English. - Bid includes one original and four copies. - No unacceptable alterations, omissions, or additions in the bid.
	<p style="text-align: center;">Substantial Responsiveness</p> <ul style="list-style-type: none"> - Bidder participates in only one bid. - Bidder responds to all requirements - Consistency across original and copies. - Bid is free from any unacceptable material deviation or reservation.
Detailed Financial Evaluation	<ul style="list-style-type: none"> - Consideration of modifications and discounts. - Adjustments for evaluation currency, additions, and priced deviations. - Margin of preference for local bidders

Following these evaluations, the bid price is compared to the engineer’s estimate. The **lowest evaluated bid** among the submitted bids is then selected as the winning bid. In summary, ERA’s evaluation process ensures that contractors meet minimum technical requirements using a pass/fail approach in the technical evaluation (post-qualification phase). Contractors meeting these requirements proceed to financial evaluation, where the lowest responsive bid is selected. There is no percentage or weightage applied in either technical or financial evaluations those who pass the minimum requirements proceed, and the contract is awarded to the lowest evaluated bid.

2.4. Contractor Selection Criteria Importance and Challenges

2.4.1. Contractor Selection Criteria and its Importance

The process of contractor selection is an important aspect of project performance in the construction industry, impacting project quality, timelines, and costs. Selecting a suitable contractor is a multi-dimensional decision-making process that account for numerous factors. Bidders are prevented from being awarded from jobs that exceed their qualifications and

capabilities, unprepared contractors are eliminated, and project risks are decreased (Chen, 2021). Before hiring the contractors for the project, their potential is carefully assessed. This enables the achievement of optimal performance in terms of cost, time, and quality. Choosing a capable contractor will contribute to success assurance. Before hiring a contractor, their potential is carefully assessed. This allows for the best possible performance to be achieved in terms of schedule, cost, and quality.

Selecting a qualified contractor significantly impacts construction performance by ensuring projects are completed on time and within budget, thus optimizing the efficient use of limited financial resources (Huang, 2011). There have been reports that the project owner's contractor selection process is less subjective when prequalification criteria are used. Because they have a big impact on the project's success, the prequalifying requirements for contractors are essential in project planning (Rashvand, 2015). Selecting a contractor may help with a number of things, including assessing past performance, identifying competent and capable contractors, and weeding out competent but insolvent firms (Alptekin, 2017). Table 2-6 attempts to clarify the various selection criteria and their significance.

Table 2- 6: Importance of Contractor Selection Criteria

Id No.	Selection Criteria	Importance
1	Financial capability	To help a client to generate an educated view on the company's overall financial status.
2	Financial statement & profit & loss of last 5 years	It is evidence to show the financial standing of the company.
3	Return on net worth ratio	One of the most significant ratios for assessing a company's overall efficiency
4	Quick ratio	Evaluates a company's capacity to use its short-term or near-term cash resources to pay off or retire its current debts.
5	Current ratio	This financial ratio indicates whether a company has enough cash on hand to cover its debts over the

		coming year by comparing its current assets to its current liabilities.
6	Asset turnover ratio	It is a measurement used to specify how the contractor arranges the money needed to complete the job.
7	Working capital	It's a financial indicator that shows how much operating liquidity is accessible to a company, group, or other entity.
8	Technical capability	Allowing the company to prove that it is technically capable of completing the work for which it is applying for registration or prequalification for particular projects.
9	Firms work experience	Previous projects finished with project details and a certificate of completion
10	Equipment & plant owned by the contractor	It is a list of the contractor's assets, such as machinery or plants.
11	Labors (skilled & unskilled)	Sufficient manpower and material resources to complete the task at hand.
12	Personnel experience in similar projects	Professionals, experts who worked on previously finished projects.
13	Management capability	To promote industry best practices and human resource management in order to reduce workplace conflict and increase worker productivity.
14	Time overruns in past projects	Give the client, the ability to evaluate the company's project management and delivery capabilities.

15	cost overruns in past projects	It enables the customer to assess the business' ability to manage and complete projects within the budgeted amount.
16	Reputation condition	A collection of entities' judgement (or, more precisely, their social appraisal) of an individual, a group of individuals, or an organization based on a particular criterion
17	Health and safety policy	In order to motivate employers to set up and keep up efficient procedures for handling risks to workers' health and safety as well as other risks resulting from the type of work they do

Source: (Meghalkumar, 2011)

2.4.2. Challenges in Contractor Selection

Selecting the right contractor is a critical decision in the construction industry, as it directly impacts the project's quality, timeline, and overall success. However, contractor selection is fraught with challenges due to the complex, multifaceted nature of the criteria involved and the varying priorities of stakeholder. (Agboola S. A, 2023) notes in his research that the following are significant obstacles related to the contractor selection criteria: the contractor's requests for time extensions, the delay in providing the owner with pertinent contract documents, a history of not completing projects on schedule, delays beyond the initial agreement period, demands for price and contract sum reviews, contractor's lack of financial capability and the client's tardy mobilization. Table 2-7 presents several researchers illustrations of the obstacles that impact contractor selection criteria.

Table 2- 7: Challenges in Contractor Selection Criteria

S/N	Challenges	Researcher
1	Balancing cost Vs. Quality	(Biruk, 2017), (Flynn, 2017)
2	Evaluating bidder capabilities	(Bagies, 2006), (Olatunji, 2017)
3	Bid compliance issues	(Olatunji, 2017)
4	Risk management	(Bagies, 2006)
5	Limited client Expertise	(Holt,1993,1995), (Hatush & Skitmore, 1997)
6	Technology and innovation capacity	(Wang, 2021)
7	Transparency and hidden cost	(Bagies, 2006), (Olatunji, 2017)
8	Incomplete bids and compliance	(Bagies, 2006), (Olatunji, 2017)
9	Political influence and contract Delays	(Agboola S. A, 2023)
10	Environmental and sustainability concerns	(Green & Clark, 2018)

Given the multitude of factors influencing contractor performance, it is critical for decision-makers to adopt a structured and objective approach to contractor evaluation. Implementing multi-criteria decision-making methodologies, such as the Analytical Hierarchy Process (AHP), can help navigate these complexities, offering a balanced assessment framework that integrates both quantitative and qualitative criteria. Moreover, aligning selection methods with regulatory standards ensures transparency and compliance, fostering a competitive yet fair bidding process. Ultimately, overcoming the challenges in contractor selection contributes to improved project outcomes, enabling efficient resource utilization, enhanced quality control, and reduced project risks.

2.5. Overview of Contractor Selection Methods

2.5.1. Multi-Criteria Decision Making

Selecting a contractor is among the most crucial choices that clients have to make. (Abera., 2017) Describes a procurement system that comprises pre-qualification, packaging, invitations, shortlisting, and bid review. (Alamoudi., 2015) Notes that there exist techniques that aim to evaluate contractors' values through the application of diverse selection criteria. Fuzzy Set Theory (FST), multivariate discriminant analysis (MDA), cluster analysis (CA), bespoke approaches (BA), multiple regression (MR), multi-criteria decision-making (MCDM), and multi-attribute analysis (MAA) are some of these techniques.

While there are several well-known techniques, choosing contractors using MCDM is still relatively new. MCDM seeks to solve decision problems by applying a set of criteria. Several MCDM approaches, including the AHP, ANP, fuzzy set theory, data envelopment analysis, mathematical programming, case-based reasoning, generic algorithm, and simple multi-attribute rating technique, have been presented for contractor selection (Afolayan, 2018). From the aforementioned MCDM methodologies this study focuses on constructing a theoretical selection model based on the AHP approach.

2.5.2. Decision-Making Techniques Applied in Contractor Selection Models

In order to succeed in any profession, decision-making is essential. Correspondingly, in the construction industry where choosing a contractor necessitates a substantial amount of information and expertise in selecting the qualified contractor (Ali, 2021). Most constructing processes and procedures are a combination of numerous unusual tasks, steps, and requirements that involve a wide range of variables and aspects to take into account. In this continuation, making decisions in a setting with this much diversity is a challenging and laborious task. Various techniques from previous models were used to assist decision-makers (DMs) in choosing the best contractor to execute each individual task.

These techniques included simulation, AHP, ANP, DEA, Multi Utility Theory, Fuzzy Set Theory, TOPSIS, ELECTRE, PROMETHEE, VIKOR, ANN and grey theory, etc. AHP is the most widely used technique among these due to its fairly easy approach, nonetheless, it has been questioned for not accounting for data interdependencies and for having lower accuracy in construction (Gurgun,

2020). ANP was utilized by (Cheng E. W., 2004) to pick contractors while taking the interdependencies of the criterion into account. As per (El-Abbasy, 2013), it takes into consideration the interdependence of the contractor's criteria, something that AHP neglects to examine. However, the ANP has fewer applications because it requires more time and is less versatile (Ismail, 2021).

Although DEA was employed by (Cheaitou A, 2019) & (Yang, 2016) the method is rarely utilized and it is not a suitable way to measure the efficiency of contractors (Jato, 2014). While the PROMETHEE technique has been modified by (Semaan N, 2017) , it does not function well at higher criteria and there are typically many criteria for choosing a contractor. (Hasemi, 2018) Enforced ELECTRE, however despite the benefits, the process takes a lot of time (Aruldoss M, 2013) .

The applicability and limitations of MCDM approaches in CS models are depicted in Fig. 2-4, along with their suitability. Additionally, (Senthil S, 2014) studied a hybrid approach in a contractor evaluation example using fuzzy TOPSIS and AHP. (San, 2012) Compared and produced comparable findings between the VIKOR and TOPSIS approaches, two of the best MCDM techniques. (Liu H, 2007) Used a model to combine a typical AHP with a variety of VIKORs to determine the best way to bid on construction projects. Thus, the approaches were intended to compute the final ranking of the alternatives and the Eigen-vector, respectively.

For CS models, a variety of fuzzy techniques were used and combined with other techniques. For example, fuzzy TOPSIS by (Taylan O, 2018) , fuzzy with Mikhailov's approach by (Tomczak, 2018) , fuzzy with AHP by (Taylan O, 2018) , fuzzy with ANP and VIKOR by (Ebrahimnejad S, 2012), and fuzzy ELECTRE III by (Chen, 2021) are just a few examples of the fuzzy techniques that were used. Lately, a hybrid model based on AHP and PROMETHEE was used by (Marović I, 2021) ; (Mehrabani, 2020) used ANN; and (Niewerth S, 2020) used DEA.

2.5.2.1. Types of Contractor Selection Models

According to (Ali, 2021) contractor selection model based on their purpose can be classified in to six categories. Figure 2-4 shows types contractor selection models based on their suitability and purpose.

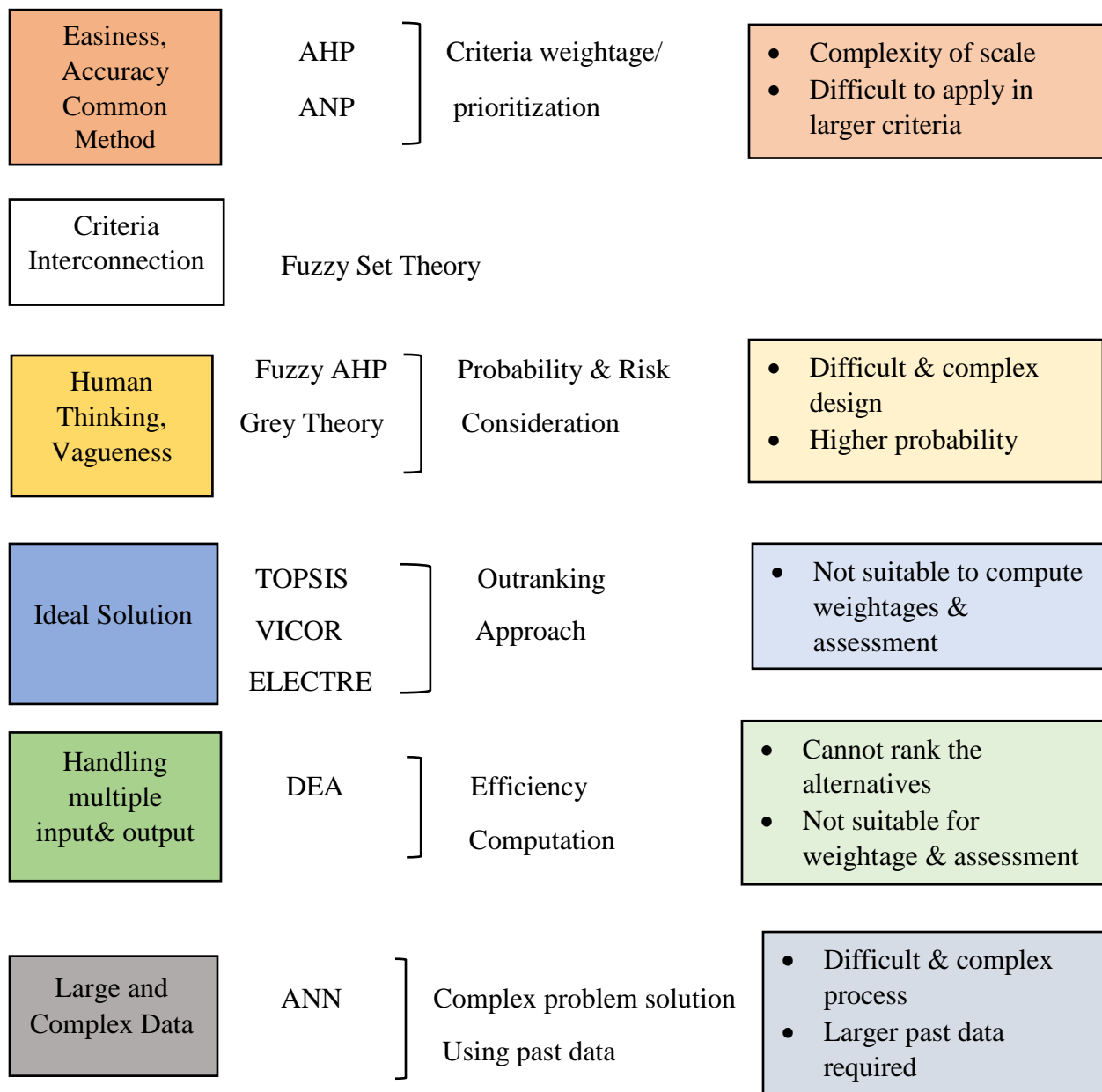


Figure 2- 4: Suitability and Problems of MCDM Applied in CS Model's; Source: (Ali, 2021)

In essence, choosing the right contractor for a construction project requires sound decision-making. To help choose the best contractor, a multi criteria method of evaluating contractors using appropriate criteria might be used. The benefits and drawbacks of the fourteen distinct MCDM techniques that (Ojokoh, 2021) found are displayed in Table 2-8.

Table 2- 8: Advantage and Disadvantage of MCDM Methods

ID No.	Method	Advantage	Disadvantage
1	Dimensional Weighting Method (DWM)	It is easy to use and doesn't require any special knowledge to comprehend.	The decisions made by the decision makers determine the outcome. For example, a high score in one area may offset a low score in another; the experts' judgements may not have been sufficiently consistent; or the criteria may have been different and the units of measurement varied.
2	Multi-Attribute Utility Theory (MAUT)	Considers a variety of stakeholders, permits for the analysis of both qualitative and quantitative criteria, incorporates preferences, and takes uncertainty into account.	Needs a lot of input; its preferences must be exact; it cannot handle multiple decision-makers at once; its decision-making process is time-consuming and tedious when there are numerous factors to evaluate.
3	Multi-attribute Analysis Method (MAA)	This straightforward paradigm aids in decision-making when there are several competing factors to take into account.	Decision makers typically utilize the input variable as a subjective metric.
4	Analytic Hierarchy process (AHP)	AHP is easy to use, scalable, and adaptable to an array of issue sizes, requires little data, and may combine both subjective and qualitative elements. It also permits consistency checks.	AHP's limitations include its strict 1–9 scale, inability to account for ambiguity and uncertainty during pairwise comparisons, and it is only effective when all matrices have the identical mathematical structure.
5	Analytic Network Process (ANP)	It permits communication and feedback across clusters and can be applied to assess the reciprocal relationships between various criteria.	It rejects the various impacts among groups, takes a lot of time.

ID No.	Method	Advantage	Disadvantage
6	Case Based Reasoning (CBR)	Requires low preservation, few data, can get better over time, and can adjust to changes	CBR needs several cases since it is sensitive to data that is inconsistent.
7	Data Envelopment Analysis (DEA)	Numerous inputs and outputs can be handled by DEA, and efficiency can be measured and examined.	Requires that all input and output are precisely understood and does not take into consideration unclear data.
8	Goal Programming	Able to handle complex decision-making situations and generate an endless number of options.	Its coefficient-weighting capability; usually requires usage in conjunction with other MCDM techniques.
9	Simple Additive Weighting (SAW)	Capacity to balance several factors; decision-makers find it intuitive; computation is straightforward	Estimates disclosed don't always accurately depict the circumstances, and the outcome might not make sense.
10	Weighted Product Method (WPM)	The criteria weights are determined by multiplying all of the powered performance values for each option by the exponents of their payoffs. This results in the comparison index for each alternative.	Since every unit will be removed during the process, it is a dimensionless analysis.
11	TOPSIS	It has an easy-to-use and programme decision-making process, and no matter how many qualities there are, there are always the same number of steps.	Its application of Euclidean Distance ignores attribute correlation, makes weighing decisions difficult, and fails to verify decision makers' consistency.
12	ELECTRE	It accounts for the ambiguity and uncertainty of the data.	Its procedure and result are difficult to describe in simple terms; the advantages and disadvantages of the options are obscured by outranking.

ID No.	Method	Advantage	Disadvantage
13	PROMETHEE	Simple to use; does not rely on the proportionality of the criteria.	Does not offer a precise process for allocating weights.
14	Fuzzy MCDM Methods	Accepts inaccurate input and accounts for incomplete information	Challenging to create; may need multiple simulations before usage

Source: (Ojokoh, 2021)

Numerous comprehensive research focused on a variety of decision-making strategies within the contractor selection paradigm. (Chen, 2021) Assert that the use of improper contractor selection techniques has a significant negative impact on a project's performance. To address this relevant issue, numerous attempts have been made in the past and in the present to create an appropriate mechanism in the form of a contractor selection model. Among the various decision-making models, the Analytic Hierarchy Process (AHP) stands out as a powerful tool for contractor selection. AHP is particularly effective in scenarios where multiple criteria must be evaluated and prioritized. Unlike other methods, AHP allows for both qualitative and quantitative factors to be considered, making it a versatile choice for addressing the complexities inherent in contractor selection. The next section will explore how AHP provides a structured and systematic approach to decision-making, enhancing consistency and helping to mitigate the risks of poor project outcomes.

2.6. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a mathematical technique that is well-known for its effectiveness in solving complex decision-making problems. It was first introduced by Saaty in 1987. When a decision-maker has numerous criteria to consider, the AHP approach helps them select the optimal choice (Benfares, 2021). This method incorporates both quantitative and qualitative components and aids in organizing difficult decision-making issues into a step-by-step decision model. It is based on the notions that interconnections between clusters are unidirectional across the decision levels of the hierarchy and that there are no connections between clusters and elements.

The AHP process works as follows: First, it identifies criteria and the appropriate sub-criteria, breaking down the decision into distinct aspects to be taken into account. It then performs pairwise comparisons of the components to provide a relative relevance scale. In order to compare the significance of each pair of items at each level of the hierarchy, experts in the relevant domains are asked to determine the relative value of each criterion with respect to those at the second level. At the second level and beyond, experts compare the significance of every pair of sub-criteria under the same criterion.

This process is repeated throughout the hierarchy. There is no guarantee of consistency in these judgements because AHP relies on decision-makers' subjective assessments. Therefore, in order to guarantee an optimal result, consistency tests become crucial. Normalization is the process of adjusting numbers for precise weight computations based on the results of these comparisons. After that, weights are allocated to the criterion and sub-criteria that make up the decision components. Lastly, all of the factors are combined into a final conclusion by combining the weights assigned to the decision components.

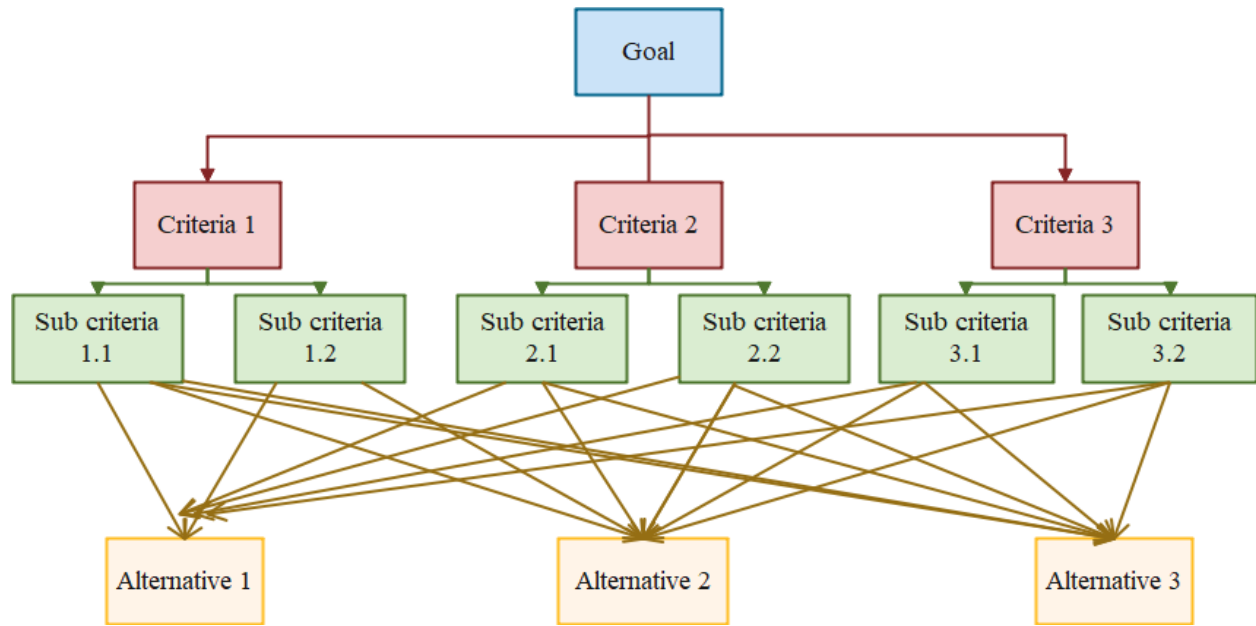


Figure 2- 5: Hierarchical Tree; Source: (Anna, 2021)

When creating decisions, it takes into account human judgement, experience, perception, and thoughts. It is a simple MCDM technique that makes use of pairwise comparisons and hierarchy. Prior to constructing ranking, it computes the consistency index to guarantee consistency. Other MCDM techniques, such as weighted product (WP) and simple additive weighing (SAW), rely on a weighted average approach but do not have any internal consistency checks. Although AHP is easy to apply, its higher effort and time requirements make it less viable in complicated scenarios with many criteria and choices (Hadikurniawati, 2018). The scale created by Saaty, as shown in Table 2-9, is used when referring to the importance level scale.

Table 2- 9: The scale of each level of importance

No.	Description	AHP scale
1	Extreme preference	9
2	Very strong preference	7
3	Strong Preference	5
4	Medium Preference	3
5	Same Preference	1
6	Medium lower	1/3
7	Strong lower	1/5

No.	Description	AHP scale
8	Very strong lower	1/7
9	Extreme lower preference	1/9

Source: (Dedi, 2021)

2.6.1. Application of AHP in Contractor Selection

AHP is frequently utilized in many different domains, including the ones listed below, for decision-making processes (Siraj, 2021).

1. Choice- the process of choosing one option from a range of options, typically when there are several different factors to consider.
2. Ranking- Sorting a list of options from most to least favorable.
3. Prioritization- evaluating each member of a group of options according to their relative quality rather than picking one or just ranking them.
4. Resource allocation- Distributing resources among several options.
5. Benchmarking- Comparing internal processes to those of other top-performing companies.
6. Quality management- addressing the multifaceted nature of quality and its enhancement.
7. Conflict Resolution- resolving conflict between parties who don't seem to have the same objectives or viewpoints.

2.6.2. Advantage of AHP

The decision-maker's quantitative pairwise comparisons are understandable and straightforward since they only consider two factors at a time and make it simple to assess each preference's intensity. The decision-maker determines the verbal intensity of importance and uses Saaty's scale to determine the appropriate numerical degree for the verbal preference. The method's establishment of the hierarchical structure within the first phase of the decision-making process is a big advantage. This adds to a more thorough grasp of the problem as a whole by clarifying the issue and making its component pieces easier to understand. It is feasible to determine whether the model has incorporated all significant facets of the issue.

AHP can be applied to several kinds of criteria. As a result, the approach can integrate requirements that have been specified both orally and mathematically without the need for further adjustments.

Verification of the decision-makers judgements' consistency is provided by the approach. The benefit of consistency is that, while complete consistency isn't always achievable, a certain amount of variation is also tolerated. It is feasible to reconsider each individual comparison in the event that the matrix exhibits a significant disagreement. Better concentration and the ability to locate new information during the reassessment allow the decision-maker to potentially determine a different intensity of relevance. The wide range of applications available to the AHP approach is another of its advantages. The approach, for instance, can also be applied to situations involving risks.

(Linh, 2019) Include in his study that AHP has many benefits, including its capacity to integrate quantitative and qualitative data utilizing monetary and non-monetary units, which allows it to take into account a greater variety of criteria even in circumstances where quantification is challenging or impossible. It can also be relatively transparent and easy to use, which reduces costs and saves time. Expert judgement can be applied quite effectively, including several stakeholders and relying from both academic and local knowledge sources.

2.7. Empirical Review

For construction projects to be completed successfully, choosing a contractor's competencies throughout the tender review process is essential. Several scholars have established a number of characteristics that are used to assess a contractor's competency. Different selection criteria by numerous researchers for contractors in tender evaluations are shown in Table 2-10, which is based on an extensive review of empirical research.

Table 2- 10: Criteria for Contractor Selection

Item no.	Criteria for Contractor Selection During Tender Evaluation	Methodology used	Reference
1	Financial stability, Background of the company, technical capacity, Cost, performance, Standard of quality, Occupational health and safety, Time performance, Management capability, Failed contract, Progress of work, Human resource management, Level of technology	AHP, Fuzzy sets, QFD, ANP, COPRAS,	(Topcu, 2004), (Palaneeswaran E. &., 2001), , (Jafari, 2013), (Cheng E. W., 2004), (Kaklauskas, 2006), (Nieto-Morote, 2012), (Darvish, 2009), (Zavadskas E. K., 2008), (Turskis, 2008), (Banaitiene, 2006)
2	Relationship with client, Relationship with sub-contractors, Fraudulent activity, Competitiveness	AHP, ANP, Fuzzy set Theory,	(Topcu, 2004) (Cheng E. W., 2004), (Vahdani, 2013), (Banaitiene, 2006)
3	Financial standing, technical ability, Management Capability, Health and safety, Reputation	Fuzzy Set Theory, AHP	(Plebankiewicz, 2009), (Raju, 2017), (Sanjana Patil1, 2020), (Afolayan, 2018)
4	Financial standing, technical; ability, management capability, Quality, safety, senior management, tenure with firm, division of responsibility, current project/backlog, including number, size and location of projects	Quantitative Methodology	(Dwarika, 2014)
5	Responsiveness, Meeting deadlines, correctness and valid information, obeying the law and complying with local government regulations, standards and bylaws, quality , safety, resource	Fuzzy set theory	(Palaneeswaran E. &., 2001)

Item no.	Criteria for Contractor Selection During Tender Evaluation	Methodology used	Reference
	(financial, machinery, plant and equipment, human resource), experience		
6	Cost, time, performance and qualification, quality management and design alternates.	Best Value	(Scott, Molenaar, Gransberg, & Smith, 2006)
7	Construction time, quality of performed projects, bid estimates and communication with stakeholders.	Questionnaire	(Turskis, 2008)
8	Design, Cost, Planning, Risk, Regulation, Materials, constructability, Geotechnical Knowledge, Site planning and Preparation and HSE	Literature Review and Semi structured interview	(Nadina Memića, 2022)
9	Financial soundness, Experience and past performance, personal capability, quality, safety, management capabilities, Equipment capability, Relationship, Geographic familiarity, Miscellaneous criteria	Systematic Literature Review, Content Analysis	(Khoso Y. , 2020)
10	Tender cost, technical competence, past performance, managerial, financial strength and credibility, health and safety aspects, lowest price offer.	TOPSIS	(Zavadskas M. A., 2016)
11	Political consideration	Comprehensive Literature Review, Content Analysis	(Rashid i. M., 2017)
12	Environmental measures	TOPSIS	(Alptekin, 2017), (Rashid i. M., 2017)

Item no.	Criteria for Contractor Selection During Tender Evaluation	Methodology used	Reference
13	Proper planning	TOPSIS, Quantitative Methodology	(Alptekin, 2017) (Maqsoom A. B., 2020)
14	Project location	Factor Analysis	(Sidik, 2020)
15	Project duration/time of completion	Mixed method research methodology, Factor analysis Comprehensive literature review, Content analysis	(Tarawneh, 2004), (Sidik, 2020), (Rashid i. M., 2017)
16	Quality compliance records	TOPSIS, Mixed Research Methodology, Factor Analysis, Quantitative Methodology	(Tarawneh, 2004), (Marzouk M. E., 2013), (Sidik, 2020), (Alptekin, 2017) (Maqsoom A. B., 2020)
17	Competitive tender/bid price	TOPSIS, Quantitative Methodology	(Tarawneh, 2004), (Marzouk M. E., 2013), (Sidik, 2020), (Alptekin, 2017), (Manideepak, 2009)
18	The reputation of the contractor	Mixed Research Methodology	(Salama, 2006), (Marzouk M. E., 2013), (Manideepak, 2009)
19	Size in relation to project size	Quantitative Methodology	(Tarawneh, 2004)

From the above table, most of the selection criteria that are included in selecting competent contractors are financial stability, technical proficiency, management competency, health, and safety. Again, various studies proposed different contractor selection criteria. For instance, a study done by (PCC, 2012) demonstrated that technology, quality, function, management, commercial terms, prior performance, price, and financial goals are major factors that are used in the selection of contractors. Adhering to an organized approach enhances the assessment process significantly, which raises the possibility that the project will fulfil its potential success criteria.

Evaluating contractors and selecting the best bidders requires a strong foundation of knowledge and expertise to ensure that the chosen contractor can finish the project in compliance with the owner's standards. Many researches argue that past performance and experience should be the number one criterion in contractor selection process, (Brunjes, 2020), (Chen, 2021), (Mehrabani, 2020) , (Cheaitou A, 2019), (Birjandi, 2019), (Zhao L, 2020), (Afshar, 2017), (Rao, 2018), (Tomczak, 2018),and (Maqsoom A. B., 2019).

Further, (Cheaitou A, 2019), (Birjandi, 2019), (Zhao L, 2020) , (Safa, 2016), (Hasnain M. T., 2018), (Alptekin, 2017), (Afshar, 2017), (Rao, 2018), (Tomczak, 2018), (Maqsoom A. B., 2019) , (Ebrahimi A, 2016), (Taylan O, 2018), and (Chen, 2021) asserts that personal capability is the second and financial soundness is the third contractor selection criteria next to past performance and personal capability competency during tender evaluation.

In addition, (Birjandi, 2019), (Huo, 2015), (Polat, 2016) (Hosseini, 2015) (Alhumaidi, 2015) (Polat, 2016) (Safa, 2016), (Taylan O, 2018), and (Chen, 2021) found that contractor's health and safety implementation is the fourth criteria in selection of contractors. In addition (Chen, 2021) (Birjandi, 2019), (Yang, 2016), (Hasnain M. T., 2018) (Afshar, 2017), (Rao, 2018) (Maqsoom A. B., 2019), and (Taylan O, 2018) , emphasized management capability of contractor should be considered during contractor selection.

Numerous studies have created diverse systems with various standards of evaluation to help owners choose the right contractors. The primary benefit of these techniques and assessment frameworks is that they offer a methodical and impartial procurement approach that considers a variety of elements other than the bid price. When evaluating contractors, a multi-criteria approach

can help address several issues related to their technical and economic elements, quality standards, historical performance, and other tangible and intangible attributes.

A study by (Habib, 2024) develops a multiple contractor selection criterion and selection model by integrating the Delphi and Fuzzy AHP methodologies. Six key criteria categories, including bid pricing, financial capacity, technical capacity, managerial capacity, experience and reputation, and health, safety, and environment, were used to finalize the thirty sub-criteria. The survey also showed that staff experience is the most crucial selection criterion out of all the sub-criteria, bid price, and projects finished on schedule and within budget.

In Ethiopia, (Siferaw, 2019) investigate the most important criteria in construction contractor selection and develop decision support model using fuzzy analytical hierarchy process (FAHP). Thirty-two selection criteria were discovered and grouped into 8 major criteria. On the other hand, (Iman, 2023) studied contractor selection criteria using AHP and based on the result obtained the study found that pre-qualification criteria, project management, technical and commercial criterion are the major criteria used to select contractors. The criterion value is consistent with the value of 0.002, ratio index (RI) is 0.99.

The best option for selecting contractors using the multi-criteria decision FUZZY-AHP method was offered by (Dedi, 2021). The process involves a tender committee made up of five appointed employees and fourteen experts who are registered contractors with the company and have demonstrated good performance. According to the study's findings, the following factors and weights can be used to choose a contractor: 35% of the bid price, 22% of the technical ability, 13% of the financial ability, 11% of reputation, 10% of management ability, and 9% of safety management. The result has a consistency ratio that is less than 10%.

In addition, (Doloi, 2009) made an attempt to comprehend the preventive qualification standards and how well contractors performed on projects in relation to them. The technical criteria components of forty-three distinct criteria were identified using a thorough study process. A systematic questionnaire survey was utilized to assess the relative importance and effects of the attributes. The factor analysis revealed seven elements that were essential to the contractors' success. The findings showed that contractors' performance in terms of time, cost, and quality

success is significantly influenced by technical expertise, prior performance, and length of business, work methodologies, and working capital.

A study done by (Tam, 2014) employed an AHP vendor selection system for the telecommunication system, which is a complicated multi-criterion, multi-person decision problem. They discovered that AHP was quite helpful in bringing together a number of decision-makers with disparate and competing goals in order to reach a consensus. As a result, choosing a provider is quicker and the decision-making process is more methodical. Furthermore, in the development of modular software products, (Jung, 2011) presented optimization methods for choosing the optimal software product from among the choices of each module. AHP assigns a weight to the module based on how frequently it is accessed.

In a similar vein, (Harbi, 2003) described an analytical hierarchy procedure for selecting contractors. Its goal is to choose the most qualified contractor. There are four steps in the study. Establishing a hierarchical structure with a minimum of three levels is the initial stage. The problem's general goals and focal point are represented by the first level. The criteria for assessing the alternatives are included in the second level, and the sub-criteria are listed in the third level. A set of questions was created in order to compare the criteria in pairs. The contractor chosen was the one with the highest Eigen vector, or priority.

A study by, (Rashid I. S., 2018) looked at a set of standards for choosing contractors for public sector building projects in Malaysia. Following a preliminary assessment of the content analysis, 43 selection criteria were identified and further categorized into seven groups. The results of the investigation showed that each of the 43 selection factors was significant when selecting contractors. The application of the analytical hierarchy process (AHP) as a decision-support model for contractor selection was studied by (Balubaid, 2015). The study tests an AHP-based model under a hypothetical, typical contractor evaluation scenario. Six prerequisites for the primary objective were evaluated. The model specifies the criteria that are used to choose contractors, and a questionnaire is used to gauge how important each criterion is. The best candidate is the one who receives the highest score. Each candidate's total score is rated in accordance with each criterion to make comparisons.

Additionally, (Nasab, 2015) Conducted research and presented a fuzzy multiple criterion model for contractor prequalification as a means of selecting contractors. An analysis of the literature yielded six criteria and 22 sub-criteria for evaluating contractor prequalification. These were combined with triangular fuzzy numbers and the analytical hierarchy process (AHP) to create a fuzzy evaluation model that ranked the relative importance of the prequalification criteria for contractors. Next, the contractors are rated according to how closely they resemble the ideal solution using the fuzzy TOPSIS algorithm. The method's outcomes demonstrated that a contractor's expertise, technical skill, and financial stability were the most important considerations when selecting one. (Idrus, 2011) Evaluated and rated the parameters used by clients in Malaysia for the selection of major contractors and assessed the relative relevance as assessed by seasoned professionals operating in the construction business. A sample size of 150 specialists in the building business was selected for the questionnaire survey. The data analysis employed severity index and frequency analysis.

2.8. Research Gap

This section emphasizes the research gaps in the body of current knowledge for subsequent investigations by analyzing the work that has been done and the areas that still need to be investigated, this section identifies.

Table 2- 11: Knowledge Gaps Found in Review of Literature

Title	Author	Methodology Used	Finding of the Study	Knowledge Gap	Focus of the Current Study
Development Of Building Contractor Selection Decision Making Model Using Analytical Network Process: A Case of Amhara Region	(Mitiku, 2022)	Questionnaire	ANP was utilized to examine the gathered data. The main criteria were weighed, a decision support model was created, and a real project (case study) was used to assess the model's validity. According to the study, the three most crucial selection criteria are experience, technical capability, and management capability.	The author employs a different kind of MCDM technique. The population he uses are mainly building contractors. Moreover, the study focuses on a specific region. The sample he took is too small.	This study used another type of MCDM technique by including larger sample size on road contractors.
Development of FUZZY Decision Model for Ethiopian Construction contractors' selection	(Bishaw, 2019)	Questionnaire Interview	The study's main criteria for choosing contractors are, according to the results, technical capability, financial soundness, bid value, and management capacity.	The study analyzes the data using a distinct type of MCDM methodology. Furthermore, the sample size he used is modest, despite the fact that the study covers the entire country.	The study uses another kind of approach with a larger sample size.

Title	Author	Methodology Used	Finding of the Study	Knowledge Gap	Focus of the Current Study
Assessment of contractors' qualification criteria in Ethiopia federal road project tender practices	(Dametachew, 2015)	Desk study Case study	According to the project's findings, federal road projects in Ethiopia do not apply uniform qualification criteria that take the project's size into account. The results showed that, even within the same project category, the technical capacity required for contractors differed. Furthermore, the results showed that the ERA's yearly turnover and cash flow requirements did not meet PPA and World Bank standards.	Even though the study's main objective is to evaluate the contractors' qualifying requirements in ERA, the author attempts to evaluate the quantifiable criteria (such as annual turnover) but doesn't give each selection criteria weight.	The current analysis demonstrates major contractor selection criteria using the AHP technique. And using the decision support model, a real project was used to verify the validity of the model.
Assessment of Tender Evaluation System for Public Building Project Works in Ethiopia	(WUBE, 2019)	Questionnaire Case study	The study's findings indicate that the most competitive evaluation method is employed for federal public projects. Road projects that were judged according to the performance of the lowest bidder were not considered satisfactory. The author suggests that clients should adopt other methods that will go parallel with construction law.	The study's primary focus is on public construction projects. The study's conclusions are only applicable to building projects. Even though the research focuses on tender evaluation assessment, it examines the specific objectives using a different approach.	The purpose of this study is to elucidate the primary contractor selection criteria by means of the MCDM methodology.

Title	Author	Methodology Used	Finding of the Study	Knowledge Gap	Focus of the Current Study
Assessment of Bidders qualification Criteria in Tender Evaluation Process, A case of Jimma City Public Building Projects	(Zerfu, 2021)	Questionnaire	According to the study, the most important selection criteria were a solid financial history, a list of subcontractors, registration in the Ethiopian construction industry, and previous project performance.	Though this study identifies contractor selection criteria in construction projects, the methodology used to identify the selection criteria is different from the one that is used in this study. Further, the study doesn't show the validity of the aforementioned criteria by taking a case.	The MCDM technique was used in the study to develop the contractor selection criteria, and a real-world case study was used to verify the model's validity.
An integrated Delphi and Fuzzy AHP model for contractor selection a case of Addis Ababa Design and construction works Bureau	(Mitikie, 2024)	Questionnaire	The study, which combines the Delphi and fuzzy AHP methodologies, concludes that the most crucial selection criteria are bid price, projects finished on schedule and budget, familiarity with identical types and sizes of projects, and staff qualifications, quantity, and competence	The study selects contractors using a different kind of MCDM technique; nevertheless, it does not employ a case study to demonstrate the model's validity.	The AHP decision technique was employed in the study to choose an appropriate contractor. In addition, the study employs real-world examples to demonstrate its validity.

In general, this research primarily focused on assessing contractors during tender evaluation by means of the AHP decision technique, which is a form of multi criteria decision method. AHP's structured decision-making framework allows for the simplification of complex contractor selection criteria into a hierarchical model, enabling a comprehensive evaluation of both qualitative and quantitative factors. By integrating subjective judgments into a numerical format and providing a consistency ratio to measure the reliability of decisions, AHP enhances the overall decision-making process. Its flexibility allows for accommodation of changing project requirements and facilitates the simultaneous comparison of multiple alternatives, ensuring a balanced assessment. Moreover, AHP promotes consensus building among stakeholders, making the decision more collaborative and accepted.

Although other advanced methods can handle complex interdependencies or uncertain data, they often introduce additional computational demands and may complicate the decision-making process. For this study, the contractor selection criteria are relatively measurable and structured, making AHP an effective balance between practicality and simplicity. Additionally, AHP's framework allows for the quantification of qualitative judgments, which is critical in evaluating subjective factors.

In general, this study validates the AHP model with real-world examples from road projects, offering a thorough analysis of contractor selection criteria. It addresses gaps identified in previous research, which often highlight quantifiable parameters without assigning weights to selection criteria or lack case study validation. By employing AHP, this research aims to provide a comprehensive examination of contractor selection criteria, contributing to more effective decision-making in the tendering process.

CHAPTER THREE: MATERIALS AND METHODS

3.1. Introduction

This chapter provides an overview of the research approach that was employed. In order to accomplish the set of objectives, this chapter outlines the processes and methodology that were employed in the study. These comprise a description of the study area, a research approach outlining the actual procedures and methods to be employed in the analysis, the establishment of the research design, the study population, sampling techniques, methods for gathering data that explain how the data were gathered and used in accordance with the procedures covered in the methods section, data source, data analysis method, model specification and its pretesting process to ensure validity and reliability, procedures for data collection and finally method for analysis were included in the following section.

3.2. Study Area

As previously discussed in chapter one of this research, the Federal Democratic Republic of Ethiopia's Ethiopian Roads Administration is a state organization tasked with the development and management of federal roadways; as such, it enters into contracts with various domestic and foreign construction companies to design and build road projects. The Office of Directors, the Construction Projects Management Programme (CPM DDG), the Project Development Directorate (PD DDG), the Road Asset Management (RAM DDG), and the Corporate Services Deputy Directorate (CS DDG) are the five deputy director directorates that make up ERA's organizational structure, as illustrated in Figure 3-1.

The bid evaluation committee at the Ethiopian Roads Administration (ERA) is structured to ensure a thorough and transparent evaluation of bids for construction projects. Members of this committee are selected from Engineering Procurement Directorate (EPD) under the Office of the Project Development Deputy Directorate General (DDG). This directorate is responsible for the selection of the most competent and competitive contractors, thus playing a critical role in the procurement process. In order to assess bids, the Procurement Endorsement Committee (PEC), appointed by the Director General (DG), collaborates with the Technical Analysis Committee (TAC). The PEC chairman nominates TAC members, typically three to five qualified individuals depending on the size and complexity of the assignment.

TAC members are selected using a randomization software which developed by the ICT directorate. Selected committee members must have the capability to assess both the technical and financial aspects of the assignment and should have prior evaluation experience. The TAC confirms that its members have no conflict of interest, understand the rating and scoring system, have been provided with evaluation worksheets and agree on the approach to evaluating the proposals.

The selection and preparation of TAC members comprises the following key steps:

1. **Candidate listing:** Different Engineering related directorates will select and list of candidates for tender evaluation to Human Resource Development & Management Directorate (HRDD)
2. **Minimum Qualifications and Trainings:** TAC members should be, at a minimum, senior Engineers with relevant technical experience and training, as specified below:
 - a) EPD prepares training manual and material in collaboration with HRDD
 - b) EPD trains the selected candidates in collaboration with HRDD
 - c) The HRDD sends a list of candidates who have completed the training to the engineering procurement unit.
3. **Uploading candidates:** The PEC secretary & ICT directorate upload the names of trained candidates in to the randomization software.
4. **Preparing Assignment:** The PEC secretary then prepares TAC assignment through the software, with the PEC chairperson approving the assignments and issuing assignment letters to all TAC members.
5. **Assignment process:** The PEC secretary, in coordination with the EPD, issues the assignment letters and the relevant tender proposal to the assigned TAC members.
6. **Updating the Approved List:** The list of approved TAC members is updated every six months.

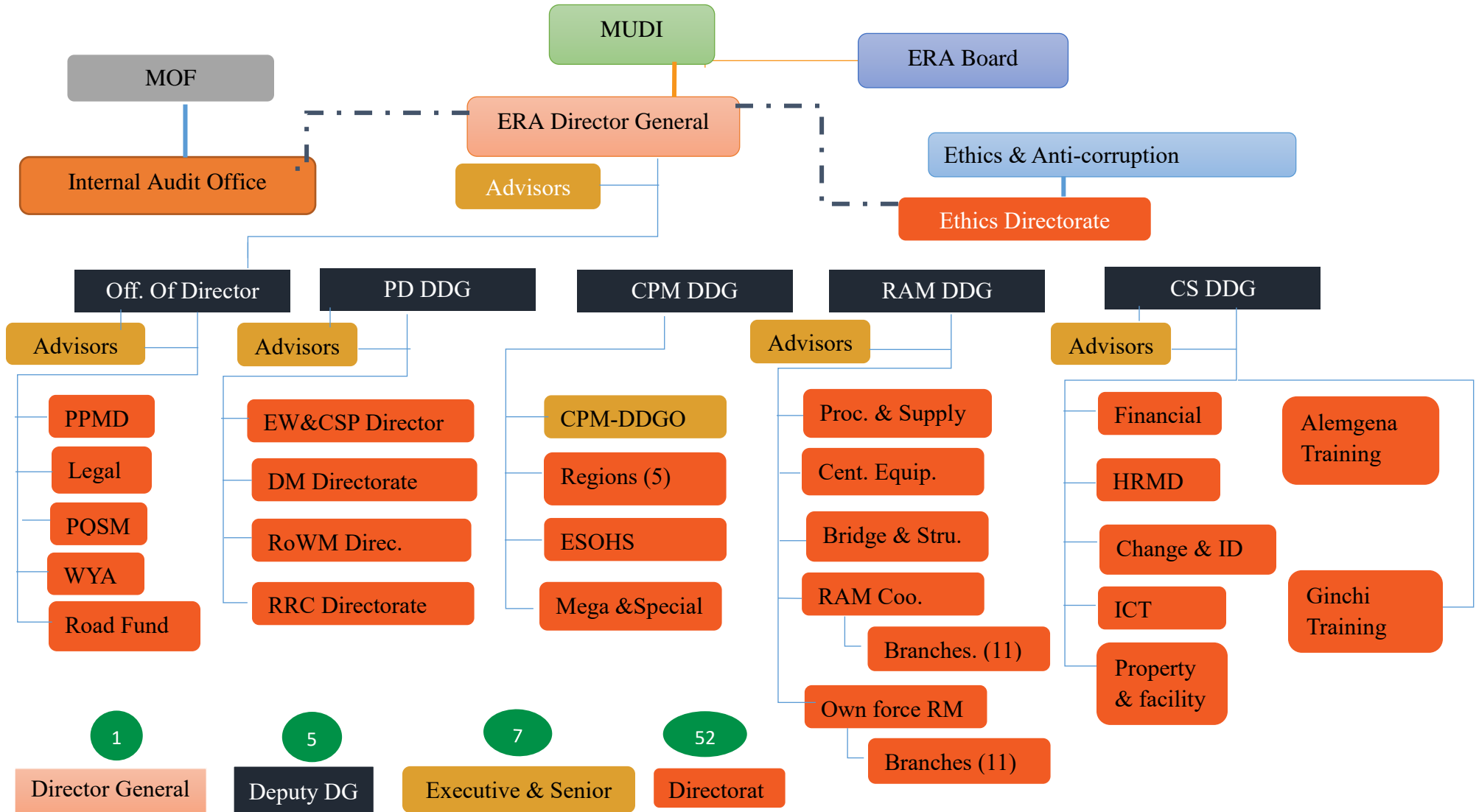


Figure 3- 1: ERA Revised Organizational Structure; Source: (ERA)

3.3. Research Design

"Research" refers to the methodical process of gathering data and understanding about a certain topic or issue. (Shanti, 2017) Stated in his study that research design is the process of collecting, assessing, analyzing, and reporting data for research investigations. It is the primary strategy for tying the conceptual research challenges to relevant (and doable) actual research. The main goal of research design is to provide a general process for rationally and consistently integrating the various study components. It comprises the strategy for gathering, measuring, and analyzing data. A flexible research design that allows for the examination of numerous aspects of a problem is considered useful in situations where the goal of the research study is evident (Shanti, 2017).

Hence, this research has chosen two research design approaches from among the various types of research designs that are appropriate for various study types and research questions. The first research design is the descriptive research design, which aids in determining and prioritizing the selection criteria and serves as a foundation for additional analysis using AHP. The second research design that is used for this study is case study research design method which aid to broaden the understanding and findings behind the notion of analytical hierarchy process.

3.4. Research Methodology

Research methodology describes how the goals of the research were developed and carried out throughout the entire investigation. Figure 3-2 provides a summary of the total study methodology that is used in the current study. The first step in the research process was identifying the problem, which was accomplished through an unstructured survey of the literature and informal conversations with administration specialists. After the research area was determined, a conceptual and contextual literature analysis was conducted to gain a thorough grasp of the subject matter and set objectives that centered on consequences and the creation of a substitute bidding system. Books, research articles, documents, and internet resources were all included in the review.

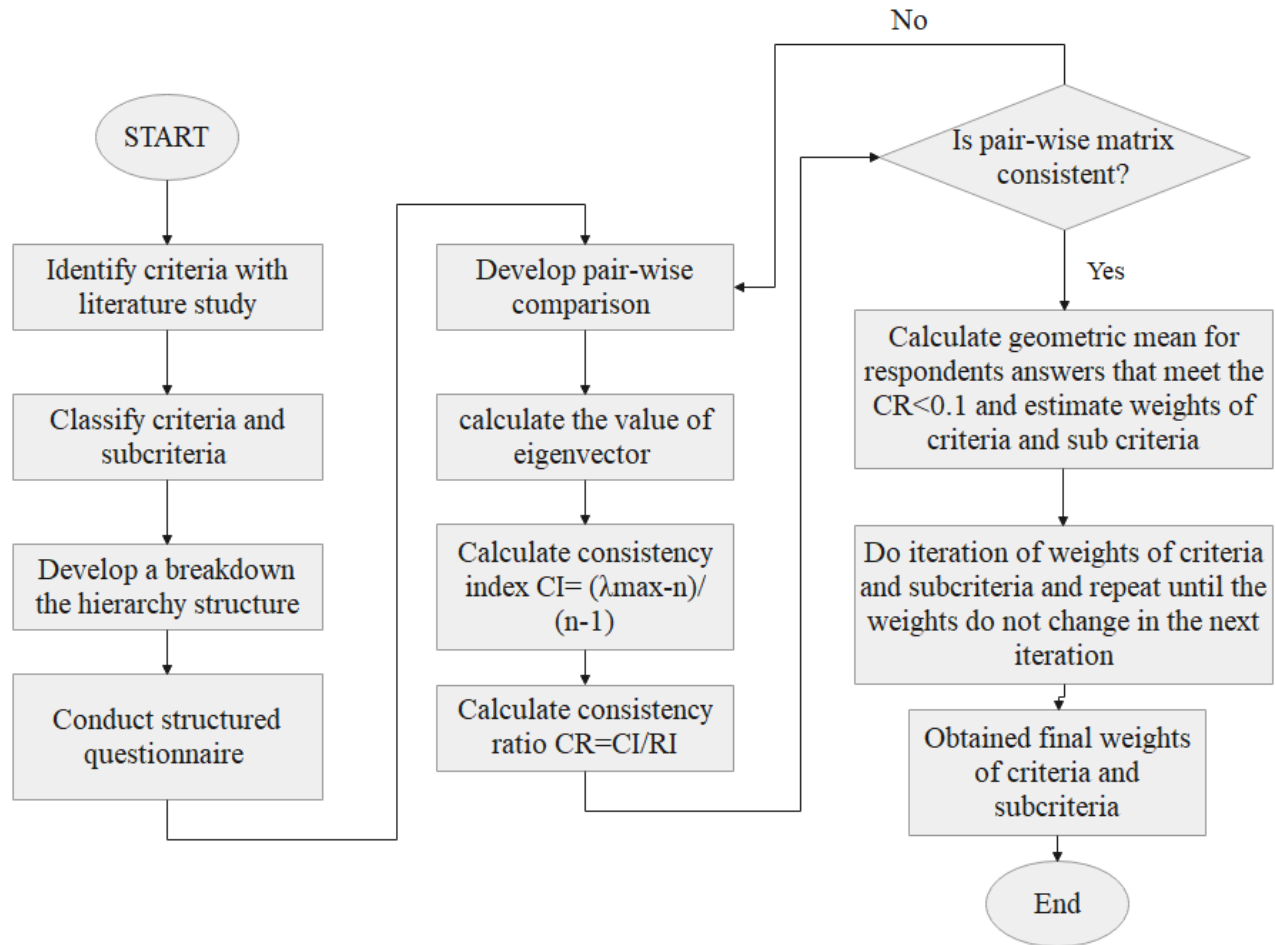


Figure 3- 2: Research Methodology

3.5. Research Approach

There are two fundamental research approaches, qualitative and quantitative approaches these two strategies will be integrated into comprehensive study designs in order to increase research completeness and report a number of methodological and epistemological critiques. Thus, both qualitative and quantitative research approaches are used for this specific study.

3.5.1. Qualitative Approach

It describes a situation in its natural setting. It is an individualized perspective on life as it is experienced and an attempt to make sense of the behavior under study. Additionally, a qualitative method could explain how to better understand the research and its context, explain why certain things happen and how they relate to one another, analyze the efficacy of assessments, and aid in the creation of theories or plans. Researchers suggest a variety of data collection techniques,

including observation, document analysis, audiovisual materials, and interviews. For this specific research, analysis of documents and discussion with the relevant stakeholders are used as qualitative research approach.

3.5.2. Quantitative Approach

Quantitative research involves the collection of data in order to quantify and statistically analyze information in order to establish various knowledge assertions (William, 2011). The primary positivist paradigm of quantitative methods is investigating the relationship between variables in order to assess objective hypotheses. These could usually be assessed using tools, allowing data numbers to be sorted using statistical procedures. Subsequently, the comprehensive report will be composed of an introduction, theory and literature review, methodology, findings, and discussion (Creswell, 2008).

In summary, the researcher employed a mixed research technique, which combines qualitative and quantitative research methods, to answer research questions and accomplish the study's goal. As a qualitative approach, data from a case study and document analysis was developed to highlight significance, experiences, opinions, perspectives, views, and opinion towards the objects as descriptive, non-numerical, and word-use that applies reasoning management, whereas a quantitative research approach was used to determine quantitative analysis and to generate data in a suitable quantitative format.

Table 3- 1: Research Question

No.	Research Questions	Research Approach	Data Collection Instrument
1	What are the major contractor selection criteria during tender evaluation	Qualitative	Questionnaire & Literature Review
2	What are the weights of the selection criteria?	Quantitative	Questionnaire
3	How to develop a theoretical model that represent the appropriate contractor selection?	Quantitative	Questionnaire

3.6. Target Population

The term "target population" describes a set of people or things that a researcher is interested in examining due to specific traits. The study's target group are road contractors who were supervised by the Ethiopian Road Administration, professional engineers, project managers, road project consultants, tender assessment committees, and procurement specialists. The decision to focus on these stakeholders as the target population for this research was influenced by several practical considerations. Firstly, due to the limited time available for conducting this study, the researcher prioritized stakeholders directly engaged in the broader lifecycle of construction project implementation, where the impact of contractor selection criteria can be observed in practice. Further, the inclusion of these population ensures a holistic evaluation that bridges the gap between theoretical selection frameworks and their practical implications.

Logistical challenges, including the availability of representatives from regulatory bodies for data collection within the given timeline, further necessitated the narrowing of the target population. Hence, this research does not discount the valuable perspectives of regulatory bodies but reflects a strategic decision to align the study's scope with the available resources and its core objectives. Future studies could incorporate perspectives from additional stakeholders, such as regulatory bodies, to complement these findings and provide a broader framework for analysis.

The construction works regulatory authority in 2024 reports that there are 3119 contractors, ranging in grade from 1 to 9. Furthermore, as shown in Figure 3-3, data from ERA revealed that 48 contractors in total are working on federal road projects that are now being built by both domestic and international contractors. These contractors are participating in the construction of new and upgraded road projects. The figure mentioned below excludes contractors who have a contract with ERA and participate in road maintenance and restoration projects; and contractors who are involved in projects that has been suspended because of ongoing political unrest in the project region.

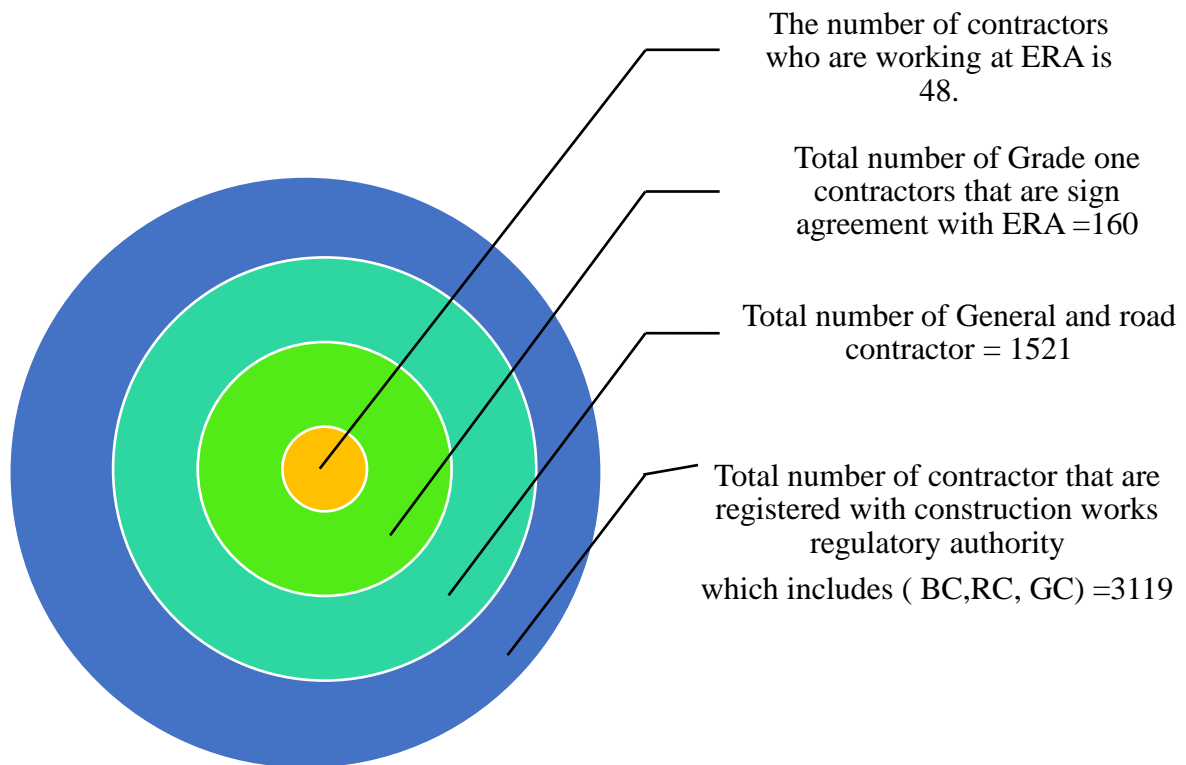


Figure 3- 3: Target Population

Furthermore, data from an internal ERA report indicated that, currently a total of 65 main consultants are working on construction supervision of road projects. This number exclude design consultants, individual consultants, and consultants involved in non-consultancy services and technical assistance.

3.7. Sampling and Sample Selection Techniques

Sampling is selecting representative population units for a study or research effort. A sample is a tiny subset of the population that has been chosen for examination and observation. Therefore, for the results to be generalized to represent the population, the sample that was chosen must share characteristics with the population being studied (Jabbar, 2017) . Sample techniques are classified into two categories: probability sampling and non-probability sampling. In this particular study, the researcher utilizes a sort of non-probability sampling method called purposive sampling to select contractors and consultants, and a probability sampling technique to select the employer.

3.7.1. Sample Size Distributions

For selecting a representative sample from the total population, a statistical equation was employed to determine the sample size for contractors and consultants. The sample size for different categories of respondents was calculated using Equation 3.1 as used by (Shash, 1993).

$$n = \frac{n'}{[1 + (\frac{n'}{N})]} \dots \dots \dots \text{[Equation 3.1]}$$

Where:

N = total number of populations

n = sample size from finite population

n' = sample size for infinite population; can be calculated by using desired confidence level, margin of error and estimated proportion (p). Equation 3.2 was used to calculate the sample size for finite population

$$n' = \frac{z^2 * p * (1 - p)}{e^2} \dots \dots \dots \text{[Equation 3.2]}$$

Where:

Z = Z-value corresponding to the desired confidence level (for 95% confidence $Z=1.96$)

P = Estimated proportion of the population; 0.5

e = Margin of error; 5%

Therefore n' for a 95% confidence level, 5% margin of error and $p = 0.5$

$$n' = \frac{1.96^2 * 0.5 * (1 - 0.5)}{0.05^2} = 384.16 \approx 384$$

Once, n' is calculated the next step will be determining the sample size for finite population using Equation 3.1.

$$n = \frac{384}{[1 + (\frac{384}{113})]} = 87.33 \approx 87$$

Out of the calculated samples, the contractors account for about 42.48% (48/113) of the total samples, i.e., $87 \times 0.4248 = 36.95575 \approx 37$. The remaining 57.52%, which is 50 ($87 \times 65/113$) questionnaires, are distributed to the consultants. Further, since the client is ERA, there is no need to calculate the sample size, and randomly, 30 engineers who are working on contract administration and directorate levels in each contract administration program are selected.

The time allotted for conducting the research, the money available for the study, and the reliability of the respondents were taken into consideration when selecting the samples. Consequently, the survey included 1 employer, 37 contractors, and 50 consultants as participants.

3.8. Source of Data

As mentioned by (Etikan, 2016), study is strengthened and given legitimacy by the use of multiple data sources. Thus, the researcher used a variety of primary and secondary data sources. Questionnaires were used to gather primary data from respondents; published books, the internet (web pages), articles, documents, and standards were used to gather secondary data. In addition, the secondary sources of data used in this study came primarily from internal and external sources. Bid documents, financial data, and reports are examples of internal secondary sources that are used by the study.

3.9. Data Collection Instruments

The following data collection instruments are used by the study:

3.9.1. Questionnaires

Primarily, a questionnaire is utilized to gather quantitative primary data; they are closed-ended questions that compare the responses to each item and require less time and energy. Once the data is gathered, the criteria are ranked in order of significance and prioritized for use in the AHP model. Experts in project management, contract procurement, contractor evaluation, consultants, and contractors were among those who received the questionnaire. Quantitative data can be consistently collected via a questionnaire, ensuring internal coherence and uniformity for evaluation.

3.9.2. Questionnaire Development

The research objectives and the results of the literature review were taken into consideration when designing the questionnaires. A questionnaire was used in two rounds for the current investigation. A synopsis of the extensive literature review, which highlighted many criteria, served as the basis for the creation of the first-round questionnaire. The results of the frequency responses to the first round's questionnaire served as the basis for designing the second round's questionnaire. Experts were given a brief overview of AHP models for contractor selection criteria prior to the questionnaires being distributed. Based on their understanding of the subject and level of expertise, the survey specialists were selected for the study and requested to fill out the questionnaire. The experts were asked to assess the importance of the primary criteria and any supporting criteria that were crucial for choosing a contractor in two rounds.

Hence, the first-round questionnaire contains two sections. Data on the respondent's general information or demographics are included in the first section (**Section A**). Then a list of criteria for selecting contractors is presented in the second part of the questionnaire (**Section B**). In this section respondents were asked to rank the criteria on a Likert scale. On the second round, pairwise comparisons of the criteria using the Saaty rating scale of 1–9 is included which is shown in the third section (**Section C**). The rating scale represents: 1- equal importance, 3 - considerably more importance, 5- substantially more importance, 7- very much importance, and 9- totally more importance.

3.10. Data Collection Procedure

Data collection is the process of obtaining participants and gathering information for a study (Burns & Grove, 2010). The researcher obtained approval from the university (AAiT) before beginning data collection, and the respondents were given overall information about the self-administered structured questionnaire. Senior engineers, contractors, and managing directors of construction enterprises were all surveyed using structured questionnaires. An earlier meeting was organized with the various contractors and their teams or staff to help with scheduling for data collecting. In certain instances, appointments were scheduled over the phone. A few participants received emails. This was essential to preventing any interference or disruption of the respondents' personal schedules throughout the data collection process.

3.11. Data Analysis

In order to preserve as much detail as possible, the data that was gathered via a questionnaire was categorized, sorted, and organized. Statistical methods are used to analyze the first section of the questionnaire. Data presentation, frequency determination, and coding are done using SPSS Version 21.0.1.0. Frequency tables and charts are employed in conjunction with Microsoft Excel Spreadsheets for data analysis, data summarization, and determining the quantity of replies for each category. The Analytical Hierarchy Process (AHP) analysis in this study was conducted using Super Decisions software, a specialized tool designed to support multi-criteria decision-making processes. Super Decisions offers advanced features that streamline the pairwise comparison, priority calculation, and consistency checking processes. However, it is important to note that the same analysis can also be conducted using Microsoft Excel. Excel provides a flexible and accessible platform for setting up pairwise comparison matrices, performing normalization, and calculating priority vectors, making it a practical alternative for organizations with resource constraints. Hence, Super decision software 3.2.0 is used to assess the third section of the questionnaire. The software tests the model's validity in a case study before tallying the ranks of the participating contractors and identifying the tender winner.

3.12. Case Study

Since it will enable the administration to more fully appreciate the significance of each factor in the contractor selection process, this research serves as an evaluation framework. By weighting each component with percentages from the AHP model and evaluating bids using the weighted aggregate, the methodology described here can be used to evaluate bidders. The standard procedure for case studies includes selecting a limited selection of cases that most effectively depict the subject under study. In other words, a case that most closely aligns with the genuine objectives and purposes of the study is selected, contextual investigation of a small number of circumstances or occurrences and their connections (Abduljelil, 2019).

In contrast to quantitative methodologies, case studies are more adapted to explain the specific outcomes of unique situations. This study focused on a single, actual and past road construction project that is under the ownership of the Ethiopian Road Administration. In the same way, (Mitiku, 2022), (Bishaw, 2019) & (Khalid, 2020) uses similar procedures when applying case study method

in their research. In order to create a foundational understanding of the cases and to guide the formulation of research questions, a review of the literature, reports, and procurement documents are assessed. Case studies frequently contained data that was both quantitative and qualitative in character. Following the acquisition of the sampled data needed for the project, the suggested contractor assessment model was tested and validated using the case study.

3.13. Reliability and Validity of Instruments

In the present study, attention was taken to reduce the possibility of obtaining higher errors. Therefore, tests for validity and reliability were conducted in order to determine whether these mistakes were present or not. In order to satisfy all requirements for validity and reliability, the researcher carried out the pilot and reliability testing.

3.13.1 Reliability of Instruments

Reliability is the consistency and stability of an instrument over time used for measurement. In other words, a tool's reliability is its ability to yield results that are similar when utilized in different situations (Sürücü, 2020). Various techniques are employed to ascertain the dependability of study scales. From those techniques Cronbach alpha test is one of them. The Cronbach alpha coefficient of internal consistency, which was developed by Cronbach in 1951, can be used to assess the internal consistency of an instrument. According to (Sylvester, 2023) a reliability value that gives the value of $\alpha > 0.9$ (Excellent); $\alpha > 0.8$ (Good); $\alpha > 0.7$ (Acceptable); $\alpha > 0.6$ (Questionable); $\alpha > 0.5$ (Poor) and $\alpha < 0.5$ (Unacceptable). The study therefore used the Cronbach's value that ranged between 0.7 and above to determine reliability of instruments. Summary of the α presented below in Table 3-2.

Table 3- 2: Cronbach Alpha Result

Variables	No of items	Cronbach's Alpha (α)	Internal consistency
Financial competency	5	0.777	Acceptable
Management competency	5	0.748	Acceptable
Technical Competency	7	0.935	Excellent
Past performance competency	6	0.912	Excellent

Based on the internal consistency coefficients, Table 3-2 shows that all the variables met the reliability criterion. This is because every variable met the appropriate threshold of 0.7 for assessing reliability and an appropriate cutoff point for evaluating reliability.

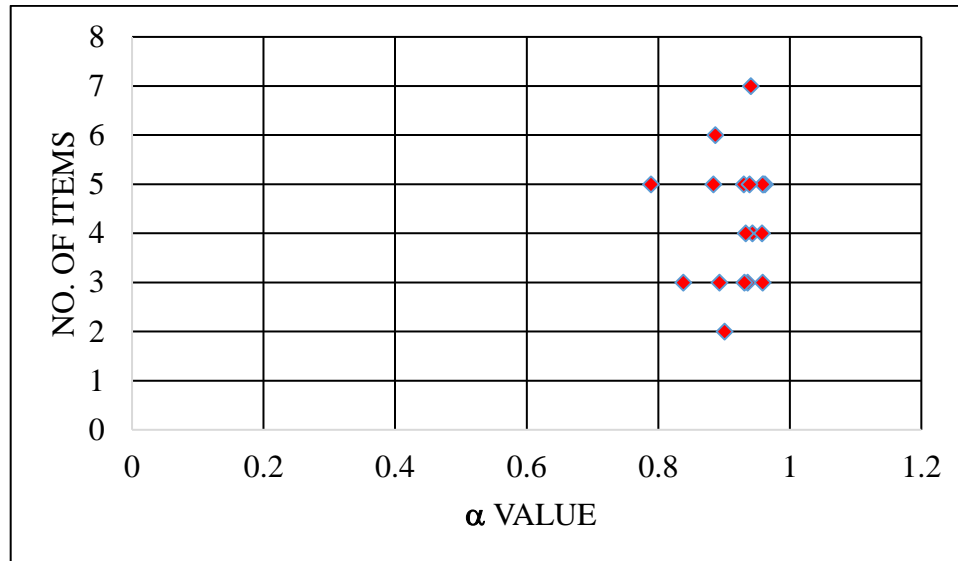


Figure 3- 4: Graphical Presentation of Cronbach Alpha Values

Figure 3-4 shows the alpha value and number of items with a sample size of 87. Each variable's alpha value is displayed on the horizontal axis, while the questionnaire's individual items are displayed on the vertical axis. Further, the graph's closely spaced data points indicate a high degree of internal reliability and consistency for different combinations of the questionnaire's contractor selection criteria.

3.13.2. Validity of Instruments

Validity refers to the degree to which a measuring tool satisfies its intended purpose and is related to whether or not it measures the trait or behavior that the tool is intended to evaluate (Sürücü, 2020). Research possesses high validity when its findings align with actual properties, attributes, and variances in the physical or social world. There are several types of validity tests, including content validity, criterion validity and construct validity.

In this study the researcher utilized content validity testing to assess whether the items in the measurement instrument or tool adequately represent the construct being measured. At the start of the research, a pilot study with five construction industry professionals was carried out using a small population sample. The pilot study suggested that the researcher reduce the number of pair-wise

comparison questions in the questionnaire in order to prevent respondents from growing weary and lowering the quality of the data. After the pilot test was conducted with a team of five construction professionals, coworkers with more and comparable expertise in the road construction industry assessed and verified the final questioner's content to assure the validity of the study. In order to ensure that the designed instruments measured the intended purposes, the final questionnaire's content and measurement scales were assessed and confirmed.

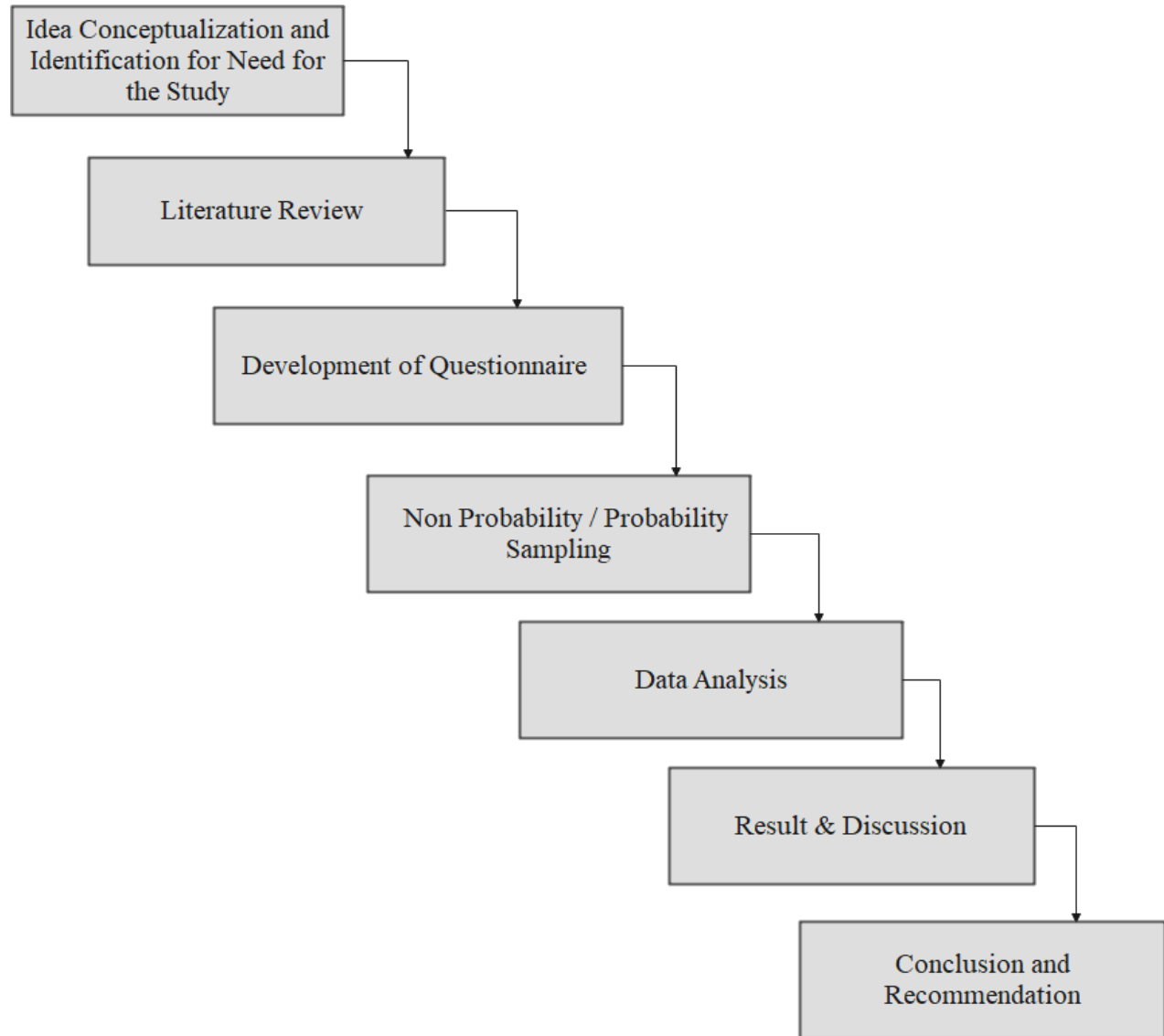


Figure 3- 5: Study Methodological Flowchart

CHAPTER FOUR: RESULTS AND DISCUSSION

The primary objective of this section is to ascertain and evaluate the results obtained from case studies and questionnaire surveys. Thematic area includes questionnaire return rates, background information about the respondents, identification of major selection criteria and AHP model development are comprised in this specific chapter. The major contractor selection criteria in road construction projects have been reviewed, and the level of significance and weight of each selection criteria using AHP have been analyzed and finally, a theoretical model has been developed to represent the selection criteria based on AHP.

4.1. Questionnaire Return Rate

The researcher distributed questionnaires to 117 respondents, of whom 30 respondents were from the client, 37 were contractors, and 50 were consultants. Of these, 87 were completed and returned, indicating a questionnaire return rate of 74.35%. It was determined that 30 questionnaires, as indicated in Table 4-1, were not returned regardless of extensive efforts on the part of the researcher to have them completed and returned. The completed questionnaires were subjected to reliability checks prior to analysis, and it was noted that one questionnaire from the contractor and one from the employer were incomplete and needed to be rejected for further analysis. Additionally, the questionnaire responses were coded for convenience of reference during the data analysis. The complete questionnaire responses and their rates are summarized in the Table 4-1.

Table 4- 1: Questionnaire Response Rate

Respondent category	Questionnaires		Percentage
	Distributed	Returned	
Employer	30	24	27.58%
Contractor	37	30	34.48 %
Consultant	50	33	37.93%
Total	117	87	74.35%

It is understood from table that consultant take 37.93 % of the total questionnaire returned, followed by contractor which is 34.48 % and then lastly by employer 27.58%. The percentage of the valid returned questionnaires is depicted in Figure 4-1.

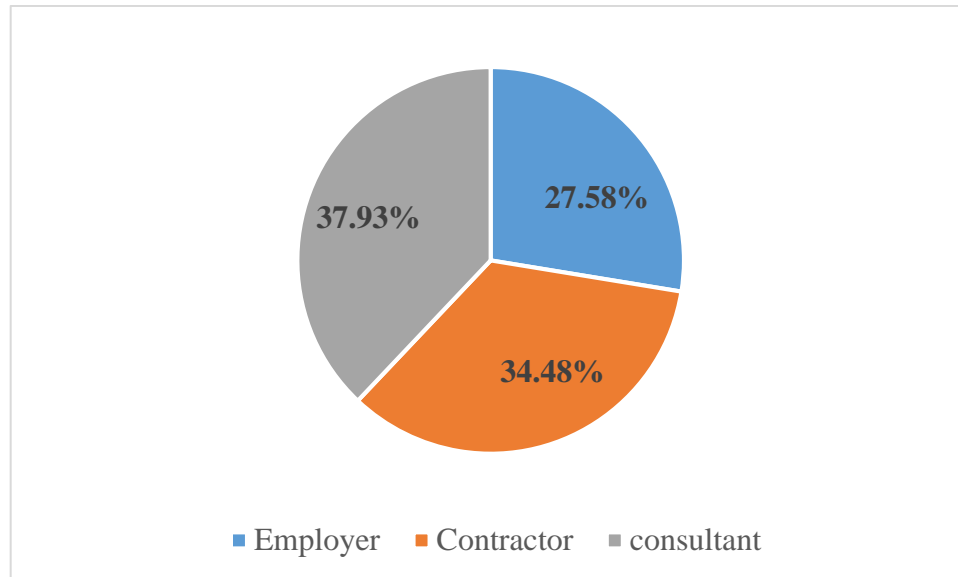


Figure 4- 1: Percentage for Valid Returned Questionnaire

4.2. Demographic Information

This section presents demographic information of respondents, the question related to the establishment year of the respondent's organization and its experience in the road sector, educational level, qualification, overall experience, experience in the road sector and experience in contract administration are asked and the summary of the responses are indicated as follows. Out of the total surveyed respondents, 44.83% of the professionals are working in an organization which have more than 15 years of establishment and of which 42.53% have work experience of more than 15 years in the road sector while, 27.58, 24.1 and 3.45% of them have work in an organization with a year of establishment of 10-15, 5-10 and less than 5 years respectively. Accordingly, 32.18, 21.84 and 3.45% of the professionals are within 10-15, 5-10 and less than 5 years of experience in the road sector respectively as clearly depicted in Table 4-2 and 4-3.

Table 4- 2: Years of Establishment of the Organization

Years of establishment	Frequency	Percent	Valid percent	Cumulative percent
<5 years	3	3.45	3.45	3.6
5-10 Years	21	24.1	24.1	27.7
10-15 Years	24	27.58	27.58	55.28
>15 years	39	44.83	44.83	100
Total	87	100	100	

Table 4- 3: Experience of the Organization in the Road Sector

Experience	Frequency	Percent	Valid percent	Cumulative percent
<5 years	3	3.45	3.45	3.45
5-10 Years	19	21.84	21.84	25.29
10-15 Years	28	32.18	32.18	57.47
>15 years	37	42.53	42.53	100
Total	87	100	100	

As indicated in Table 4-4, 33.33% of the professionals are MSC holders, 56.32% are qualified with BSc degree and the remaining 10.34% are qualified with Advanced Diploma.

Table 4- 4: Educational Qualification

Educational level	Frequency	Percent	Valid percent	Cumulative percent
MSc	29	33.33	33.33	33.33
BSc	49	56.32	56.32	89.65
Advanced Diploma	9	10.34	10.34	100
Total		100	100	

Further, 52.87% of the respondents specialized with civil Engineering, 31.03 and 16.09% of the respondents specialized with COTM and other qualification.

Table 4 - 5: Field of Specialization

Field of specialization	Frequency	percent	Valid percent	Cumulative percent
Civil Engineer	46	52.87	52.87	52.87
COTM	27	31.03	31.03	83.9
Other	14	16.09	16.09	100
Total	87	100	100	

In addition, out of the professionals who have an overall work experience between 10-15 years, 48.27% have direct involvement in the road sector. The overall work experience and specific experience in the road sector of the respondents are indicated in the table below.

Table 4 - 6: Respondents Overall Work Experience

Experience	Frequency	percent	Valid percent	Cumulative percent
<5 years	4	4.59	4.59	4.59
5-10 years	28	32.18	32.18	36.77
10-15 years	42	48.27	48.27	85.04
>15 years	13	14.94	14.94	100
Total	87	100	100	

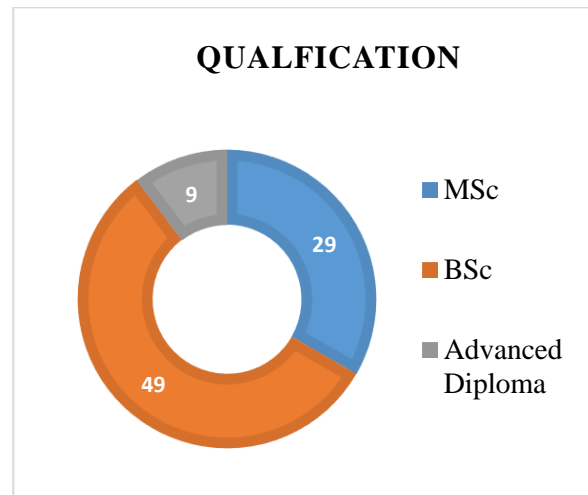
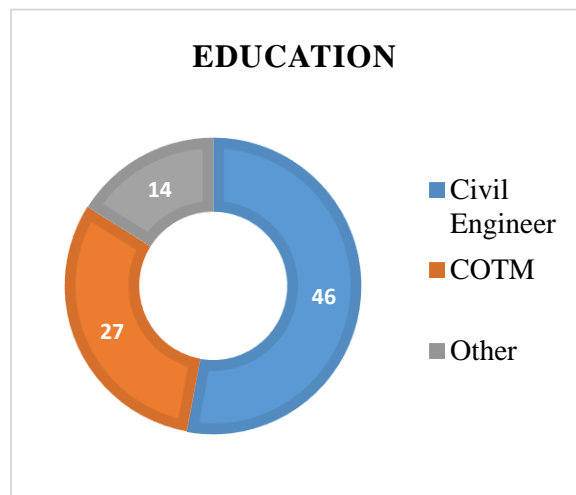
Table 4 - 7: Respondents Experience with in Their Organization

Experience	Frequency	Percent	Valid percent	Cumulative percent
< 5 Years	16	18.39	18.39	18.39
5-10 Years	37	42.53	42.53	60.92
10-15 Years	30	34.48	34.48	95.4
>15 Years	4	4.59	4.59	100
Total	87	100	100	

Respondents who return the survey varied as shown in the Table 4-8, 68.96 % are senior staff, while nearly 19.54% were supervisor. Slightly over 5% of respondents were managers, while smaller percentages of respondents were director and managing director.

Table 4 - 8: Status of Respondents' Organization

Organizational status	Frequency	Percent	Valid percent	Cumulative percent
Managing Director	1	1.15	1.15	1.15
Director	2	2.29	2.29	3.44
Manager	7	8.04	8.04	11.48
Senior Staff	60	68.96	68.96	80.44
Supervisor	17	19.54	19.54	100
Total	87	100	100	



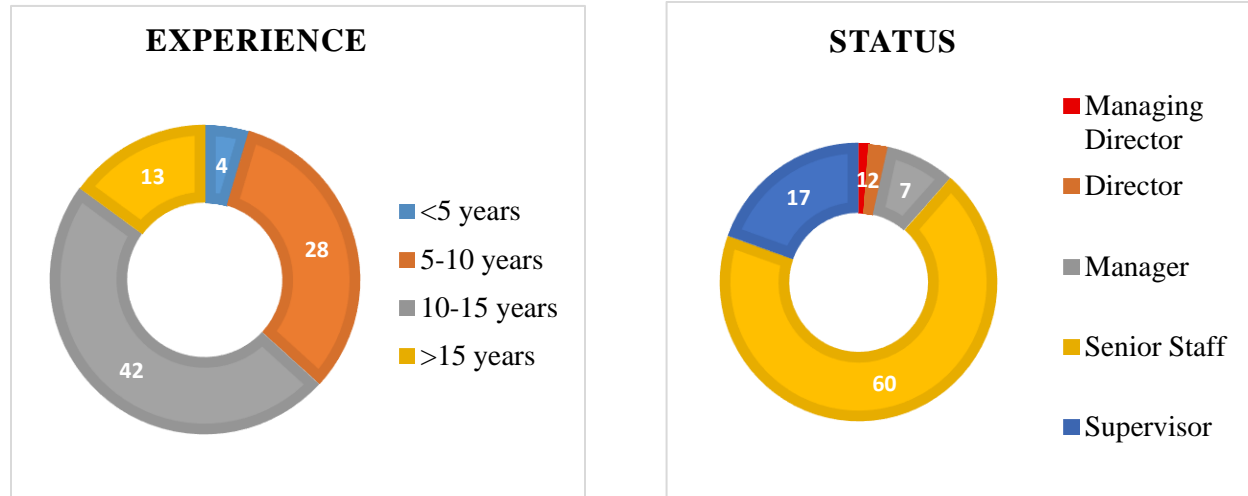


Figure 4- 2: Details of the Experts; Education, Qualification, Experience, Status

4.3. Identification of Major Contractor Selection Criteria

The current study shows how to choose a contractor by using knowledge gathered from numerous publications and industry experts in the construction sector. This is thought to improve the set of selection criteria that will be applied in evaluating the relative merits of each contractor in comparison to the others and in order to identify the most practical and appropriate option. A variety of literature reviews and stakeholder surveys (including clients, consultants, and contractors) are participated to determine the main selection criteria. Previous research and studies on related contractor selection criteria were used as secondary sources and reviewed to reveal related selection criteria for the problem at hand. Figure 4-3 and Table 4-9 present the distribution of 29 articles published between 2014 and 2024, along with the names of the journals that report various selection criteria for contractors during tender evaluation. These criteria have been utilized in the current study to identify contractor selection requirements.

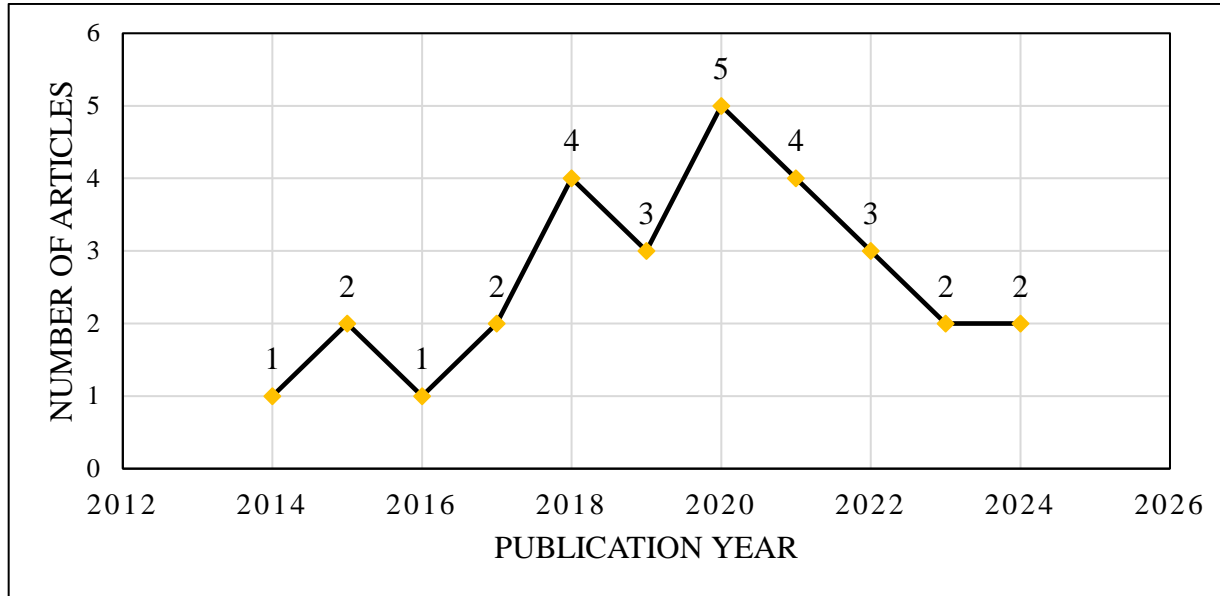


Figure 4- 3: Number of Selected Articles According to Publication Year

Table 4- 9: Top Ten Journals Publishing Selected Articles

ID. No.	Journals	Number of Articles
1	Journal of Construction Engineering and Management (ASCE)	2
2	Automation in Construction	5
3	Construction and Building Materials	4
4	Journal of Management in Engineering (ASCE)	1
5	Building and Environment	2
6	International Journal of Project Management	6
7	Structural Safety	1
8	Journal of Civil Engineering and Management	2
9	International Journal of Construction Education and Research (Taylor & Francis)	4
10	Engineering, Construction, and Architectural Management	2

After reviewing different literatures, the most significant criteria determined using the mean score and ranking approach. The main and sub criteria of the various hierarchical levels are then included in the hierarchical decision-making model by using the AHP approach. A group of experts is asked to participate in an AHP questionnaire survey. After the creation of super matrices, the findings are finally analyzed. Super-decision software is then used to synthesize the outcomes after super matrices have been constructed. Figure 4-4 illustrates the decision-making process in detail.

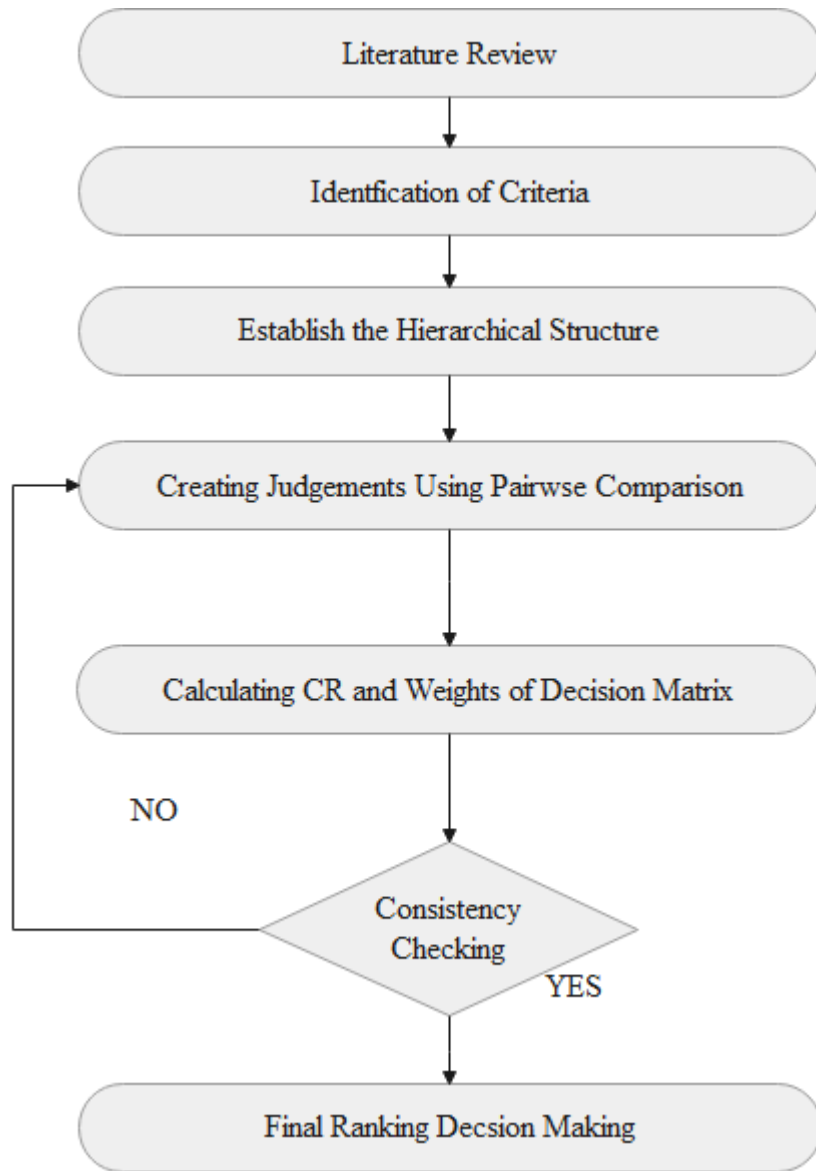


Figure 4- 4: Decision Making Process

4.3.1. Major Contractors’ Selection Criteria Participating in Road Construction Projects

The first objective states to identify major contractor selection criteria in road construction industry. The study uses questionnaire survey to identify the criteria’s; Table 4-10 shows that tender evaluation criteria answered by 87 respondents.

$$Relative\ Important\ Index = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{A * N} \dots \dots \dots Equation\ 4.1$$

Where:

n_5 = Number of respondents for strongly agree

n_4 = Number of respondents for agree

n_3 = Number of respondents for neutral

n_2 = Number of respondents for disagree

n_1 = Number of respondents for strongly disagree

A (highest weight) = 5

N (Total number of respondents) = 87

The analysis result indicated that for annual turnover (RII= 0.9684 mean= 4.8419 ranked 1st), contractors working capital (RII= 0.9485 mean 4.7425 ranked 2nd), financial stability (RII=0.9099 mean 4.5493 ranked 3rd), bid price (RII= 0.8897 mean 4.4484 ranked 4th), cash flow projection (RII= 0.8617 mean 4.3085 ranked 5th), expertise in the field (RII= 0.8171 mean 4.0853 ranked 6th), not able to finish contract (RII= 0.7926 mean= 3.9628 ranked 7th), past record conflict and dispute (RII= 0.7851 mean = 3.9253 ranked 8th), quantity of comparable work completed by the contractor (RII= 0.7776 mean= 3.8878 ranked 9th), performance of contractor on previously completed project (RII= 0.7662 mean= 3.8311 ranked 10th).

The quality of the project delivered through the allocated time and budget (RII= 0.7545 mean= 3.7725 ranked 11th), sufficient equipment/ plant (RII= 0.7355 mean= 3.6774 ranked 12th), technical competency of staff members (RII= 0.7268 mean= 3.634 ranked 13th), contractor knowledge regarding work methodology (RII= 0.7205 mean= 3.6024 ranked 14th), health and safety principles implementation (RII= 0.711 mean= 3.5549 ranked 15th), extent of QA/QC programs that have been used in previous projects (RII= 0.7045 mean= 3.5224 ranked 16th), the comprehensiveness of work techniques description (RII= 0.6464 mean= 3.2321 ranked 17th).

Further, responding to tender specific requirements (RII= 0.6248 mean= 3.124 ranked 18th), project management skill (RII= 0.6026 mean= 3.013 ranked 19th), risk management (RII=0.59151 mean= 2.9756, ranked 20th), number of personnel for the key position (RII=0.5876 mean= 2.9381 ranked 21st), managerial capability (RII= 0.5242 mean= 2.6208 ranked 22nd) and finally it is found that,

subcontractors management ranked last with RII value of 0.4764 and mean value of 2.3819. All things considered, when choosing qualified contractors for road construction projects, all of the evaluated characteristics are important. As a result, these requirements receive sufficient attention and care while evaluating each contractor's bid submission in relation to them in order to identify the top contractors capable of carrying out the project to the required standards within the established baselines.

Table 4 - 10: Major Contractors' Selection Criteria in Tender Evaluation

ITEM	CRITERIA	RII	MEAN	RANK
1	Annual turnover	0.9684	4.8419	1
2	Contractors working capital	0.9485	4.7425	2
3	Financial stability	0.9099	4.5493	3
4	Bid price	0.8897	4.4484	4
5	Cash flow projection	0.8617	4.3085	5
6	Expertise in the field	0.8171	4.0853	6
7	Not able to finish a contract	0.7926	3.9628	7
8	Past record conflict and dispute	0.7851	3.9253	8
9	The quantity of comparable work completed by the contractor	0.7776	3.8878	9
10	Performance of contractor on previously completed project	0.7662	3.8311	10
11	The quality of the project delivered through the allocated time and budget	0.7545	3.7725	11
12	Sufficient equipment/plant	0.7355	3.6774	12
13	Technical competency of staff members	0.7268	3.634	13
14	Contractors' knowledge regarding work methodology	0.7205	3.6024	14
15	Health and safety principles implementation	0.711	3.5549	15
16	The extent of QA/QC programs that have been used in previous projects	0.7045	3.5224	16
17	The comprehensiveness of the work technique description	0.6464	3.2321	17
18	Responding to tender specific requirements	0.6248	3.124	18
19	Project management skill	0.6026	3.013	19
20	Risk management	0.5951	2.9756	20

ITEM	CRITERIA	RII	MEAN	RANK
21	Number of personnel for the key position	0.5876	2.9381	21
22	Managerial capability	0.5242	2.6208	22
23	Subcontractors' management	0.4764	2.3819	23

4.3.2. Alignment of Proposed Methodology with PPA Contractor Selection Requirements

In developing an effective contractor selection methodology for the Ethiopian Roads Administration (ERA), it's essential to align with the Public Procurement Authority (PPA) standards, which emphasize comprehensive and standardized evaluation criteria. This comparison demonstrates how an Analytical Hierarchy Process (AHP) based multi-criteria decision analysis aligns with PPA requirements while offering additional insights. The AHP approach not only meets regulatory standards but enhances the contractor selection process by integrating detailed criteria weighting, allowing for a more thorough differentiation among contractors. Table 4-11 shows the comparison of contractor selection criteria with PPA requirements.

Table 4 - 11: Comparison of Contractor Selection Criteria with PPA Requirements

Item No.	Criteria	Alignment with PPA Requirements	Additional Insights Provided by AHP Approach
1	Annual Turnover	Meets PPA requirement for financial capability, ensuring contractors have necessary economic strength	Uses weighted scoring to reflect the relative importance of turnover among other financial indicators
2	Working Capital	Aligns with PPA's requirement to confirm contractor liquidity and financial readiness.	AHP approach assesses working capital in relation to other financial criteria.
3	Financial Stability	Complies with PPA's focus on financial soundness for project sustainability	Enables a detailed evaluation of financial stability, enhancing insight into financial resilience.
4	Bid Price	Ensures alignment with PPA's requirement for cost feasibility and competitiveness.	Uses AHP to balance bid price with quality indicators, which can prevent sole reliance on lowest bid.
5	Cash Flow Projection	Matches PPA's requirement to confirm sustained cash	Assesses cash flow as part of a broader financial risk profile,

Item No.	Criteria	Alignment with PPA Requirements	Additional Insights Provided by AHP Approach
		flow for ongoing project needs.	allowing for a multi-faceted view of financial health.
6	Expertise in the Field	Meets PPA's emphasis on industry-relevant experience for quality assurance	Evaluates expertise through weighted scoring
7	Past Record and Disputes	Aligns with PPA requirement to consider contractor reliability based on previous projects.	Adds dispute history analysis, offering deeper insight into contractor reliability.
8	Quality of Comparable Work	Meets PPA standards for quality evaluation of past projects.	Uses AHP to prioritize quality of similar projects, adjusting importance based on project-specific needs.
9	Performance on Previous Projects	Complies with PPA's requirement to evaluate timely and within-budget project completion.	Enables a weighted assessment of timeliness and budget adherence, giving detailed performance insights.
10	Adherence to time and budget	Ensures alignment with PPA's emphasis on project timeline and budget compliance	Adds weighted scoring emphasis time and budget adherence based on project scale
11	Equipment Sufficiency	Meets PPA requirement to verify the contractor's resource readiness.	Evaluates both availability and quality of equipment, increasing rigor in resource assessment.
12	Technical Competency	Aligns with PPA's requirement to verify technical expertise of staff.	Uses AHP to weight specific technical competencies relevant to project needs.
13	Knowledge of Work Methodology	Meets PPA's standard for ensuring contractors understand project methodologies.	Adds flexibility by weighting methodology knowledge according to project complexity.
14	Health and Safety Implementation	Fulfills PPA's requirement for health and safety	Considers historical safety practices, enhancing risk assessment.

Item No.	Criteria	Alignment with PPA Requirements	Additional Insights Provided by AHP Approach
		compliance in contractor operations.	
15	QA/QC Programs	Matches PPA's emphasis on previous quality assurance/control efforts.	Evaluates comprehensiveness of QA/QC programs, improving quality predictability
16	Work Techniques Description	Complies with PPA's requirement for detailed methodology description.	Weighted scoring evaluates thoroughness and adaptability of work techniques.
17	Response to Tender Requirements	Aligns with PPA's need to ensure adherence to tender-specific requirements.	Uses AHP to prioritize responsiveness, linking it directly to project scope and complexity.
18	Project Management Skills	Ensures alignment with PPA's requirement for managerial competency.	Prioritizes project management skills based on project demands, adding specificity to evaluation.
19	Risk Management	Matches PPA's emphasis on effective risk mitigation practices.	AHP can weigh the quality and relevance if the contractor's specific risk management strategies.
20	Key Personnel	Complies with PPA's focus on sufficient and qualified staffing	Uses weighted scoring to prioritize critical roles for complex projects.
21	Managerial Capabilities	Ensures alignment with PPA's emphasis on contractor's organizational management.	Evaluates both experience and effectiveness in managing teams and subcontractors.
22	Subcontractor Management	Matches PPA's requirement for effective management of subcontractors.	Adds scoring based on subcontractor management track record, enhancing accountability.

The proposed selection criteria in this study aligns closely with PPA requirements while enhancing ERA's evaluation process. Unlike ERA's current pass/fail approach, the AHP model leverages weighted criteria to capture detailed differences among contractors, which can improve selection accuracy. By integrating PPA's guidelines with AHP's structured decision-making framework, this methodology supports a more thorough, regulation-compliant, and practical contractor selection

process for ERA. This alignment underscores both compliance with PPA standards and a forward-looking approach that could improve project outcomes for ERA in the long term.

4.3.3. Grouping the Criteria

The components that aid in solving a problem are grouped to create the model. Table 4–12 displays the logical arrangement of the criteria, which are divided into four groups based on relative relevance. They were organized in such a way that each category only contains criteria that are comparable to each other or do not differ significantly. Lower significance items were therefore not grouped with higher significance item.

Table 4 - 12: Summary of Grouped Criteria

Item	Selection criteria	Symbol	Sub Criteria	Symbol
1	Financial Competency	FC	Annual Turnover	FC 1
			Contractors working capital	FC 2
			Financial stability	FC 3
			Bid price	FC 4
			Cash flow projection	FC 5
2	Past Performance Competency	PC	Expertise in the field	PC1
			Not able to finish a contract	PC 2
			Past record conflict and dispute	PC 3
			The quantity of comparable work completed by the contractor	PC 4
			Performance of contractor on previously completed project	PC 5
			The quality of the project facility is delivered according to the allocated time and budget	PC 6
			Sufficient equipment/plant	TC 1
			Technical competency of staff members	TC 2
			Contractors' knowledge regarding with work methodology	TC 3

Item	Selection criteria	Symbol	Sub Criteria	Symbol
3	Technical competency	TC	Health and safety principles implementation	TC 4
			The extent of QA/QC programs that have been used in previous projects	TC 5
			The comprehensiveness of the work technique description	TC 6
			Responding to tender specific requirements	TC 7
4	Management competency	MC	Project management skill	MC 1
			Risk management	MC 2
			Number of personnel for the key position	MC 3
			Managerial capability	MC 4
			Subcontractors' management	MC 5

Furthermore, the results of the Kruskal-Wallis's test (see Table 4-13), which was used to compare the opinions of the client, consultant, and contractor respondent's groups on the relative ranking of the assessed variables, showed that 75% of the variables were ranked similarly by the participants. In other words, their perspectives account for 75% of the selection criteria used for contractors. The significant p-value for these variables is higher than the significance level of 5%. This suggests that there is no difference in the participant's rankings of these criteria that is statistically significant. Despite this, there were differences in opinion in one variable, as the p-value was smaller than the 5% significance threshold.

This indicates the participants' ratings of these criteria varied in a statistically significant way. Chi-square values for technical competency (5.836; sig. = 0.0504) is the variable that have a lower sig. value. While it's very close to the 0.05 threshold, it does not strictly indicate a significance difference. Respondents are largely similar, but there's a slight trend suggestion possible differences that may warrant further investigation. As indicated by the total mean rank of the client, consultant, and contractor's organizations, which was higher than the average values, there is a slight difference in responses among the three participant groups. However, the majority of the participants exhibited similar responses. These suggest that while there are minor variations, the overall trend in the data is consistent across the groups.

Table 4 - 13: Kruskal-Walli's Test Results

Item No.	Variables	Respondent group	N	Mean Rank	Chi-Square	df	Asymp. Sig.
1	Financial competency	Client	24	47.67	1.991	2	0.369
		Consultant	33	38.21			
		Contractor	30	42.21			
2	Past performance competency	Client	24	40.48	0.160	2	0.912
		Consultant	33	41.89			
		Contractor	30	43.22			
3	Technical Competency	Client	24	47.62	5.836	2	0.054
		Consultant	33	46.05			
		Contractor	30	33.33			
4	Management competency	Client	24	39.48	1.338	2	0.512
		Consultant	33	39.95			
		Contractor	30	46.16			

4.4. AHP Model Development

4.4.1. Structure the Hierarchical Model

Numerous methods can be employed to assess the multiple criteria decision-making problem, which comprises criteria that vary in their significance to the decision maker. The significance of each criterion is ascertained by means of paired comparison using AHP. The first step before implementing AHP is to decompose the decision problem into a hierarchy of more manageable sub problems that can each be individually investigated. Any element that pertains to the decision at hand, whether it be tangible or intangible, precisely measured or approximately estimated, well or poorly understood, can be related to the elements of the hierarchy.

After the hierarchy is constructed, the decision-makers compare each of its elements, two at a time, to determine how each would affect an element higher up in the hierarchy. This allows them to systematically assess each element. Although the decision makers can utilize actual data about the elements to establish the comparison, they usually rely on their assessments of the element's relative

significance and meaning. The fundamental idea behind the Analytic Hierarchy Process (AHP) is that assessments can be conducted using human judgement in addition to the underlying data. These assessments are transformed into numerical values by the AHP, allowing them to be analyzed and compared consistently across the entire issue domain.

The hierarchy assigns a numerical weight or priority to each element, allowing for a rational and consistent comparison of various and often incompatible elements. Numerical priority is determined for every choice alternative in the process's last stage. This allow for a clear evaluation of the different options since they show how capable each alternative is of achieving the chosen course of action. Therefore, an assessment is conducted to ascertain the relative levels of significance of the criterion. In the hierarchical model formation four levels make up the developed AHP model: the goal, the criteria, the sub criteria and the alternative. After the development of the model is finished it is easier to calculate the weight of each criterion and sub criteria.

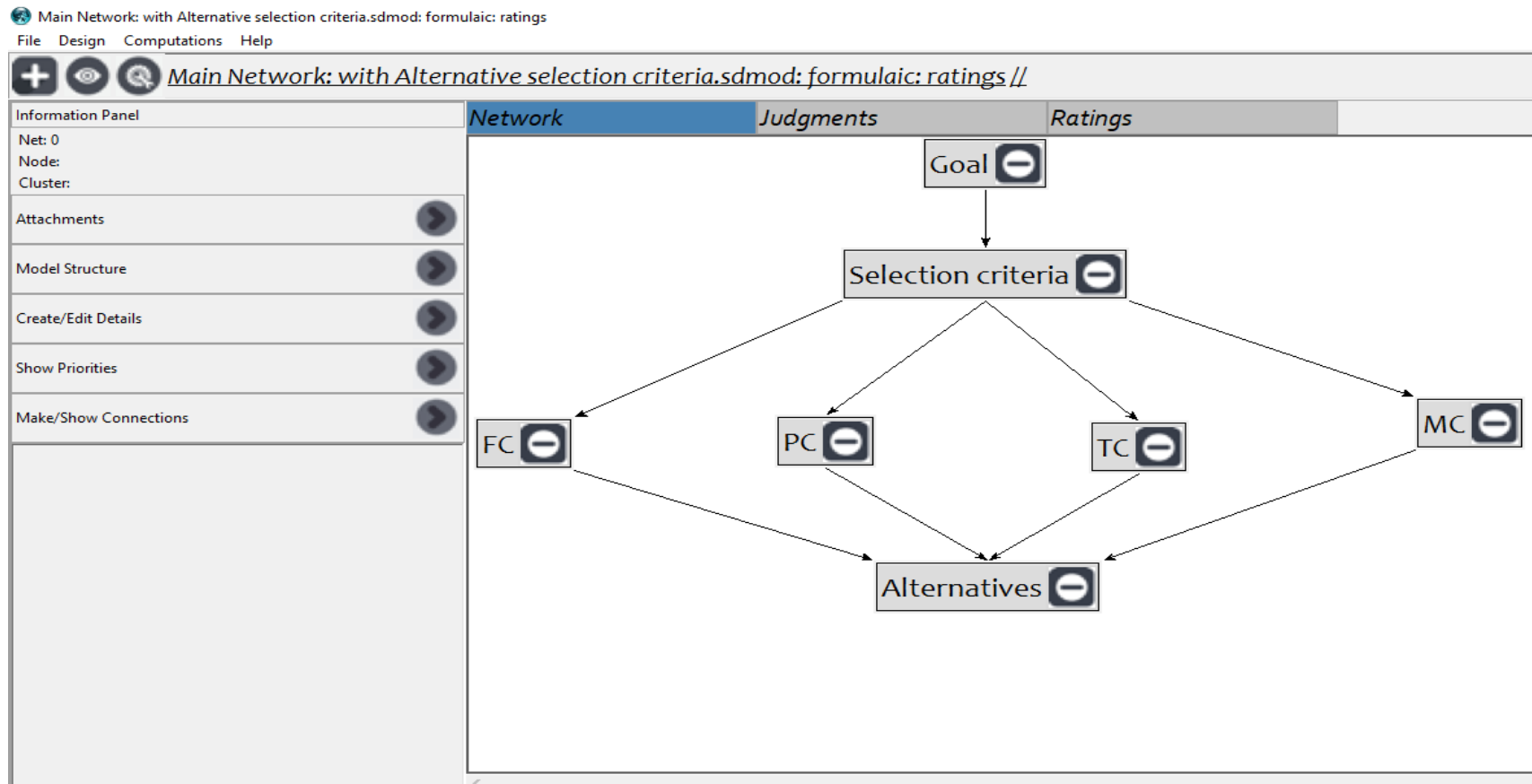


Figure 4- 5: AHP Model; Source: (Super decision software)

4.4.2. Methodology and its Implementation

To implement the proposed AHP (Analytic Hierarchy Process) model effectively, a series of systematic steps must be followed. These procedures are essential for ensuring the accurate application of AHP in determining the contractor evaluation criteria. Below are the key steps that should be applied, which include defining the problem, structuring the hierarchy of criteria, performing pairwise comparisons, calculating weights, and verifying consistency to ensure that the evaluation process is both objective and reliable.

Step 1. Determine the main criteria and sub-criteria that will be applied to the model. Developing a set of evaluation criteria that contractors' competencies can be measured and assessed against is a critical step in the contractor selection process. Numerous works of literature proposed the aforementioned criterion as well as the sub criteria given in Table 4-10. A comparative analysis is conducted between the selection criteria utilized by certain earlier researchers. The four primary criteria that are taken into consideration by decision-makers are financial competency, technical competency, management competency, and past performance competency.

Step 2. Take into consideration the most basic AHP scale for determining relative weights (see Table 4–14).

Table 4 - 14: The Saaty Rating Scale

Intensity of importance	Definition	Explanation
1	Equal importance	i and j are equivalent
3	Somewhat more important	i is slightly preferred to j
5	Much more important	i is strongly preferred to j
7	Very much important	i is very strongly preferred to j .
9	Absolutely more important	i is absolutely preferred to j
2,4,6,8	Intermediate values	When compromised is needed

Step 3. The weights assigned to each criterion have been determined, and the matrix is created by averaging the responses from the three groups of participants who filled out the questionnaire: clients, consultants, and contractors. Here below is a pairwise comparison matrix that is used to assess a set of n criteria based on their respective weights. A is a real matrix of size $m * m$ where

m is the number of evaluation criteria taken in to account. The significance of each a_{ij} in matrix A represents, the j^{th} criterion relative importance to the i^{th} criterion.

$$A = a_{ij} = \begin{bmatrix} a_{1,1} & \dots & a_{1,n} \\ \dots & \dots & \dots \\ a_{n,1} & \dots & a_{n,n} \end{bmatrix}$$

Here, the criteria in this case are $a_1, a_2 \dots a_n$. Where " n " is the total number of criteria. A scale from 1 to 9 was used to establish the relative importance of the two criteria.

The entries in the i^{th} row and the j^{th} column of a matrix A are denoted by the notation a_{ij} . The i^{th} element of vector V is represented by v_i . In case the value of a_{ij} is greater than 1, the j^{th} criterion takes priority over the i^{th} criterion; conversely, if a_{ij} is less than one, the i^{th} criterion holds less significance. When two criteria are equally important, the entry a_{ij} equals one. The entries a_{ij} and a_{ji} gratify the following constraint:

$$a_{ij} * a_{ji} = 1$$

For every j , $a_{jj} = 1$. Table 4-14 displays a numerical scale from 1-9 that is used to quantify the relative importance of two criteria. It is presumed that the i^{th} criterion is correspondingly or more essential than the j^{th} criterion. After matrix A is created, the normalized pairwise comparison matrix A norm can be obtained from matrix A by setting the total of the records in each column to 1. i.e. Each entry a_{ij} of the matrix A norm is computed as:

$$\frac{a_{ij}}{\sum_{i=1}^m a_{ij}} \dots \dots \dots \text{Equation 4.2}$$

Lastly, the average of the elements on each row of the A norm is used to create the criteria weight vector w , which is a m dimensional column vector.

$$w_j = \frac{\sum_{i=1}^m a_{ij}}{m} \dots \dots \dots \text{Equation 4.3}$$

4.4.3. Pairwise Comparison Questionnaires

In order to determine the number of pairwise comparison questions required to establish the complete set of pairwise judgement for each parent element $\frac{n(n-1)}{2}$, where 'n' denotes the number

of elements used (Sangeeta, 2022). Appendix A displays the format of the questionnaire list that was used. A scale from 1 to 9 was used to measure the relative relevance of the two criteria. For instance, there are ten comparison matrices for financial competency, as Table 4-15 illustrates. Each major criteria's components can be compared pairwise with regard to its sub-criteria. The annual turnover, working capital, financial stability, bid price, and cash flow prediction are the sub-criteria for financial competency. All other elements were compared using the same methodology. Below here is an example of how to calculate the number of comparison questions needed to demonstrate technical competency:

$$\text{No. of pairwise questions} = \frac{n(n-1)}{2}, \text{ Where } n = \text{number of criteria for technical competency } n = 7$$

$$\text{No. of pairwise questions} = \frac{7(7-1)}{2} = 21$$

Table 4 - 15: Pairwise Comparison Matrix for Financial Competency Criteria

Criteria	FC 1	FC 2	...	FC 5	Eigenvector	Criteria vector (w)
FC 1	1	FC_{12}	...	FC_{15}	$\left(v_{ij} = \prod_{k=1}^k a_{ij} \right)^{\frac{1}{k}}$	$W_i = \frac{v_i}{\sum v_i}$
FC 2	$1/FC_{12}$	1	...	FC_{25}		$W_i = \frac{v_i}{\sum v_i}$
⋮	⋮	⋮	1	⋮		$W_i = \frac{v_i}{\sum v_i}$
FC 5	$1/FC_{15}$	$1/FC_{25}$	...	1		$W_i = \frac{v_i}{\sum v_i}$
Eigenvalue λ_{max}	$\sum c_{ji} * w_i$					$\sum w_i = 1$
Consistency Ratio	$\frac{\lambda_{max} - n}{n - 1}$					RI

Table 4 - 16: Pair Wise Comparison for Past Performance Competency

Criteria	PC 1	PC 2	...	PC 6	Eigenvector	Criteria vector (w)
PC 1	1	PC_{12}	...	PC_{16}	$\left(v_{ij} = \prod_{k=1}^k a_{ij} \right)^{\frac{1}{k}}$	$W_i = \frac{v_i}{\sum v_i}$
PC 2	$1/PC_{12}$	1	...	PC_{26}		$W_i = \frac{v_i}{\sum v_i}$
⋮	⋮	⋮	1	⋮		$W_i = \frac{v_i}{\sum v_i}$

Criteria	PC 1	PC 2	...	PC 6	Eigenvector	Criteria vector (w)
PC 6	$1/PC_{16}$	$1/PC_{26}$	...	1		$W_i = v_i / \sum v_i$
Eigenvalue λ_{max}	$\sum c_{ji} * w_i$					$\sum w_{i=1}$
Consistency Ratio	$\frac{\lambda_{max} - n}{n - 1}$					RI

Table 4- 17: Pairwise Comparison for Technical Competency

Criteria	TC 1	TC 2	...	TC 6	Eigenvector	Criteria vector (w)
TC 1	1	TC_{12}	...	TC_{16}	$\left(v_{ij} = \prod_{k=1}^k a_{ij} \right)^{\frac{1}{k}}$	$W_i = v_i / \sum v_i$
TC 2	$1/TC_{12}$	1	...	TC_{26}		$W_i = v_i / \sum v_i$
⋮	⋮	⋮	1	⋮		$W_i = v_i / \sum v_i$
TC 6	$1/TC_{16}$	$1/TC_{26}$	...	1		$W_i = v_i / \sum v_i$
Eigenvalue λ_{max}	$\sum c_{ji} * w_i$					$\sum w_{i=1}$
Consistency Ratio	$\frac{\lambda_{max} - n}{n - 1}$					RI

Table 4 - 18: Pairwise Comparison for Management Competency

Criteria	MC 1	MC 2	...	MC 5	Eigenvector	Criteria vector (w)
MC 1	1	MC_{12}	...	MC_{15}	$\left(v_{ij} = \prod_{k=1}^k a_{ij} \right)^{\frac{1}{k}}$	$W_i = v_i / \sum v_i$
MC 2	$1/MC_{12}$	1	...	MC_{15}		$W_i = v_i / \sum v_i$
⋮	⋮	⋮	1	⋮		$W_i = v_i / \sum v_i$
MC 5	$1/MC_{15}$	$1/MC_{25}$	...	1		$W_i = v_i / \sum v_i$
Eigenvalue λ_{max}	$\sum c_{ji} * w_i$					$\sum w_{i=1}$
Consistency Ratio	$\frac{\lambda_{max} - n}{n - 1}$					RI

4.4.4. Combining Experts' Judgement

A crucial concern in group decisions is integrating distinct opinions into a solitary conclusion that embodies the viewpoint of the entire group. To merge individual judgements into the combined PC matrix, many methods are applied (Konrad, 2021). Given that the AHP employs a ratio scale, geometric means as opposed to arithmetic means are favored for averaging in order to produce findings that are consistent in meaning across all opinions. The primary rationale for selecting geometric mean is that it satisfies the reciprocal relation, which requires that the reciprocal of the synthesized judgements equal the syntheses of the reciprocals of this judgement. Arithmetic mean, on the other hand, does not satisfy the reciprocal relation (Edward, 2022). For instance, six respondents estimated that expertise in the field (PC 1) is scalable four times, seven times, three times, five times, one time and six times larger than quantity of comparable work completed by the contractor (PC 4). Thus, the geometric mean of these judgements is $(4 * 7 * 3 * 5 * 1 * 6)^{1/6} = 3.688$ reciprocals of these judgements is $\frac{1}{3.688} = 0.27108$, which is also equal to the sum of the reciprocals of these judgements $(\frac{1}{4} * \frac{1}{7} * \frac{1}{3} * \frac{1}{5} * \frac{1}{1} * \frac{1}{6})^{1/6} = 0.27108$, while the arithmetic mean is $\frac{(4+7+3+5+1+6)}{6} = 4.333$ but the reciprocal of 4.3333= 0.2307 $\neq \frac{(\frac{1}{4}+\frac{1}{7}+\frac{1}{3}+\frac{1}{5}+\frac{1}{1}+\frac{1}{6})}{6} = 0.3487$.

This is shown in equation 4.4. The k^{th} root of the k multiples provides a means of combining the k opinions while maintaining the relationship of a_{ij} always equal $1/a_{ij}$ (Edward, 2022).

$$\left(a_{ij} = \prod_{k=1}^k a_{ij} \right)^{\frac{1}{k}} \dots \dots \dots \text{Equation 4.4}$$

Where, a_{ij} are expert opinion evaluated by the k^{th} expert.

The gathered group assessments were then organized in corresponding consensus pair-wise judgement matrices, which are required to compute the synthesized findings. The method of the judgements is placed into the pair wise comparison matrices illustrated in the next section.

After completing the evaluation cycle, the opinions of the respondents need to be assessed for consistency. The CR is calculated as the consistent index (CI) divided by the Random Consistency index (RI). This can be seen in Equation 4.5, where λ_{max} is the maximum Eigen value and n is the

contract. The relationships among the criteria and sub-criteria are determined and reflected in the hierarchy for the contractor selection criteria model is displayed in Figure 4-6.

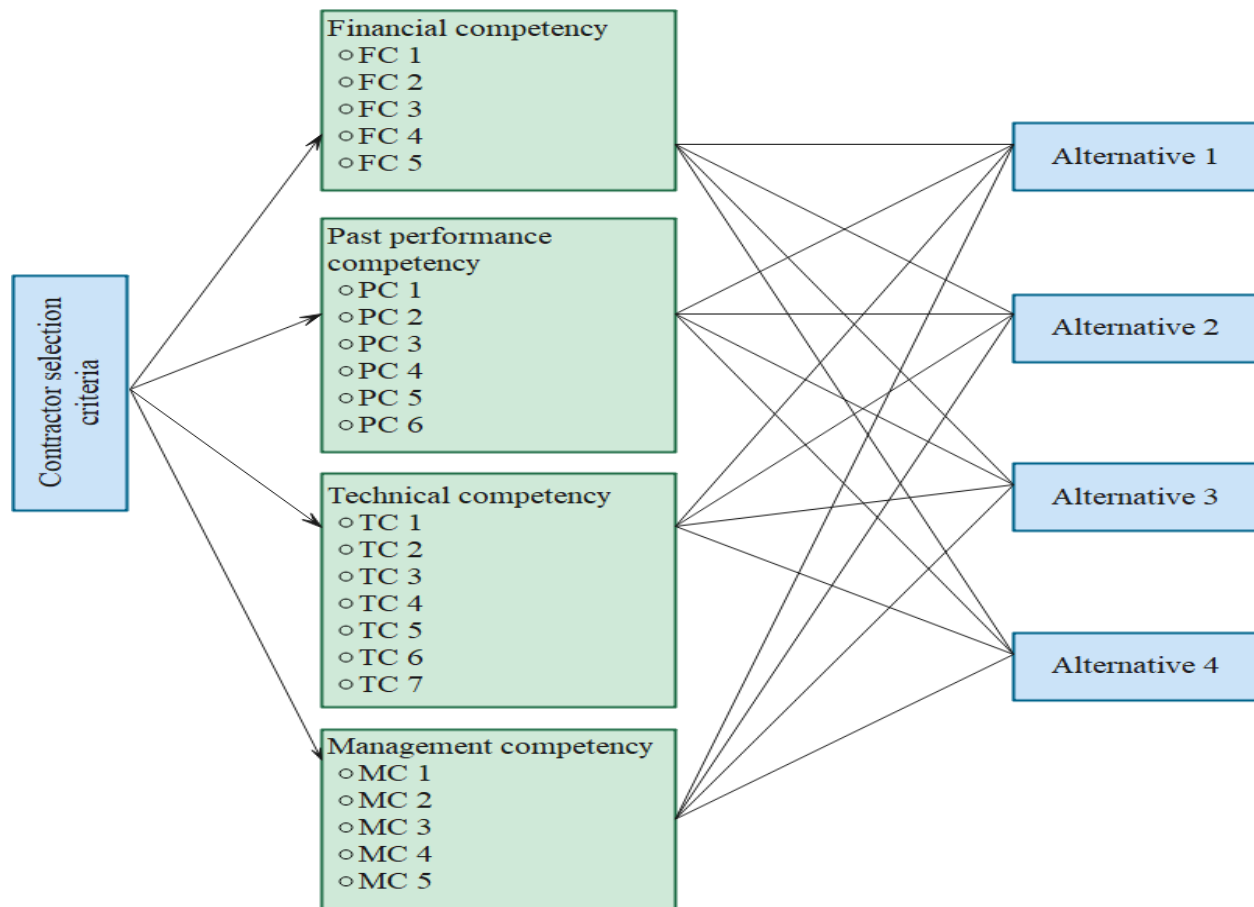


Figure 4- 6: A Hierarchical Representation of the AHP Model.

4.5.2. Performing Pairwise Comparisons

After developing the hierarchy, pairwise comparison was methodically carried out across the structure.

4.5.2.1. Main criteria comparison

This section determines how the primary criteria are compared in pairs in relation to the goal. Table 4-20 presents the results of the pairwise comparison of the criteria for each of the four primary criteria: FC, PC, TC, and MC.

Table 4 - 20 : Pair Wise Comparison for Major Criteria Comparison

<i>Goal</i>	<i>FC</i>	<i>PC</i>	<i>TC</i>	<i>MC</i>
<i>FC</i>	1	1/2	1/2	2
<i>PC</i>	2	1	2	2
<i>TC</i>	2	1/2	1	1
<i>MC</i>	1/2	1/2	1	1

Notes: FC= Financial competency, PC= Past performance competency, TC= Technical competency, MC= Management competency

Divide each matrix element by the total number of columns once the pairwise comparison matrix is formed to create a matched matrix for normalization. Table 4-21 displays the normalized pairwise criteria matrix, which is the normalization of the paired matrix between the criteria. For this all the elements of the column are divided by the sum of the column.

Table 4 - 21: Normalization Matrix for Main Criteria

<i>Goal</i>	<i>FC</i>	<i>PC</i>	<i>TC</i>	<i>MC</i>	Criteria weight
<i>FC</i>	0.182	0.200	0.111	0.333	0.2042
<i>PC</i>	0.364	0.400	0.444	0.333	0.3856
<i>TC</i>	0.364	0.200	0.222	0.167	0.2416
<i>MC</i>	0.091	0.200	0.222	0.167	0.1684

$$\lambda_{max} = 4.19, CI = 0.06, RI = 0.89, CR = 0.0694 < 0.1 \text{ OK!}$$

Notes: CI= Consistency index, RI= Random consistency index, CR= Consistency ratio

4.5.2.2. Sub criteria Comparison

These are the sub criteria comparisons of the chosen competency criteria for the selection of contractors that are presented in the questionnaire; they are pairwise comparisons with respect to the major criteria.

Table 4 - 22 : Pair Wise Comparison for Sub Criteria Comparison for Financial Competency

<i>FC</i>	<i>FC₁</i>	<i>FC₂</i>	<i>FC₃</i>	<i>FC₄</i>	<i>FC₅</i>
<i>FC₁</i>	1	1/3	1	1/2	1/2
<i>FC₂</i>	3	1	1	1/2	2
<i>FC₃</i>	1	1	1	1	3
<i>FC₄</i>	2	2	1	1	2
<i>FC₅</i>	2	1/2	1/3	1/2	1

Notes: FC1= Annual turnover, FC2= Contractor working capital, FC3= Financial stability, FC4= Bid price, FC5= Cash flow projection

To create a paired matrix in normalization, divide each matrix element by the total number of columns after the pairwise comparison matrix is formed. The normalization of paired matrix between criteria for financial competency is given in Table 4-23. For this all the elements of the column are divided by the sum of the column.

Table 4 - 23: Normalization Matrix for Financial Competency

<i>FC</i>	<i>FC₁</i>	<i>FC₂</i>	<i>FC₃</i>	<i>FC₄</i>	<i>FC₅</i>	Criteria weight
<i>FC₁</i>	0.10	0.07	0.23	0.11	0.05	0.1201
<i>FC₂</i>	0.30	0.21	0.23	0.16	0.21	0.2314
<i>FC₃</i>	0.10	0.21	0.23	0.32	0.32	0.2373
<i>FC₄</i>	0.30	0.41	0.23	0.32	0.32	0.2784
<i>FC₅</i>	0.20	0.10	0.08	0.11	0.11	0.1326

$$\lambda_{max} = 5.333, CI = 0.083, RI = 1.11, CR = 0.07368 < 0.1 \text{ OK!}$$

Notes: CI= Consistency index, RI= Random consistency index, CR= Consistency ratio

Table 4 - 24: Pair Wise Comparison for Sub Criteria Comparison for Past Performance

Competency						
<i>PC</i>	<i>PC₁</i>	<i>PC₂</i>	<i>PC₃</i>	<i>PC₄</i>	<i>PC₅</i>	<i>PC₆</i>
<i>PC₁</i>	1	1/3	1/4	4	1/2	1/2
<i>PC₂</i>	3	1	1/2	3	1	1/3
<i>PC₃</i>	4	2	1	4	1	1/3
<i>PC₄</i>	1/4	1/3	1/4	1	1/3	1/3
<i>PC₅</i>	2	1	1	3	1	1/3
<i>PC₆</i>	2	3	3	3	3	1

Notes: PC1= Expertise in the field, PC2= Not able to finish a contract, PC3= Past record conflict and dispute, PC4= quantity of comparable work completed by the contractor, PC5= Performance of contractor on previously completed project, PC6= quality of project delivered according to the allocated time and budget.

The normalization of the paired matrix between criteria for past performance competency is given in Table 4-25, which represents the normalized pairwise criteria matrix. To do this, divide each element in the matrix by its total column after the pairwise comparison matrix has been formed.

Table 4 - 25: Normalization Matrix for Past Performance Competency

<i>PC</i>	<i>PC₁</i>	<i>PC₂</i>	<i>PC₃</i>	<i>PC₄</i>	<i>PC₅</i>	<i>PC₆</i>	Criteria weight
<i>PC₁</i>	0.081	0.043	0.042	0.222	0.073	0.176	0.1000
<i>PC₂</i>	0.244	0.130	0.083	0.166	0.146	0.117	0.1485
<i>PC₃</i>	0.326	0.261	0.166	0.222	0.146	0.117	0.2105
<i>PC₄</i>	0.020	0.043	0.042	0.055	0.048	0.117	0.0522
<i>PC₅</i>	0.163	0.130	0.167	0.166	0.146	0.117	0.1493
<i>PC₆</i>	0.163	0.391	0.500	0.166	0.43	0.352	0.3391

$$\lambda_{max} = 6.566, CI = 0.113, RI = 1.25, CR = 0.0880 < 0.1 \text{ OK!}$$

Notes: CI= Consistency index, RI= Random consistency index, CR= Consistency ratio

Table 4 - 26: Pair Wise Comparison for Sub Criteria Comparison for Technical Competency

		Criteria						
<i>TC</i>	<i>TC</i> ₁	<i>TC</i> ₂	<i>TC</i> ₃	<i>TC</i> ₄	<i>TC</i> ₅	<i>TC</i> ₆	<i>TC</i> ₇	
<i>TC</i> ₁	1	1/5	1/4	1/3	1/2	1/3	1/4	
<i>TC</i> ₂	5	1	1	1/3	3	3	1/3	
<i>TC</i> ₃	4	1	1	1/3	1	1/2	1/3	
<i>TC</i> ₄	3	3	3	1	4	4	1/2	
<i>TC</i> ₅	2	1/3	1	1/4	1	1/3	1/3	
<i>TC</i> ₆	3	1/3	2	1/4	3	1	1/2	
<i>TC</i> ₇	4	3	3	2	3	3	1	

Note: TC1= Sufficient equipment/ plant, TC2= Technical competency of staff members, TC3= Contractor’s knowledge regarding with work methodology, TC4= Health and safety principle implementation, TC5= extent of QA/QC programs that have been used in previous projects, TC6= comprehensiveness of work technique description, TC7= responding to tender specific requirement.

To create a matched matrix in normalization, divide each matrix element by the total number of columns after the pairwise comparison matrix is formed. The normalized pairwise criteria matrix, or normalized paired matrix between criteria, is shown in Table 4-27. To calculate this, the total of each column's elements is divided.

Table 4 - 27: Normalization Matrix for Technical Competency

<i>TC</i>	<i>TC</i> ₁	<i>TC</i> ₂	<i>TC</i> ₃	<i>TC</i> ₄	<i>TC</i> ₅	<i>TC</i> ₆	<i>TC</i> ₇	Criteria Weight
<i>TC</i> ₁	0.05	0.02	0.02	0.07	0.03	0.03	0.08	0.0419
<i>TC</i> ₂	0.23	0.11	0.09	0.07	0.19	0.25	0.11	0.1526
<i>TC</i> ₃	0.18	0.11	0.09	0.07	0.06	0.04	0.11	0.0932
<i>TC</i> ₄	0.14	0.34	0.27	0.22	0.26	0.33	0.16	0.2577
<i>TC</i> ₅	0.09	0.04	0.09	0.06	0.06	0.03	0.11	0.0636
<i>TC</i> ₆	0.14	0.04	0.18	0.06	0.19	0.08	0.11	0.1139
<i>TC</i> ₇	0.18	0.34	0.27	0.44	0.19	0.25	0.32	0.2769

<i>TC</i>	<i>TC₁</i>	<i>TC₂</i>	<i>TC₃</i>	<i>TC₄</i>	<i>TC₅</i>	<i>TC₆</i>	<i>TC₇</i>	Criteria Weight
$\lambda_{max} = 7.639, CI = 0.0106, RI = 1.35, CR = 0.07943 < 0.1$ OK!								

Notes: CI= Consistency index, RI= Random consistency index, CR= Consistency ratio

Table 4 - 28: Pair Wise Comparison for Sub Criteria Comparison for Technical Competency

<i>MC</i>	<i>MC₁</i>	<i>MC₂</i>	<i>MC₃</i>	<i>MC₄</i>	<i>MC₅</i>
<i>MC₁</i>	1	1	2	1	2
<i>MC₂</i>	1	1	2	1	3
<i>MC₃</i>	1/2	1/3	1	1/3	1/2
<i>MC₄</i>	1	1	3	1	3
<i>MC₅</i>	1/2	1/3	2	1/3	1

Note: MC1= Project management skill, MC2= Risk management, MC3= Number of personnel for the key position, MC4= Managerial capability, MC5= Subcontractors management

When the pairwise comparison matrix is formed, divide each element by the total number of columns in the matrix to create a matched matrix for normalization. Table 4-29 displays the normalized pairwise criteria matrix where the paired matrix between the criteria has been normalized. Every column element is divided by the total column elements for this purpose.

Table 4 - 29: Normalization Matrix for Management Competency

<i>MC</i>	<i>MC₁</i>	<i>MC₂</i>	<i>MC₃</i>	<i>MC₄</i>	<i>MC₅</i>	Criteria weight
<i>MC₁</i>	0.250	0.273	0.182	0.273	0.211	0.2382
<i>MC₂</i>	0.250	0.273	0.273	0.273	0.315	0.2618
<i>MC₃</i>	0.125	0.091	0.091	0.091	0.053	0.0981
<i>MC₄</i>	0.25	0.273	0.273	0.273	0.315	0.2810
<i>MC₅</i>	0.125	0.091	0.182	0.091	0.105	0.1206

$$\lambda_{max} = 5.086, CI = 0.086, RI = 1.11, CR = 0.0214 < 0.1 \text{ OK!}$$

Notes: CI= Consistency index, RI= Random consistency index, CR= Consistency ratio

Table 4 - 30: Summary of AHP Result

Criteria	Aggregated pairwise matrix $\left(v_{ij} = \prod_{k=1}^k a_{ij} \right)^{\frac{1}{k}}$	Sub criteria	Criteria weight $W_i = v_i / \sum v_i$	Criteria %	Rank	Consistency
Main criteria (FC, PC, TC & MC)	$\begin{bmatrix} 1 & 1/2 & 1/2 & 2 \\ 2 & 1 & 2 & 2 \\ 2 & 1/2 & 1 & 1 \\ 1/2 & 1/2 & 1 & 1 \end{bmatrix}$	FC	0.2042	20.66%	3	$\lambda_{max} = 4.19$ $CI = 0.06$ $CR = 0.0694$
		PC	0.3856	38.54%	1	
		TC	0.2416	23.81%	2	
		MC	0.1684	16.99%	4	
FC	$\begin{bmatrix} 1 & 1/3 & 1 & 1/2 & 1/2 \\ 3 & 1 & 1 & 1/2 & 2 \\ 1 & 1 & 1 & 1 & 3 \\ 2 & 2 & 1 & 1 & 2 \\ 2 & 1/2 & 1/3 & 1/2 & 1 \end{bmatrix}$	FC 1	0.1201	12.25%	5	$\lambda_{max} = 5.333$ $CI = 0.083$ $CR = 0.07368$
		FC 2	0.2314	22.98%	3	
		FC 3	0.2373	23.75%	2	
		FC 4	0.2784	27.76%	1	
		FC 5	0.1326	13.26%	4	
PC	$\begin{bmatrix} 1 & 1/3 & 1/4 & 4 & 1/2 & 1/2 \\ 3 & 1 & 1/2 & 3 & 1 & 1/3 \\ 4 & 2 & 1 & 4 & 1 & 1/3 \\ 1/4 & 1/3 & 1/4 & 1 & 1/3 & 1/3 \\ 2 & 1 & 1 & 3 & 1 & 1/3 \\ 2 & 3 & 3 & 3 & 3 & 1 \end{bmatrix}$	PC 1	0.1000	10.64%	5	$\lambda_{max} = 6.566$ $CI = 0.113$ $CR = 0.0880$
		PC 2	0.1485	14.82%	4	
		PC 3	0.2105	20.67%	3	
		PC 4	0.0522	5.46%	6	
		PC 5	0.1493	14.85%	2	
		PC 6	0.3391	33.55%	1	

Criteria	Aggregated pairwise matrix $\left(v_{ij} = \prod_{k=1}^k a_{ij} \right)^{\frac{1}{k}}$	Sub criteria	Criteria weight $W_i = v_i / \sum v_i$	Criteria %	Rank	Consistency
TC	$\begin{bmatrix} 1 & 1/5 & 1/4 & 1/3 & 1/2 & 1/3 & 1/4 \\ 5 & 1 & 1 & 1/3 & 3 & 3 & 1/3 \\ 4 & 1 & 1 & 1/3 & 1 & 1/2 & 1/3 \\ 3 & 3 & 3 & 1 & 4 & 4 & 1/2 \\ 2 & 1/3 & 1 & 1/4 & 1 & 1/3 & 1/3 \\ 3 & 1/3 & 2 & 1/4 & 3 & 1 & 1/2 \\ 4 & 3 & 3 & 2 & 3 & 2 & 1 \end{bmatrix}$	TC 1	0.0419	4.33%	7	$\lambda_{max} = 7.647$ $CI = 0.107$ $CR = 0.0794$
		TC 2	0.1526	15.25%	3	
		TC 3	0.0932	9.56%	5	
		TC 4	0.2577	24.77%	2	
		TC 5	0.0636	6.71%	6	
		TC 6	0.1139	12.06%	4	
		TC 7	0.2769	27.31%	1	
MC	$\begin{bmatrix} 1 & 1 & 2 & 1 & 2 \\ 1 & 1 & 2 & 1 & 3 \\ 1/2 & 1/2 & 1 & 1/3 & 1/2 \\ 1 & 1 & 3 & 1 & 3 \\ 1/2 & 1/3 & 2 & 1/3 & 1 \end{bmatrix}$	MC 1	0.2382	23.88%	1	$\lambda_{max} = 5.23$ $CI = 0.058$ $CR = 0.0529$
		MC 2	0.2618	25.99%	3	
		MC 3	0.0981	9.98%	5	
		MC 4	0.2810	27.99%	2	
		MC 5	0.1206	12.16%	4	

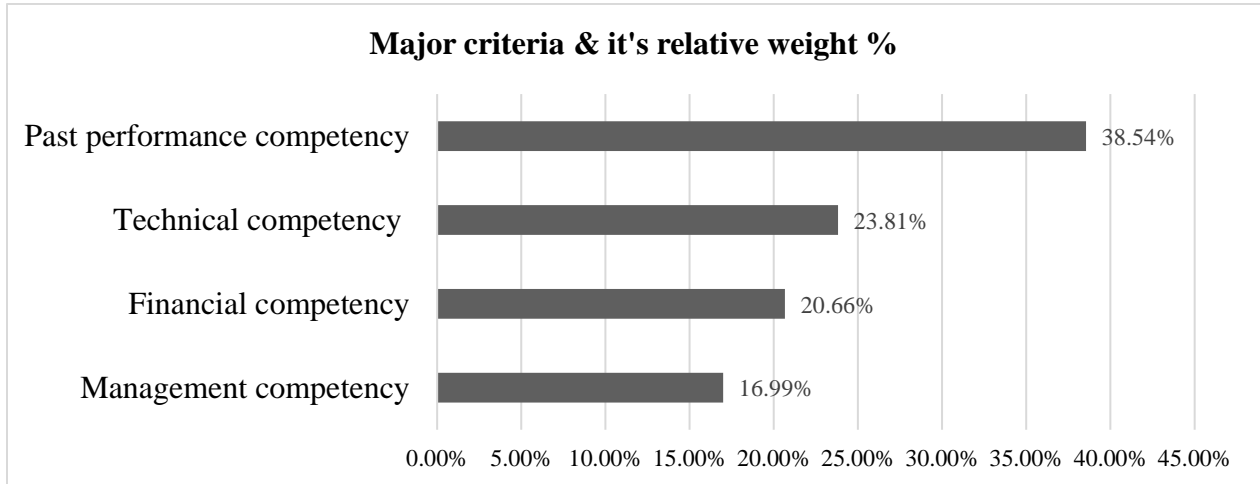


Figure 4 - 7: Major Criteria and its Relative Weight

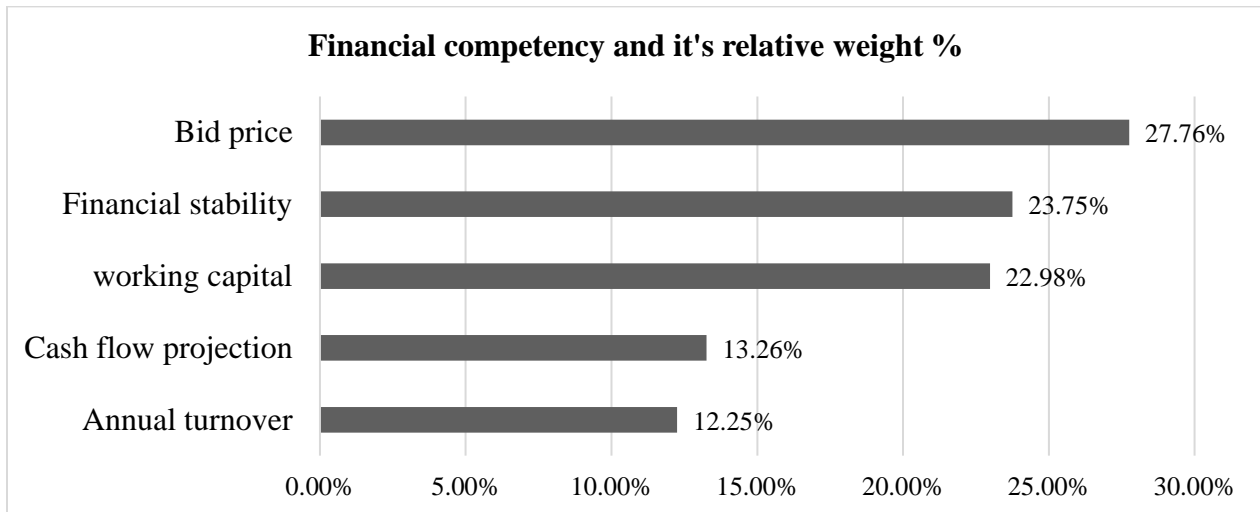


Figure 4- 8: Financial Competency and its Relative Weight

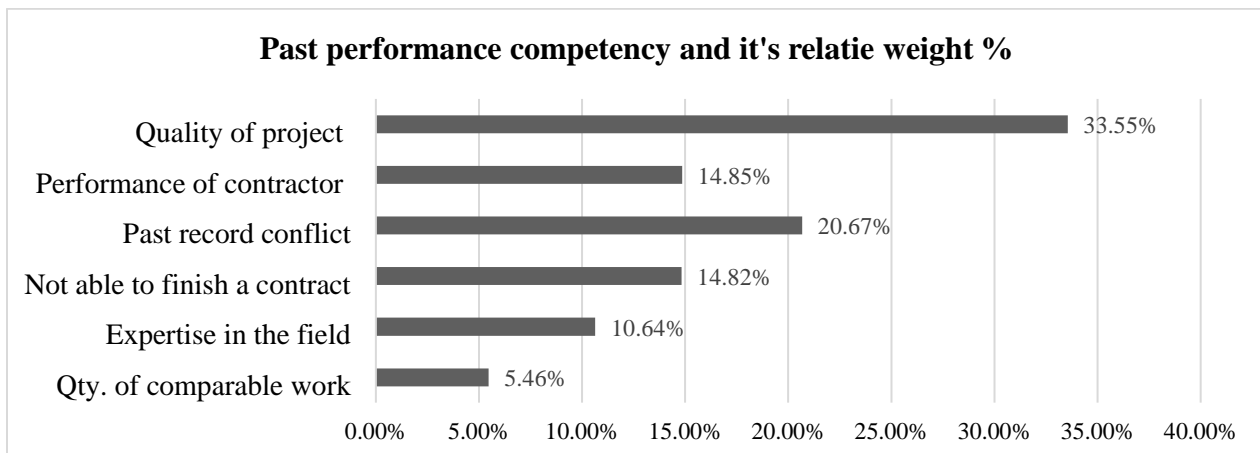


Figure 4- 9: Past Performance Competency and its Relative Weight

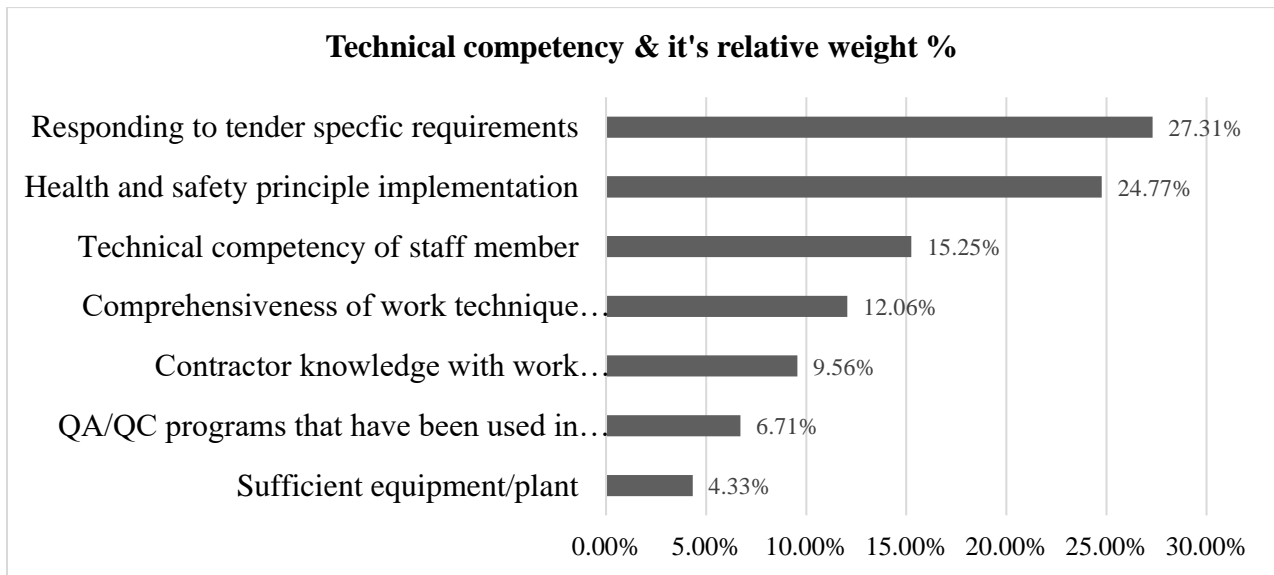


Figure 4- 10: Technical Competency & its Relative Weight

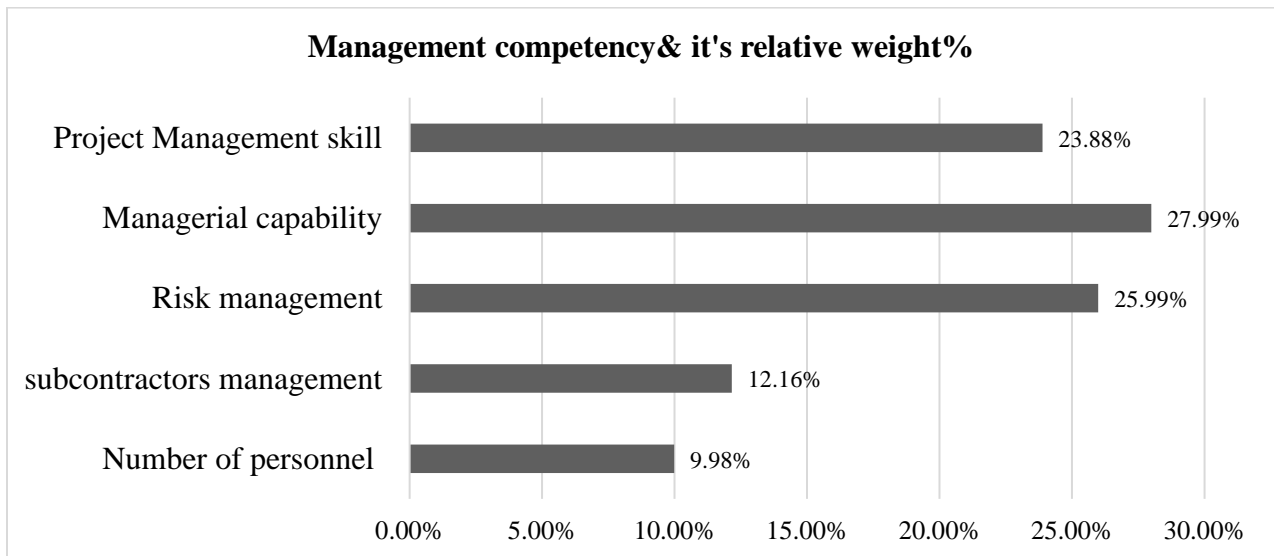


Figure 4- 11: Management Competency & its Relative Weight

4.5.3. Prioritization of Sub criteria

There are a total of 23 sub-criteria, each of which has split into its most significant major criteria. The sub criterion "quality of the project facility is delivered according to the allocated time and budget" was found to have the highest weight, based on the analytical findings displayed in Table 4-31. This outcome emphasizes how crucial it is for stakeholders to guarantee that project facilities

are provided within the predetermined budget and time restrictions, in addition to being of the finest quality. This suggests that the quality of the contractor's prior work is more significant than the sub criteria mentioned below. Therefore, if the contractor completes projects on schedule, within budget, and with other critical parameters, it will likely provide the responsible organization, ERA, with a more thorough understanding of the contractor's capacity to produce high-quality construction.

Table 4 - 31: Result of Sub Criteria

Item	Name of the Sub criteria	Code	Normalized Weight
1	Annual turnover	FC 1	0.122
2	Contractors working capital	FC 2	0.229
3	Financial stability	FC 3	0.237
4	Bid price	FC 4	0.277
5	Cash flow projection	FC 5	0.130
6	Expertise in the field	PC 1	0.106
7	Not able to finish a contract	PC 2	0.148
8	Past record conflict and dispute	PC 3	0.206
9	Quantity of comparable work completed by the contractor	PC 4	0.054
10	Performance of contractor on previously completed project	PC 5	0.148
11	The quality of the project facility is delivered according to the allocated time and budget	PC 6	0.335
12	Sufficient equipment/plant	TC 1	0.043
13	Technical competency of staff members	TC 2	0.152
14	Contractor knowledge regarding work methodology	TC 3	0.096
15	Health and safety principles implementation	TC 4	0.247
16	QA/QC programs that have been used in previous projects	TC 5	0.067
17	The comprehensiveness of the work technique description	TC 6	0.120
18	Project management skill	MC 1	0.238
19	Risk management	MC 2	0.259
20	Number of personnel for the key position	MC 3	0.099

Item	Name of the Sub criteria	Code	Normalized Weight
22	Managerial capability	MC 4	0.277
23	Subcontractors' management	MC 5	0.121

4.5.4. Summary of AHP Results

In this study, various criteria were initially identified from the literature and subsequently refined using the AHP approach. Four main criteria and twenty-three sub criteria were established. Then using AHP, weights and rankings were determined for each main and sub criterion, leading to an overall ranking, as depicted in Figure 4-12. Among the main criteria past performance competency ranked highest with a weight of 38.54%, followed by technical competency at 23.81%, financial competency at 20.66% and management competency at 16.99%.

Among the sub-criteria, project quality determined by the allocated time and budget received the highest weight at 13.07%, followed by the past record of conflict and dispute resolution at 8.12%. The ability to respond to tender-specific requirements (6.68%) and the implementation of health and safety principles (6.22%) ranked third and fourth, respectively. The remaining sub-criteria varied in weight, with the amount of comparable work completed by the contractor at 2.01%, the number of employees in key positions at 1.65%, and the extent of QA/QC programs and equipment availability at 1.01%.

Overall, the present study uses AHP to assign weighted importance to various contractor selection criteria. This approach enables prioritization and ranking of sub criteria based on expert input and calculated weights, providing a detailed, ranked scoring system. ERA in contrast, uses a two-stage pass/fail evaluation approach for technical qualification followed by financial evaluation. ERA's method ensures that only contractors meeting all minimum technical requirements are considered for financial evaluation, and the contract is awarded to the lowest bid among qualified contractors. Importantly, no weights or scores are assigned to criteria; contractors either pass or fail based on defined minimum qualifications.

The current study and ERA's approach consider similar evaluation elements, such as financial competency, technical competency, past performance, available resource (equipment, personnel), and legal compliance. For example, ERA includes requirements like financial performance history,

experience, and key personnel availability, which aligns with the sub criteria that is proposed in the current research. Further the current study highlighted past performance competency as the most important major category, particularly noting factors like project quality and past conflict history. ERA also evaluates contractors' non- performance history and pending litigation, a part of its post qualification examination, ensuring that contractors with the history of non-performance are filtered out.

A primary difference lies in AHP's weighted scoring Vs. ERA's pass/fail approach. While the AHP analysis assigns weights to prioritize criteria, ERA does not apply weightage or scoring; contractors only need to meet minimum requirements. In ERA system, all criteria are essential but do not contribute differently to an overall score, where as in the current study criteria are weighted. In addition, ERA's financial evaluation phase solely determines the contract award by selecting the lowest bid, assuming all technical requirements are met. In contrast, AHP approach ranks criteria, which support a best-value selection method rather than strictly selecting the lowest bid.

If ERA aims to improve its contractor selection to go beyond minimum standards, adopting a weighted criteria approach, such as AHP, could help prioritize contractors who offer not only cost effectiveness but also higher competency in areas to project success. Such an approach could complement ERA's post qualification evaluation by allowing differentiation among technically qualified contractors.

Table 4 - 32: Overall Ranking

Major Criteria	Normalized local weight	Sub criteria	Normalized Local weight	Global weight
Past performance competency	0.3856	Expertise in the field	0.1000	0.03856
		Not able to finish a contract	0.1485	0.0573
		Past record conflict and dispute	0.2105	0.0812
		Quantity of comparable work completed by the contractor	0.0522	0.0201
		Performance of contractor on previously completed project	0.1493	0.0576
		Quality of project delivered according to the allocated time and budget	0.3391	0.1307
Technical competency	0.2416	Sufficient equipment/plant	0.0419	0.0101
		Technical competency of staff members	0.1526	0.0368
		Contractor's knowledge regarding with work methodology	0.0932	0.0225
		Health and safety principle implementation	0.2577	0.0622
		Extent of QA/QC programs that have been used in previous projects	0.0636	0.0154
		Comprehensiveness of work technique description	0.1139	0.0275
		Responding to tender specific requirement	0.2769	0.0668
Financial competency	0.2042	Annual turnover	0.1201	0.0245
		Contractor working capital	0.2314	0.0472
		Financial stability	0.2373	0.0484
		Bid price	0.2784	0.0568
		Cash flow projection	0.1326	0.0271
Management competency	0.1684	Project management skill	0.2382	0.0401
		Risk management	0.2618	0.0441
		Number of personnel for the key position	0.0981	0.0165
		Managerial capability	0.2810	0.0473
		Subcontractor's management	0.1206	0.0203

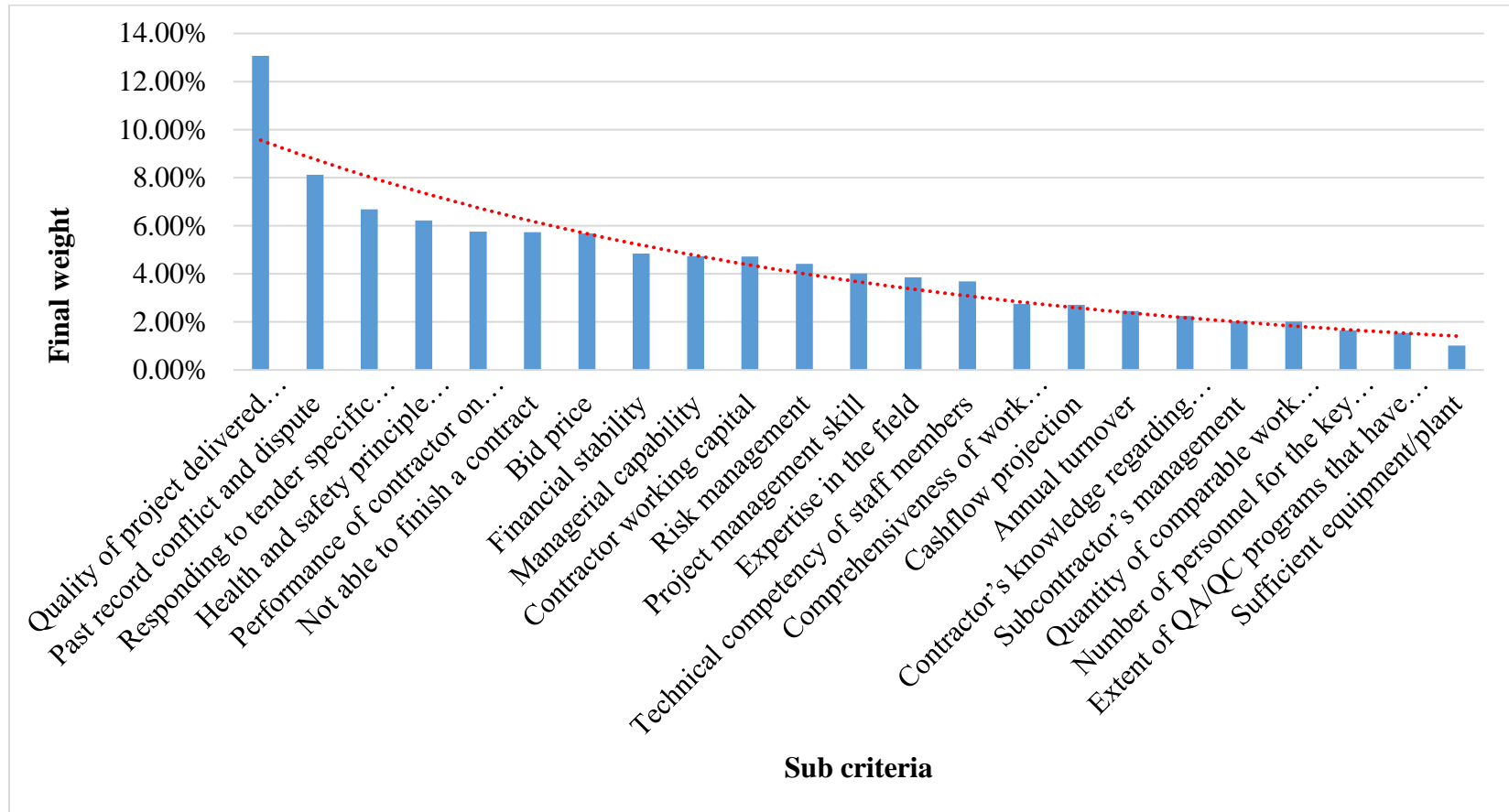


Figure 4- 12: Over all Ranking

4.5.5. Applying the Four Criteria to All of the Alternatives

Subsequently after the consistency test findings have been approved and the priority weight has been determined, apply the criteria in the AHP contractor selection process. To obtain the overall score for all categories, the tendering team must analyze each contractor on a case-by-case basis. Data from the administration were used in the investigation of contractor selection. At the end of the tender, an analysis of the contractors' choices is conducted. To create the model for assessing and identifying the best contractor relevant variables identified in this research are used as the criteria. Each priority vector for an individual criterion is represented as w_i . The priority score for each alternative is represented as SC_i . Therefore, final score is equal to

$$TS_i = \sum_1^n w_i * SC_i$$

Were,

TS_i = Total score of the contractor

n = number of sub criteria

w_i = is the global weight of the i^{th} sub criterion

sc_i = is the score of the i^{th} sub criterion that given by the owner

The project client must just assign points to each criterion in order to assess each possible contractor. After adding these points to the final equation, each contractor's overall score is determined. The contractor that scores the highest is the one who wins. The outcome of the contractor assessment, as shown in Table 4-33 the client score is entered into this table, and each contractor's score is then multiplied by w_i . Lastly, choose the highest point by adding together the column scores.

Table 4 - 33: Result of contractor evaluation criteria

No	Criteria	Weight obtained using AHP w_i	Contractors and their respective scores (sc_i)			
			1	2	3	4
1	Financial competency	0.2042				
2	Past performance competency	0.3856				
3	Technical competency	0.2416				
4	Management competency	0.1684				

$$TS_i = \sum_1^n w_i * sc_i$$

Rank

4.6. Case Study

A case study was conducted for the tender which was issued in Ethiopian Herald for the road construction project. The employer sought to assess potential bids who were capable of completing the job. Four contractors made it past the pre-qualification round out of the nine bidders who took part. All four contractors will be examined and included in the newly designed model in this case study. Prior to being assessed by the new model, the contractors were first assessed using the present selection approach and the results were compared with the present proposed model. Hence, the scenario described in the case study is one in which four contractors are thought to be on the short list for contract awards.

4.6.1. Project Information

ERA was tendered out the Construction works for the Abay River Bridge and Approach Road Design & Build Project, LOT 2: Abay River Bridge Approach Road (Re-Bid). A specific procurement notice was published in the Ethiopian Herald and posted on the ERA and public procurement and property authority websites. Following the invitation notice, nine bidders collected the tender documents before the submission deadline, including one foreign bidder and eight local contractors. Subsequently, all bidders who collected the bidding documents submitted their proposals by the bid submission deadline.

According to the requirement specified in the procurement notice and section III: Qualification criteria section of the bidding document, the information checked were presented herein below:

- ✓ Performance of Bidders on ongoing Projects

“A bidder shall be disqualified from the next step of the bidding process if ERA discovers, prior to the contract agreement being signed, that the bidder has a history of non-performance or poor performance”.

- ✓ History of Non-Performing Contracts and Pending Litigation
- ✓ Peak Annual Construction Turnover of ETB 512 million is determined by adding up all certified payments made to local bidders for contracts that have been awarded or are in the process of being awarded over the last five years.
- ✓ Average annual construction turnover of ETB 960 million calculated as total certified payments received for contracts in progress or completed within the last Five (5) years for JV of Local and Foreign Bidders and;
- ✓ Average annual construction turnover of ETB 1.281 billion calculated as total certified payments received for contracts in progress or completed within the last Five (5) years for Foreign Bidders.
- ✓ Suggested funding sources, net of current obligations, including lines of credit, liquid assets, unencumbered real estate, and other financial resources able to cover the subject's entire construction cash flow requirements of ETB 213 million for foreign bidders and ETB 160 million for local bidders; and

- ✓ Historical financial performance to confirm its current soundness and long-term profitability for the requirement of qualification document.
- ✓ Current obligations on all contracts that have been granted, those that have been the subject of a letter of intent or acceptance, and those that are almost finished but have not yet obtained an unqualified, full completion certificate

Furthermore, for Bidder's to be financially sound, the audited financial statement should be;

Local bidders: -

- ✓ Average current ratio of the last five years should be more than one (1) OR The current ratio of the recent year should be more than one (1) and
- ✓ Profit before tax of the past four years should be positive.

Foreign bidders: -

- ✓ Average current ratio of the last five years should be more than one (1)
And
- ✓ The current ratio of the recent three years should be more than one (1)
And
- ✓ Profit before tax of the past four years should be positive.

The qualification criteria of the bidding document also require bidders to have experience as contractor or management contractor or subcontractor in:

- ✓ General Construction Experience; Experience in construction contracts in the role of contractor, Joint Venture partner or sub-contractor for at least the last Two (2) years for local bidders and Five (5) years for foreign bidders prior to the submission deadline
- ✓ A minimum of one (1) project worth ETB 1.793 billion that involves road construction, upgrading, rehabilitation, or overlay;
OR
- ✓ A Minimum of Two (2) any Road Construction or Upgrading or Rehabilitation or Overlay Project with a Value of ETB 896 Million;

OR

- ✓ A minimum of three (3) asphalt road construction, upgrading, or rehabilitation projects (DBST, TST, or AC) of any type that have been effectively and significantly finished (70 percent completed) for local bidders and have a total value of ETB 597 million within the last ten (10) years
- ✓ At least Two (2) Asphalt Concrete (AC) Road Construction, Upgrading, or Rehabilitation Projects that have been effectively and significantly completed (80% Completed) within the last ten (10) years, each with a value of at least ETB 2.562 billion. For international bidders:
- ✓ Major contractor Equipment and key personnel as has to meet requirement

Accordingly, out of the (9) bidders who submitted their bids (4) bidders were qualified and responsive to the post qualification criteria set in the bidding document and recommended to the next stage of the procurement process. One bidder was eliminated from the next round due to non-responsiveness.

Following opening of the financial proposals of the responsive bidders, ERA award the bid to the least cost bidder as per the requirement of the bidding document.

4.6.2. Contractor's Profiles

The contractor's profile is studied thoroughly, and the vast details about their turnover, projects completed by them, equipment, machines, and tools owned or required by them, and the technical personnel available with them are consolidated to create a short profile that gives an idea of their strengths and weaknesses in the respective criteria under consideration. The contractors profile mentioned in tabular form as follows:

Table 4 - 34: Contractor’s profile

It. No	Applicants	Grade	Country of Registration
1	Contractor 1	GC-1	China
2	Contractor 2	GC-1	Ethiopia
3	Contractor 3	GC-1	
4	Contractor 4	GC-1	

Two processes have been used in the evaluation of bids: post-qualification and financial evaluation. After evaluating the post-qualification applications in accordance with the specifications outlined in the bidding document, TAC advised all bidders who had filed their financial bids and qualification applications to open their financial bids as shown in Table 4-35 and to be qualified.

Table 4 - 35: Contractor’s Country of Registration

Id. No	Applicants	Country of Registration	Remark
1	Contractor 1	China	Qualified
2	Contractor 2		Qualified
3	Contractor 3	Ethiopia	
4	Contractor 4		

Following the endorsement of the post-qualification evaluation outcome, applicants who are responsive to their financial bids are opened in the presence of ERA procurement endorsement committee members and representatives of the post-qualified bidders who chose to attend the opening. Finally, the evaluated bid price is shown in Table 4-36 below.

Table 4 - 36: Applicants Bid Price

I/ No	Post qualified Bidder	Read out Bid price	Country	Currency Proportion	Discount offered
1	Contractor 1	1,216,000,000.00	Ethiopia	100% ETB	None
2	Contractor 2	825,659,857.57		100% ETB	None
3	Contractor 3	970,000,000.00		100% ETB	None

I/ No	Post qualified Bidder	Read out Bid price	Country	Currency Proportion	Discount offered
4	Contractor 4	1,373,448,310.30	China	100% ETB	None

4.6.3. Comparison of Bid Price

The Engineer's estimate was prepared by XYZ consulting company and the amount of the estimate is 692,821,028.52. The corrected bid prices of each bidder expressed as percent of the corrected and adjusted Engineer's Estimate is shown in Table 4-37:

Table 4 - 37: Comparison of Bid Price with Engineer's Estimate

Id. No.	Engineer's Estimate		692,821,028.52	
	Bidders	Bidder's Bid price including 15% VAT	Difference	Percentage (%) of Bidder's bid with EE
1	Contractor 2	825,659,859.57	132,838,829.05	19.17%
2	Contractor 3	970,000,000.00	277,178,971.48	40.00%
3	Contractor 1	1,216,000,000.00	517,178,971.48	74.64%
4	Contractor 4	1,373,448,310.30	680,627,281.78	98.24%

As it can be seen from the above table, the lowest evaluated bidder's offer is 19.17% higher than the engineer's estimate. Hence, in view of the outcome of the assessment made for award, the tender analysis committee recommends that contractor 2 be invited for the pre-contract discussion and eventual award for the Construction works of the Abay River Bridge and Approach Road Design & Build Project, LOT 2: Abay River Bridge Approach Road (Re-Bid), as per the following details:

Table 4 - 38: Final Result of the Selection of the Contractor

Name:	Contractor 2
Country:	Ethiopia
Original Bid Price:	Total Lump Sum cost of ETB 825,659,859.57 including VAT
Computational Errors:	N/A
Discount (unconditional)	NONE
Proposed for Award	Total Lump Sum Cost of ETB: 825,659,857.57 (Ethiopian Birr: Eight Hundred Twenty-Five Million, Six Hundred Fifty-Nine Thousand, Eight Hundred Fifty-Seven and Cents Fifty-Seven Only) Including 15% VAT

4.6.4. Contractor Selection Based on AHP Model

A case study of the recommended AHP selection process is provided by a road construction project in the northern region. Following a prequalification process that involved reviewing their files and records, only four contractors named contractor1, contractor2, contractor3, and contractor 4 were found to be eligible for the project. The project and these four contractors are meant to serve as a prototype for validating the suggested model. The decision makers evaluate the contractor's performance in relation to the 23 sub-criteria mentioned above.

Hence the evaluation criterions are:

- Past performance competency
- Technical competency
- Financial Competency
- Management Competency

And set of alternative options as contractor '1', '2', '3', and '4'

The first phase in the AHP process is to formulate the problem and establish the decision hierarchy before moving on to the pairwise comparison. Figure 4-13 shows the problem's hierarchical structure and the flow of decision making.

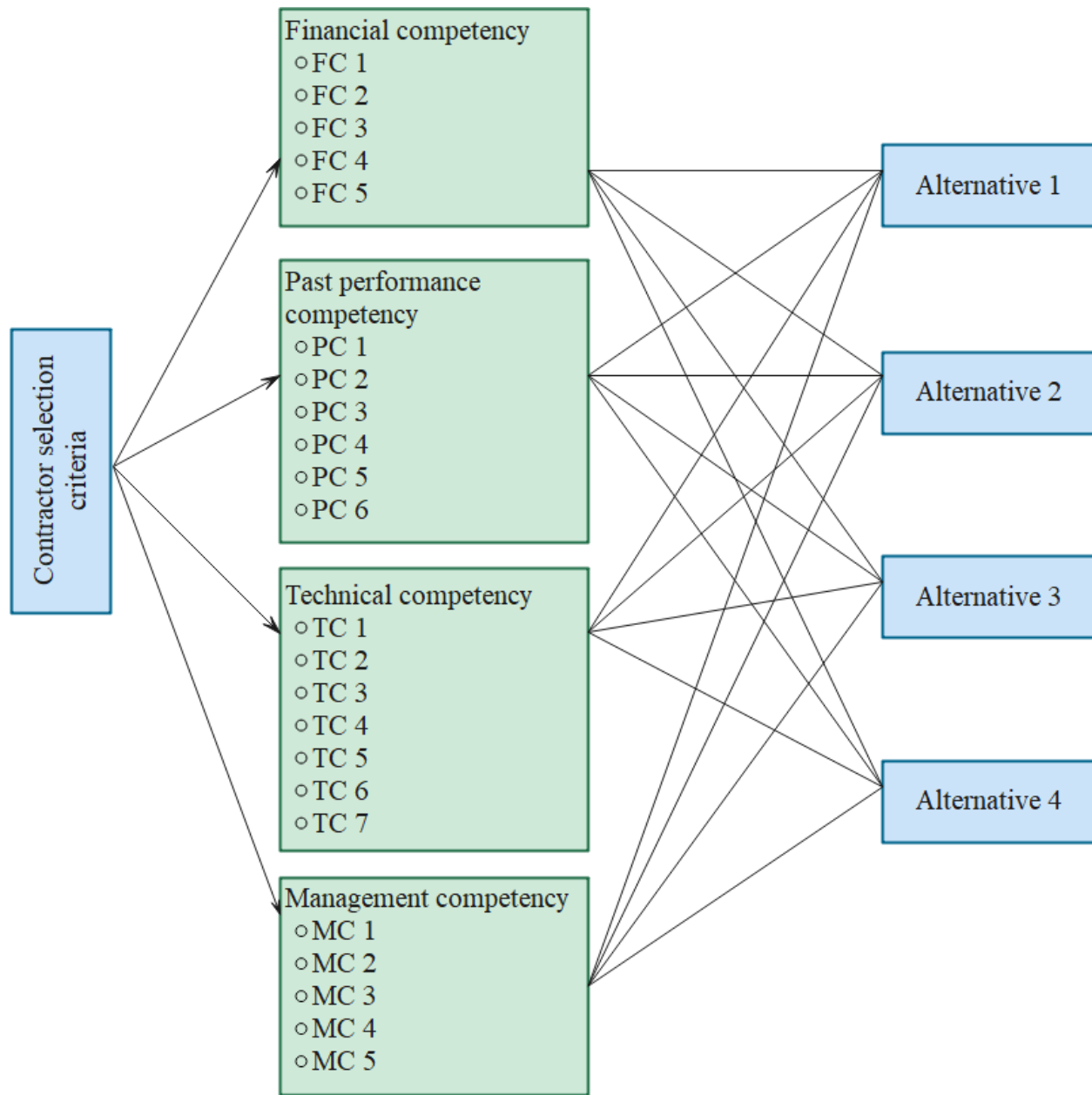


Figure 4- 13: Hierarchical Structure of the Case Study

4.6.5. Applying AHP

Saaty's AHP scale is used for a pairwise comparison following the establishment of the criteria. In the context of multi-criteria decision-making, such as this study, the Saaty's scale of comparisons provides insight into the relative significance of each choice. As was previously mentioned, each criterion is compared with another to obtain the pairwise matrix.

Table 4 - 39: Contractors Pair Wise Comparison with Respect to Main Criteria

<i>Goal</i>	<i>FC</i>	<i>PC</i>	<i>TC</i>	<i>MC</i>	Criteria weight
<i>FC</i>	0.182	0.200	0.111	0.333	0.215
<i>PC</i>	0.364	0.400	0.444	0.333	0.385
<i>TC</i>	0.364	0.200	0.222	0.167	0.238
<i>MC</i>	0.091	0.200	0.222	0.167	0.169

$\lambda_{max} = 4.19, CI = 0.06, RI = 0.89, CR = 0.069 < 0.1$ OK!

Similarly, for contractors '1', '2', '3', and '4', their respective weights, consistency index, and consistency ratio are compared with respect to the four criteria: financial competency, past performance competency, technical competency, and management competency, as illustrated in Table 4-40.

Table 4 - 40: Pairwise Comparison and Normalization Matrices for Each Criterion

Pairwise Comparison Matrix for Financial Competency					Normalization Matrix					
FC	Bidder 1	Bidder 2	Bidder 3	Bidder 4	FC	Bidder 1	Bidder 2	Bidder 3	Bidder 4	Criteria weight
Bidder 1	1	1/4	1/3	1/8	Bidder 1	0.0625	0.0285	0.0357	0.0871	0.0534
Bidder 2	4	1	2	1/7	Bidder 2	0.2500	0.1142	0.2142	0.0995	0.1695
Bidder 3	3	1/2	1	1/6	Bidder 3	0.1875	0.0571	0.1071	0.1161	0.1169
Bidder 4	8	7	6	1	Bidder 4	0.500	0.800	0.6428	0.6970	0.6599
Sum	16	8.75	9.33	1.434	$\lambda_{max} = 4.202, CI = 0.067 RI = 0.09, CR = 0.074 < 0.1$ Ok!					

Pairwise Comparison Matrix for Past Performance Competency					Normalization Matrix					
PC	Bidder 1	Bidder 2	Bidder 3	Bidder 4	PC	Bidder 1	Bidder 2	Bidder 3	Bidder 4	Criteria weight
Bidder 1	1	1/4	1/3	1/7	Bidder 1	0.0667	0.0379	0.0322	0.0946	0.0578
Bidder 2	4	1	3	1/5	Bidder 2	0.2667	0.1518	0.2903	0.1324	0.2103
Bidder 3	3	1/3	1	1/6	Bidder 3	0.200	0.0506	0.0967	0.1104	0.1144
Bidder 4	7	5	6	1	Bidder 4	0.4667	0.7594	0.5806	0.6624	0.6173
Sum	15	6.583	10.33	1.509	$\lambda_{max} = 4.228, CI = 0.076 RI = 0.09, CR = 0.0844 < 0.1$ Ok!					

Pairwise Comparison Matrix for Technical Competency					Normalization Matrix					
TC	Bidder 1	Bidder 2	Bidder 3	Bidder 4	TC	Bidder 1	Bidder 2	Bidder 3	Bidder 4	Criteria weight
Bidder 1	1	1/5	1/2	1/7	Bidder 1	0.0667	0.0259	0.0588	0.0946	0.0615
Bidder 2	5	1	2	1/6	Bidder 2	0.3333	0.1297	0.2352	0.1104	0.2022
Bidder 3	2	1/2	1	1/5	Bidder 3	0.1333	0.0649	0.1176	0.1324	0.1121
Bidder 4	7	6	5	1	Bidder 4	0.4666	0.7792	0.58823	0.6624	0.6241
Sum	15	7.7	8.5	1.509	$\lambda_{max} = 4.202, CI = 0.067, RI = 0.9, CR = 0.0750 < 0.1$ Ok!					

Pairwise Comparison Matrix for Management Competency					Normalization Matrix					
MC	Bidder 1	Bidder 2	Bidder 3	Bidder 4	MC	Bidder 1	Bidder 2	Bidder 3	Bidder 4	Criteria weight
Bidder 1	1	1/4	1/3	1/6	Bidder 1	0.0714	0.0370	0.040	0.1063	0.0637
Bidder 2	4	1	2	1/5	Bidder 2	0.2857	0.1481	0.240	0.1276	0.2003
Bidder 3	3	1/2	1	1/5	Bidder 3	0.2142	0.0740	0.120	0.1276	0.1340
Bidder 4	6	5	5	1	Bidder 4	0.4285	0.7407	0.600	0.6382	0.6019
Sum	14	6.75	8.33	1.566	$\lambda_{max} = 4.189, CI = 0.0630, RI = 0.9, CR = 0.0701 < 0.1$ Ok!					

The weights of all the calculation criteria are listed together in tabular form. Table 4-41 shows the weights of the criteria in relation to contractors.

Table 4 - 41: Criteria Weightages with Respect to Contractors

Criteria	List of bidders and their respective weightages			
	Bidder 1	Bidder 2	Bidder 3	Bidder 4
Financial Competency	0.0534	0.1695	0.1169	0.6599
Past performance competency	0.0578	0.2103	0.1144	0.6173
Technical competency	0.0615	0.2022	0.1121	0.6241
Management competency	0.0637	0.2003	0.1340	0.6019

The final step is to know the most appropriate contractor and for that global score is required. Table 4-42: represents the global score of contractors.

$$\text{Global score} = \text{Score matrix } (s) * \text{criteria weightage}(w)$$

Table 4 - 42: Global Score of Contractors

Criteria	List of bidders and their respective weightages			
	Bidder 1	Bidder 2	Bidder 3	Bidder 4
Financial Competency	0.011	0.034	0.023	0.135
Past performance competency	0.022	0.081	0.044	0.238
Technical competency	0.014	0.048	0.024	0.150
Management competency	0.010	0.033	0.023	0.101
Total score	0.057	0.196	0.114	0.623

4.6.6. Summary of the Results on Case Study

When examining the overall score, it is evident that bidder 4's score i.e. 0.623, is the highest of all bidders' global scores. Thus, it can be said that the best option is bidder 4. To determine the final score, AHP considers both the individual components of each criterion and the available options. The comparison of bidders' ranks based on established models and current practice is shown in Table 4-43.

Table 4 - 43: Rank of Bidders Based in the Two Methods

Bidders	Rank based on current practice	Rank based on developed model
1	3	4
2	1	2
3	2	3
4	4	1

4.6.7. Conclusion of the Case Study

Bidder 4 was determined to have the highest index based on the case study's findings. Despite being the highest bid price, this further supports the central idea of the study. The rankings for bidders 2 and 3 were two and three, respectively. The testing's results thus show that choosing a contractor doesn't always come down to the lowest offer price.

The differing results between the administration's method and the Analytical Hierarchy Process (AHP) can be justified by recognizing the broader scope and comprehensive evaluation offered by the AHP method. While the administration prioritizes cost efficiency, often resulting in selecting the lowest bidder, the AHP approach considers multiple criteria, such as technical expertise, financial stability, past performance, and project management capabilities. This broader evaluation ensures that the selected contractor is qualified to deliver high quality outcomes and minimize project risks.

Although cost efficiency is a crucial factor, relying solely on the lowest bid can lead to compromises in quality, delays, and higher long term costs due to rework, disputes, or suboptimal performance. The AHP ranking highlights this concern by demonstrating that contractors with the highest overall scores based on multiple qualifications are more likely to achieve project success. This does not imply that the contractor with the highest bid will always deliver better performance, but rather that a holistic evaluation of qualifications, rather than cost alone, increases the likelihood of successful project outcomes.

To reconcile these differences, the administration could benefit from integrating elements of the AHP methodology into its evaluation process. By incorporating a balanced weighting system that gives significant consideration to cost while also valuing other critical factors, the evaluation

process could better align with fiscal constraints and project goals. This approach would mitigate risks, enhance project outcomes, and ultimately contribute to more sustainable infrastructure development.

4.7. Sensitivity Analysis

Super decision software version 3.2 was used to do the sensitivity analysis, which tested the adaptability and accuracy of multi-criteria judgements through criteria change. Sensitivity analysis can be used to assess criterion values and weights. In contrast to the values, criterion weights in sensitivity analysis are more significant because of their subjectivity. It can be said that the outcomes of the multi-criteria decision analysis are sufficiently reliable and accurate if the ranking of the alternatives does not change following the sensitivity analysis. If not, criteria weights need to be reevaluated (Rikalovic A, 2015).

To see how the weights of the main criteria; financial competency, past performance competency, technical competency, and managerial competency affected the bidders' overall rating, sensitivity analysis was carried out, A \pm 10% adjustment was made to each criteria. According to the first analysis, the bidders were placed as follows: bidder 4 is the first lead, bidder 2 were placed second, bidder 3 in the third place and bidder 1 placed at the last.

The sensitivity analysis conducted using super decision software demonstrates that despite varying the percentage of weight assigned to different criteria, there is no change in the contractor selection ranking. The analysis confirms that the contractor rankings remain consistent, and no rank reversal point is observed. This indicates that the initial ranking results are stable and robust, even when subjected to changes in the weighting of the decision criteria. Figure 4- 14&15 shows that the sensitivity analysis result for the financial, past performance, technical and management competency

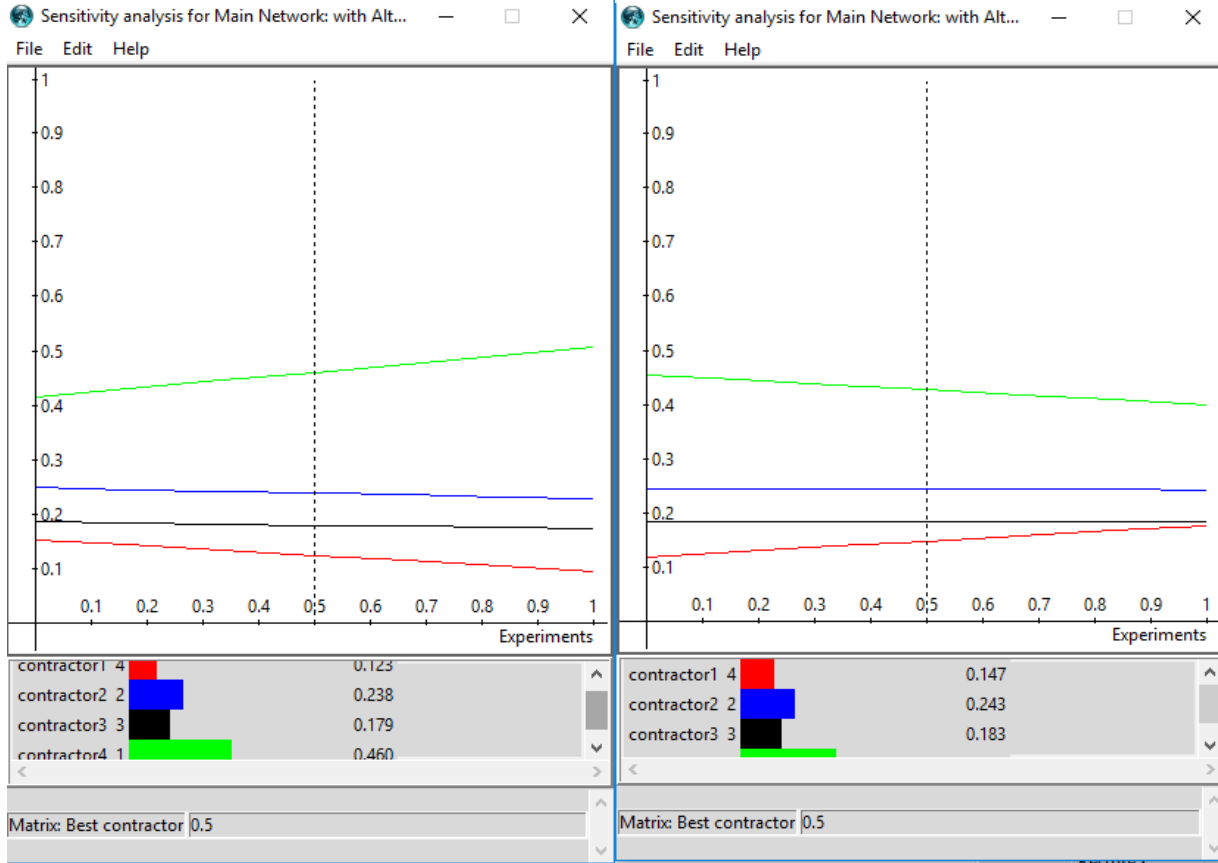


Figure 4- 14: Sensitivity Analysis With Respect to Financial and Past Performance Competency;
 Source: (super decision software, 2024)

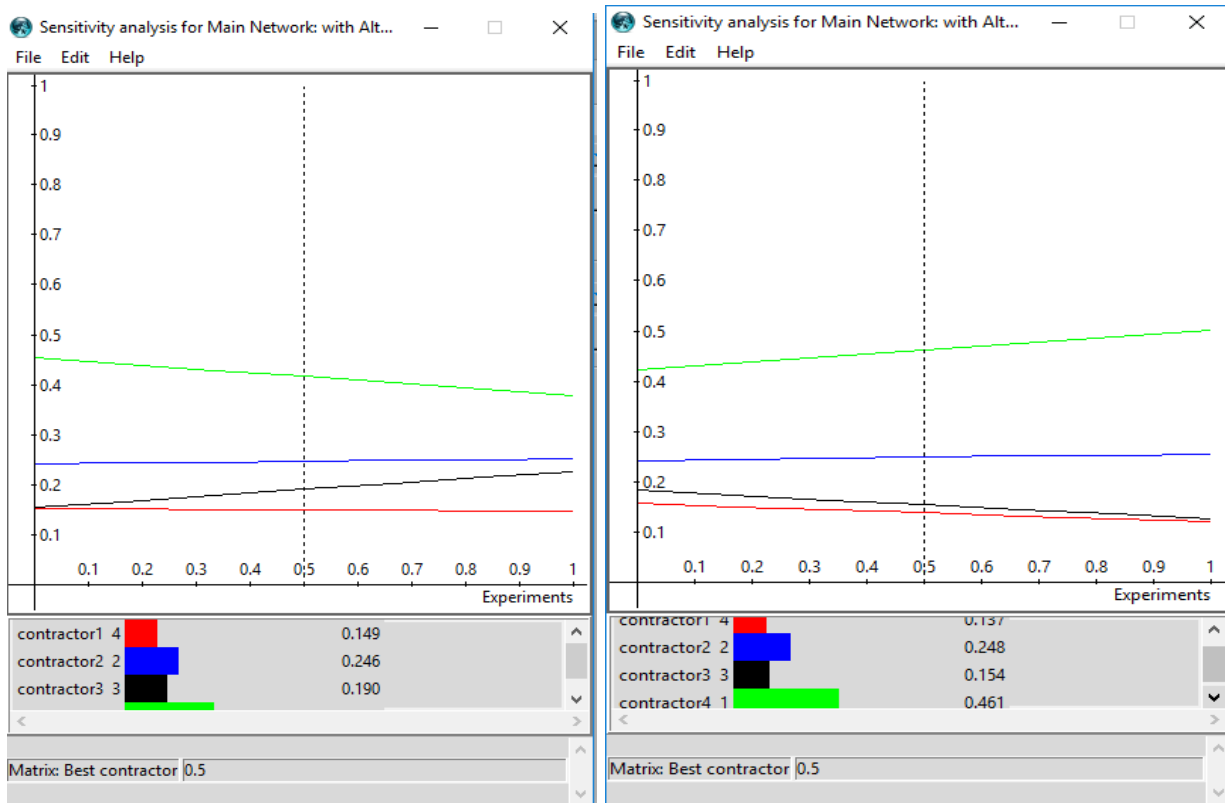


Figure 4- 15: Sensitivity Analysis with Respect to Technical & Management Competency;
Source: (super decision software, 2024)

Figure 4-16 displays the sensitivity analysis for 10% changes in financial competency, technical competency, managerial competency, and past performance. The sensitivity analysis demonstrates the robustness and adaptability of the Analytical Hierarchy Process (AHP) model. It is a critical step in validating the model, as it allows stakeholders to understand how changes in criteria weights might influence the final rankings. This transparency builds confidence in the model by illustrating that the rankings are not overly sensitive to small adjustments, thereby confirming its stability.

Furthermore, any adjustments to criteria weights should be based on objective data and a thorough understanding of project priorities. The inclusion of sensitivity analysis serves as a tool for informed decision-making rather than subjective manipulation. It provides the administration with a structured way to evaluate "what-if" scenarios and align contractor selection more closely with organizational goals and project-specific needs.

By emphasizing the methodological precision of the AHP and ensuring that adjustments follow a systematic, transparent process, this approach avoids confusion and prevents unintended misuse of the model. Additionally, the analysis highlights the importance of balancing all criteria to achieve optimal project outcomes rather than prioritizing a single factor disproportionately.

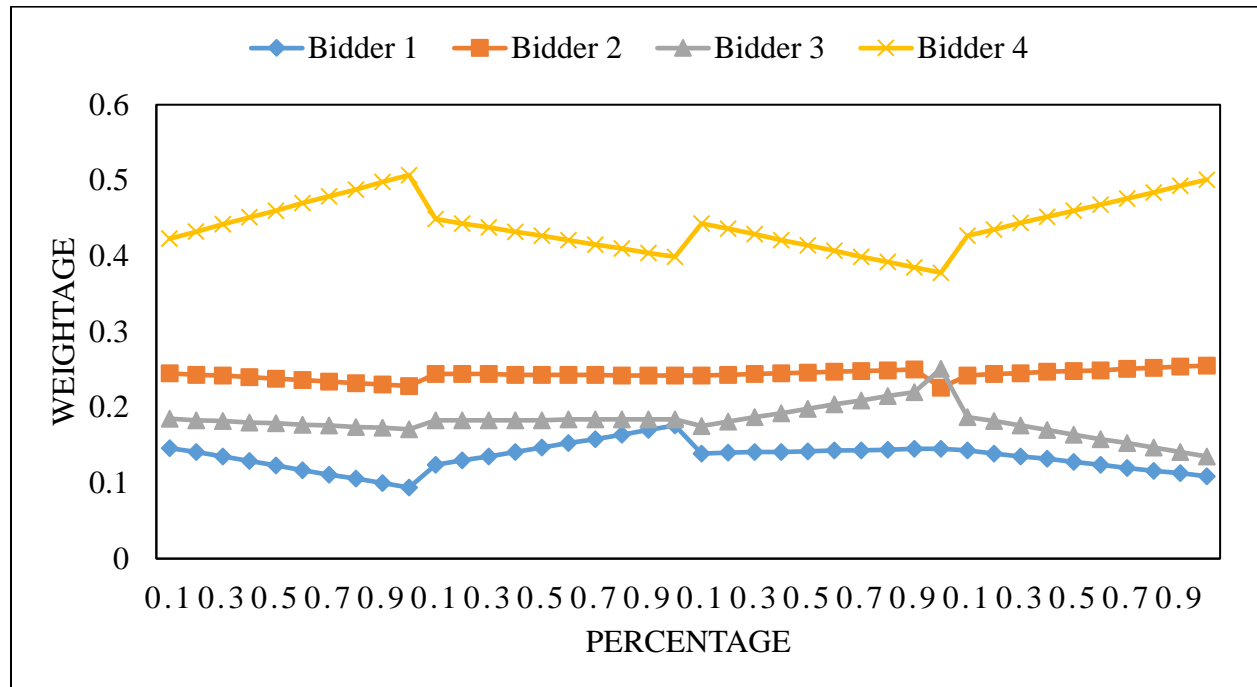


Figure 4- 16: Sensitivity Analysis for Various Percentages

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The choice of the right contractor for a given job has greatly impacted on the overall success of the project. In order to maintain cost, quality, and time, a successful completion of the project requires an effective selection process. The majority of construction clients choose the prequalified contractor whose offer is the lowest; yet, this kind of selection may lead to inefficiencies and project failures. This study developed a comprehensive decision-making model for the Ethiopian Roads Administration (ERA) aimed at enhancing the contractor selection process for road construction projects. The model leverages the Analytic Hierarchy Process (AHP), a multi-criteria decision-making method, to incorporate various factors beyond just price. Based on the results obtained from this research, the following conclusions were drawn:

- A total of 23 contractor selection criteria were identified through an extensive literature review. These criteria were categorized into four main groups: financial competency, technical competency, past performance competency, and management competency. These categories encompass both qualitative and quantitative factors that affect a contractor's ability to deliver projects within the expected time frame, budget, and quality standards.
- The Analytic Hierarchy Process (AHP) model assigned weights to these four main criteria to reflect their relative importance in the contractor selection process. The results from the AHP analysis showed that past performance competency was the most critical factor, carrying the largest weight of 38.56%. This indicates that a contractor's historical performance is the strongest predictor of their future ability to complete projects successfully. Factors under this competency, such as expertise in the field, not able to finish a contract, past record conflict and dispute, the quantity of comparable work completed by the contractor and performance of contractor on previously completed project, give clients a clear indication of how well a contractor might perform on future projects. This result is consistent with previous findings from (Alamoudi., 2015) , (Rohmat Danang, 2023) , (Watt, 2010), (Nadina Memića, 2022), (Virendra, 2023), (Reem T. Mergawy, 2023), (Khalid F. Al-Salahi, 2020), (Zubair & Hassan, 2024) and (Dissanayake, 2022), who emphasized the importance of past performance as a determinant of contractor success.

- Following past performance, technical competency was the second most important criterion, with a weight of 24.16%. Technical competency includes factors like the availability of specialized equipment, the expertise of technical staff, and the contractor's ability to implement health, safety, and quality control measures. This finding aligns with several studies, including those by (Dissanayake, 2022) , (Reuben A. Okereke, 2022), (Dedi, 2021) and (Tran Thanh Ha, 2015) which similarly emphasize the importance of a contractor's technical capability in determining the successful execution of complex road construction projects.
- Financial competency was ranked third, with a weight of 20.42%, supporting the findings of (Ekemini, 2021), who also concluded that financial capability should not be the primary contractor selection criterion but rather one of the key factors considered after technical and past performance competencies. This criterion evaluates a contractor's financial health, including their cash flow projections, bid price, and financial stability, annual turnover and working capital. Although financial strength is crucial for project sustainability, the study suggests that it should not be the primary selection criterion, as other factors like technical ability and past performance have a more direct impact on project outcomes.
- Lastly, management competency ranked fourth, with a weight of 16.84%. Although it is the least weighted of the four main criteria, it still plays an essential role in determining a contractor's ability to manage resources, personnel, and subcontractors effectively. Effective management can mitigate risks, ensure that the project remains on schedule, and address unforeseen challenges during execution.
- A case study was conducted to validate the proposed AHP model. The model was tested with four contractors engaged in an ERA road construction project. Based on the AHP assessment, Contractor 4 was selected as the most suitable choice.
- In addition to the case study, a sensitivity analysis was performed to test the stability of the model. This analysis involved adjusting the weights of the main criteria to see if the ranking of the contractors would change significantly. The results demonstrated that the model is stable, as minor variations in the weights did not affect the overall ranking of the contractors. This stability indicates that the AHP model can be a reliable tool for ERA to use in contractor selection across different projects and contexts.

- The proposed AHP-based decision-making model enhances the contractor selection process by integrating multiple key competencies including; past performance, technical ability, financial stability, and management skills. This multi-criteria approach ensures that contractors are evaluated on a broader set of factors, which not only improves project outcomes but also encourages higher standards in the industry. By adopting and potentially customizing this methodology, ERA could strengthen its contractor evaluation process, ultimately supporting improved project outcomes in terms of quality, budget adherence, and timely delivery.
- In summary, if the administration were to consider revising the current evaluation system, the findings of this study could serve as a foundational proposal for potential improvements. The results offer an alternative perspective on contractor selection, which could help inform discussions and guide future revisions of the existing process.

5.2. Recommendations

This research aimed to explore and validate the potential effectiveness of the Analytical Hierarchy Process (AHP)-based Multi Criteria Decision Analysis model for contractor selection within the context of ERA's needs. The findings and recommendations, therefore, serve as a foundational proposal that ERA could consider if it seeks to enhance its current contractor selection method to a more comprehensive evaluation model. By testing and potentially adopting the AHP model, ERA could strengthen its contractor selection process through a systematic, weighted approach that considers essential factors like past performance, technical and financial competence, and management capabilities. Therefore, the following recommendation highlights how a multi-criteria approach could reinforce ERA's evaluation process:

- It is advised that ERA should test the analytical hierarchy process (AHP) into its evaluation framework in order to improve the contractor selection procedure. This strategy guarantees a more balanced and comprehensive evaluation of possible contractors than just the lowest offer price, taking into account important variables including past performance, technical, financial, and managerial competency.
- The study's findings, suggest that the following weights might be used: technical competency (24.16%), financial competency (20.42%), managerial competency (16.84%), and past performance competency (38.56%). For typical road construction projects, the

weights in the developed multi-criteria contractor selection algorithm work well. In certain construction scenarios, such as projects with tight deadlines or those needing superior outcomes, the approach has constraints. Changes to the created multiple-criteria contractor selection model should be taken into consideration in order to get beyond these limitations. In certain instances, adding particular standards based on these demands and allocating matching weights according to their importance would improve the selection procedure.

- Since past performance was found to be the most important element, ERA ought to give this criterion more weight when evaluating candidates. This can assist in choosing contractors with a track record of completing high-quality projects on schedule and within budget.
- It is vital to reinforce the technical evaluation procedure to guarantee that bidders have the required skills and resources. This involves thorough evaluations of technical proficiency.
- Thorough examinations of the management and financial procedures should be carried out. By doing this, the hazards of unstable finances and incompetent management can be reduced, enabling the chosen contractors to oversee the project effectively.
- It is advised that the selection committee get training and capacity building programs regarding the AHP method and how to use it while choosing contractors. This will guarantee that the AHP methodology is applied consistently and effectively.

5.3. Future Research

- To further test and improve the technique, future research could explore integrating AHP with specific Multi-Criteria Decision-Making (MCDM) methods, such as TOPSIS, Fuzzy Logic, DEA, and PROMETHEE, in the contractor selection process.
- Future research could also apply the AHP-based selection process to specific project types, such as high-rise building projects or large-scale infrastructure developments like dams, to assess its adaptability and effectiveness in these contexts. This would allow for a deeper understanding of how the AHP method can be tailored to various construction sectors and provide insights into its versatility across different types of projects.

REFERENCES

- Abera., B. (2017). *Construction Procurement Practices and It's Impacts on Ethiopian Road Construction*. Addis Ababa.
- Afolayan, A. H. (2018). Evaluation of Prequalification Decision Criteria for Selecting Contractors in Nigeria using Analytic Hierarchy Process. *International Journal of Computer Applications*, 197(22), , 175-188.
- Afshar, M. A. (2017). A type-2 fuzzy set model for contractor prequalification. *Autom ConStruct* ;84, 356-66.
- Agboola S. A, U. N. (2023, September). Challenges Associated with Contractor Selection Strategy in Construction Project Delivery. *LAUTECH Journal of Civil and Environmental Studies*, 11(1), 100-106. doi:10.36108/laujoces/3202.11.0190
- Akçay, C. &. (2018). Fuzzy decision support model for the selection of contractor in construction works. *Revista de La Construcción*, , 258-266. doi:https://doi.org/10.7764/RDLC.17.2.258
- Al-Harbi, K. (2001). Application of the AHP in project management. . *International Journal of Project Management*, 19,, 19-27.
- Alhumaidi, H. M. (2015). Construction Contractors Ranking Method Using Multiple Decision-Makers and Multiattribute Fuzzy Weighted Average. *Journal of Construction Engineering & Management* 141(4)1. doi:https://doi.org/10.1061/(ASCE)CO.1943-7862.0000949
- Ali, A. M.-S.-S. (2021). Comprehensive analysis of state-of-the-art contractor selection models in construction environment-A critical review and future call. *Elsevier*, 1-17. doi:https://doi.org/10.1016/j.seps.2021.101137
- Alliance, V. C. (2008). *Best Practice Guide for Tendering and Contract Management*. Retrieved from <http://vccia.com.au/sites/default/files/2017-02/Best%20Practice%20Guide%20Final%20May08.pdf>
- Alptekin, O. &. (2017). nalysis of Criteria Influencing Contractor Selection Using TOPSIS Method. *IOP conference series: Materials Science and Engineering*, 245, 1-9. doi:10.1088/1757-899X/245/6/062003
- Anna, S. I. (2021). Analytic Hierarchy Process in Multiple–Criteria Decision–Making: A Model Example. *SHS Web of Conference* 90,0109, 1-10. doi:https://doi.org/10.1051/shsconf/20219001019
- Araujo, M. A. (2015). Contractor slection in construction industry: A multicriteria model. *International conference on industrial Engineering and Engineering Management (IEEM)*. doi:10.1109/ieem.2015.7385701
- Aruldoss M, L. T. (2013). A survey on multi criteria decision making methods and its applications. . *Am J Inf Syst ;1(1)*., 31-43.
- ASK-EHS. (2018). Selection criteria for contractors. Retrieved from <https://www.ask-ehs.com/blog/selection-criteria-for-contractors/>

- Ayettey, D. &. (2018). Contractor selection Criteria in Ghanaian Construction Industry: Benefits and Challenges. *Journal of Building Construction and Planning Research*,6, 278-297. doi:<https://doi.org/10.4236/jbcpr.2018.64019>
- Bagies, A. &. (2006). Bid/no bid decision modelling for construction projects. *Proceedings of the 22nd Annual ARCOM Conference*, 511-521.
- Balubaid, M. &. (2015). Application of the Analytical Hierarchy Process (AHP) to Multi-Criteria Analysis for Contractor Selection. *American Journal of Industrial and Business Management* , Vol. 5, 581-589.
- Banaitiene, N. &. (2006). Analysis of criteria for contractors' qualification evaluation. *Technological and Economic Development of Business Economics and Management*, 9(4). 276-282.
- Bedasso, T. B. (2020). _Factors Affecting the Implementation of Effective Public Procurement Audit in Ethiopia: The Case of Federal Public Procurement and Property Administration Agency. *Asian Journal of Basic Science & Research*, 02(01), 59-74.
- Benfares, C. A. (2021). Multi-Criteria Decision Making Semantic for Mental Healthcare. In *Research Anthology on Mental Health Stigma, Education, and Treatment*. IGI Global: Hershey, PA, USA, 178-192.
- Biruk, S. J. (2017). Modeling contractor's bidding decisions. *Procedia Engineering*, 182, 91-98.
- Bishaw, S. (2019). Development of Fuzzy Decision Model for Ethiopian Construction contractors selection. Retrieved from Available at: https://nadre.ethernet.edu.et/api/files/922d4434-0cd5-4388-9948-88a2a88b2672/DEVELOPMENT_OF_FUZZY_DECISION_MODEL_FOR_ETHIOPIAN_CONSTRUCTION_CONTRACTORS_SELECTION.pdf.
- Cheng, E. W. (2004). Contractor selection using the analytic network process. *Construction Management and Economics*, 22(10),, 1021-1032.
- Cheng, K. (2012). Integrated fuzzy preference relations with decision utilities for construction contractor selection. *J Chin Inst Eng* ;35(8), 1051-63.
- Dametachew, A. (2015). *Assessment of contractor' qualification criteria in Ethiopia federal road project tender practices*. Addis Ababa.
- Dedi, R. T. (2021, August). ANALYSIS FUZZY AHP FOR OPTIMIZATION CONTRACTOR SELECTION USING MULTI-CRITERIA IN DETERMINING THE BEST ALTERNATIVE CONTRACTOR. 2(6), 899-914. doi:<https://doi.org/10.31933/dijms.v2i6>
- Demesew, M. (2019). Assessment of Tender Evaluation System for Public Building Project Works in Ethiopia. *Thesis*.
- Dissanayake, N. S. (2022). Ranked generic criteria for \EPC contractor selection. *Engineering,construction and Architectural Management*,30 (10), 4933-4954, 1-33. doi:<https://doi.org/10.1108/ECAM-10-2021-0874>
- Doloi, H. (2009). 'Analysis of pre-qualification criteria in contractor selection and their impacts on project success'. *Construction Management and Economics Vol. 27, No. 12*, 1245-1263.

- Dwarika, P. S. (2014). Evaluating The Criteria for Contractors' Selection and Bid Evaluation. *International Journal of Engineering Science Invention*, 44-48.
- Ebrahimi A, A. M. (2016). Identification and prioritization of effective factors in assessment and ranking of contractors using fuzzy multi multicriteria techniques. *Decis Sci Lett*;5(1), 95-108.
- Edward, R. S. (2022). Applying the Analytic Hierarchy process (AHP) to expert documents. *IJAHP*, 1-14.
- Ekemini, A. J. (2021). Contractor selection using Analytical Hierarchy Process. *IOSR Journal of Computer Engineering (IOSR-JCE)*, 31-39. doi:DOI: 10.9790/0661-2303013139
- Elik, T. S. (2017). "Social Cost in Construction Projects." *Environmental Impact Assessment Review* 64. 77-86. doi:10.1016/j.eiar.2017.03.001
- Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling',. *American Journal of Theoretical and Applied Statistics* 5(1). doi:10.11648/j.ajtas.20160501.11.
- FAR. (2013, February 18). *Federal Acquisition Regulation, Section 15.304 (C)-(2) [online]*. Retrieved from <https://www.acquisition.gov/far/current/html/>
- Fekadu, G. (2013). Impacts of procurement process on contractor selection in Ethiopia Road Authority.
- Flynn, A. &. (2017). Investigating the effect of tendering capabilities on SME activity and performance in public contract competitions. *International Small Business Journal*, 35(4), 449-469.
- FPPPA. (2011). *Standard bid document for procurement of works prepared by the FPPA version I, August*. Adiss Ababa.
- Gashahun, A. D. (2020). Assessment on Impact of Covid-19 on Ethiopian Construction Industry. *Assessment on Impact of Covid-19 on Ethiopian Construction Industry*, 7.
- Gurgun, K. K. (2020). Contractor prequalification for green buildings—evidence rom Turkey. *Eng Construct Architect Manag* 27(6):, 1377-400.
- Habib, A. S. (2024). An integrated Delphi and Fuzzy AHP model for contractor selection: a case of Addis Ababa Design and Construction Works Bureau. *COGENT ENGINEERING*, 11(1), 1-25. doi:<https://doi.org/10.1080/23311916.2024.2357724>
- Hadikurniawati, W. W. (2018). Comparison of AHP-TOPSIS Hybrid Methods, WP and SAW for Multi-Attribute Decision-Making to Select The Best Electrical Expert. *J. Phys. Conf. Ser* 1114, 012100.
- Harbi, A. (2003). Contractor Selection using Analytical Hierarchy Process. *European Journal of Operational Research*,25(2):, 169-200.
- Hasnain, M. M. (2017). . "Best Value Contractor Selection in Road Construction Projects: ANP-Based Decision Support System.". *International Journal of Civil Engineering* 16, no. 6, 695-714. doi: doi:10.1007/s40999-017-0199-2

- Hosseini, N. H. (2015). A fuzzy multiple-criteria decision making model for contractor prequalification. *J.Decis Syst* , 433-448.
- Huang, X. (2011). ‘An analysis of the selection of project contractor in the construction management process’. *International Journal of Business and Management, Vol. 6, No. 3*, 184-189.
- Huo, T. L. (2015). A group decision-making aggregation model for contractor selection in large scale construction projects based on two-stage partial least squares (PLS) path modeling. . *Group Decis Negot* 24(5), 855-83.
- Idrus, A. S. (2011). Decision criteria for selecting main contractors in Malaysia. *Res. Journal of Applied Science and Engineering Technology, Vol. 3, No. 12.*, 1358-1365.
- Iman, N. R. (2023). Analytic Hierarchy Process for Determination of Decision Making in the Selection of Contractors. *Jurnal Industry Xplore*, 8(1), 1-9.
- Jabbar. (2017). Research methodology, SpringerBriefs in Applied Sciences and Technology. doi:10.1007/978-3-319-65457-7_3.
- Jafari, A. (2013). A contractor pre-qualification model based on the quality function deployment method. *Construction Management and Economics*,31(7), 746-760.
- Jato, C.-L. E.-H.-J. (2014). A review of application of multi-criteria decision making methods in construction. *Autom ConStruct* 45:, 151-62.
- Jung, H. a. (2011). Optimization model for quality and cost of modular software systems. *European Journal of Operational Research* 122(3), 213-227.
- Kaklauskas, A. Z. (2006). Selection of low-e windows in retrofit of public buildings by applying multiple criteria method COPRAS A Lithuanian case. *Energy and Buildings*, 38(5),, 454-462.
- Khalid F. AI-Salahi, K. K. (2020, December). Evaluation of the critical Success Factors (CSFs) in selecting Building contractors using Pareto Analysis and the Analytical Hierarchy Process. *JJournal of Engg.Research*, 8. doi:https://doi.org/10.36909/jer.v8i4.9123
- Khoso, A. Y. (2021). Embedded Remote Group Environment Through Modification In Macbeth-An Application of contractor's Selection In Construction. *Journal of Civil Engineering and Management*,27(8), 595-616.
- Khoso, Y. (2020). ‘Extended review on contractor selection in construction projects’. *Canadian Journal of Civil Engineering, Vol. 47, No. 7*, 771-789.
- Konrad, K. B. (2021). Understanding the Analytic Hierarchy Process. *Chapman and Hall/CRC, Taylor & Francis Group, 2021, 262 pp., \$130.00 (Hardback), ISBN 978-1-1380-3232-3.*, 278-279. doi:https://doi.org/10.1080/00401706.2021.1904744
- Linh, N. T. (2019). APPLYING ANALYTIC HIERARCHY PROCESS (AHP) TO SELECT CLIMATE CHANGE ADAPTATION METHODS IN AGRICULTURAL SECTOR: A LITERATURE REVIEW. *128*, 155-168. doi:10.26459/hueuni-jed.v128i5C.5132

- Liu H, Y. T. (2007). Bidding-evaluation of construction projects based on VIKOR method. . In: *2007 IEEE international conference on automation and Logistics*, 1778-82.
- Liu J, C. Z. (2018). Experimental investigation of the impact of risk preference on construction bid markups. *Journal of Management in Engineering* 34(3):04018003. doi:10.1061/(ASCE)ME.1943-5479.0000596
- Manideepak, G. B. (2009). *Methodologies for Contractor selection in construction industry*, ACSGE BITS . Pilani, India.
- Maqsoom, A. B. (2019). Optimizing contractor's selection and bid evaluation process in construction industry: client's perspective. *Revista de la Construcción* 18(3), 445-58.
- Maqsoom, A. B. (2020). Optimizing contractor's selection and bid evaluation process in construction industry: Client's perspective. *Revista De La Construcción. Journal of construction*, 18(3),445-458. Retrieved from <http://revistadelaconstruccion.uc.cl/index.php/RDLC/article/view/10434>
- Marzouk, M. E. (2013). Factors influencing sub-contractors selection in construction projects. Housing and building national research center (HBRC) Journal,9,. 150-158.
- Meghalkumar, I. z. (2011). An Approach of contractor selection Analytical Heirarchy Process. *National Conference on Recent Trends in Engineering & Technology*, 1-6.
- Mehrabani, M. G. (2020). Scoring of tenders in construction projects using group method of data handling. *KSCE J. Civ. Eng ;24.*, 1996-2008..
- Mitikie, H. A. (2024). An integrated Delphi and Fuzzy AHP model for contractor selection: a case of Addis Ababa Design and Construction Works Bureau. *cogent Engineering*, 11(1), 1-25. doi:<https://doi.org/10.1080/23311916.2024.2357724>
- Mitiku, B. (2022). DEVELOPMENT OF BUILDING DEVELOPMENT OF BUILDING DECISION MAKING MODEL USING ANALYTICAL NETWORK PROCESS A CASE OF AMHARA REGION. *Downloaded from DSpace Repository, DSpace Institution's institutional repository*. Retrieved from <http://ir.bdu.edu.et/handle/123456789/14659>
- Morkfinate, Z. P. (2017). Selection Criteria for Evaluating Contractors of Cultural Heritage Objects. *Procedia Engineering*, 208, 90-97.
- Nadina Memića, A. T. (2022). contractor competencies are valuable for the client in the pre-construction phase? *International Conference on ENTERprise information systems/proj management/HCist-International conference on health and social care Information Sysyems and Technologies*, 1901-1908.
- Nasab, H. &. (2015). A fuzzy multiple-criteria decision-making model for contractor prequalification. *Journal of Decision Systems*, Vol. 24, No. 4, 433-448.
- Nassar K, H. O. (2013). Fuzzy clustering validity for contractor performance evaluation: application to UAE contractors. *Autom ConStruct* , 158-68.
- Niewerth S, V. P. (2020). Tender evaluation through efficiency analysis for public construction contracts. *Front Eng Manag.*, 1-11.

- Ojokoh, A. (2021). ANALYSIS OF MULTI-CRITERIA DECISION MAKING METHODS FOR CONTRACTOR SELECTION IN NIGERIA. *e-Governance Conference*, 192-210.
- Olatunji, O. A. (2017). Bid or no-bid decision factors of indigenous contractors in Nigeria. *Engineering, Construction and Architectural Management*, 24(3), 378-392.
- Ozden. (2006). Use of Analytic Network Process in selection decision. *European Journal of Operational Research* 169(4).
- Park, J. a. (2017). “Design-Bid-Build (DBB) Vs. Design-Build (DB) in the U.S. Public Transportation Projects: The Choice and Consequences. *International Journal of Project Management* 35, no. 3, 280-295. doi:10.1016/j.ijproman.2016.10.013
- PCC. (2012, February 06). *egulation for the most advantageous tender[online]*. Retrieved from Public construction, executive Yuan, Taiwan: <http://www.pcc.gov.tw/upload/article/ed10.doc>
- Plebankiewicz, E. (2009). Contractor Prequalification Model Using Fuzzy Sets. *Journal of Civil Engineering and Management*. 15(4). 377-385.
- Polat, G. (2016). Subcontractor selection using the integration of the AHP and PROMETHEE Methods. *Journal of Civil Engineering and Management*,22(8), 1042-1054.
- Prolay, D. D. (2021). Selection of Construction Contractor by Analytical Hierarchy Process (AHP). *International Journal of Scientific Research and Engineering Development*, 4(4), 320-326. Retrieved from www.ijred.com
- Rahimdel, M. J. (2014). Application of analytical hierarchy process to selection of primary crusher. *International Journal of Mining Science and Technology*, 24(4), 519-523.
- Raju, P. e. (2017). The Criteria for Contractors’ Selection and Bid Evaluation & Factors Affecting Bidding Strategy in Construction. *International Journal of scientific Development and*
- Rashid, i. M. (2017). Contractor Selection Criteria for Construction Projects. *Journal of Engineering and Applied Sciences*, 12 (23), 733.
- Rashid, I. S. (2018). Contractor Selection Criteria; a study of Malaysain Public Construction Projects. *International Journal of Engineering & Technology Vol 7 (3.25)*, 65-70.
- Rashvand, P. M. (2015). “Contractor Selection at Prequalification Stage Current Evaluation and Shortcomings. *Jurnal Teknologi*, 81-89.
- Reem T. Mergawy, H. E. (2023). Decision support model for contractor selection. *The Open Civil Engineering Journal*, 17. doi:10.2174/18741495-v17-e230215-2022-51,2023,e187414952301270
- Reuben A. Okereke, D. I. (2022). Assesment of tha major contractors selection criteria and their impacts in civil Engineering construction project. *Journal of Engineering and Technology for Industrial Applications*, 8, 4-13. doi:<https://doi.org/10.5935/jetia.v8i36.820>
- Rohmat Danang, N. R. (2023). contractor selection startegy to minimize subcontractor performance prblems using Analytical Hierarchy process method: case study at PT.

- Hutama Karya infrastructure. *Quantitative Economics and management studies, Vol.4 No.4(2023)*, 794-800. doi:<https://doi.org/10.35877/454RI.qems1830>
- Russell, J. a. (1988). Decision criteria in contractor pre -qualification. *Journal of Management in Engineering, 4(2)*, 148-64.
- Safa. (2016). Optimizing contractor selection for construction packages in capital projects. *J Comput Civ Eng;30(5):04016002*.
- Salama, M. E. (2006). Investigating the criteria for contractors' selection and bid evaluation in Egypt. In: Boyd, D (Ed) Procs 22nd Annual ARCOM Conference, 4-6 september 2006, Birmingham, UK, Association of Researchers in Construction Management. 531-540.
- Sanjana Patil1, B. K. (2020). Review of Contractor Prequalification Criteria and their Impact on Project Success Factors. *International Journal of Rsearch in Engineering, science and Management*, 298-302.
- Scott, S., Molenaar, K., Gransberg, D., & Smith, N. (2006). *Best- value procurement methods for highway consruction projects. Report No.561,project No.10-61. NCHRP, Transportation Research Board, National Research Council*. Washington, D.C.213p.
- Senthil S, S. B. (2014). A robust hybrid multi-criteria decision making methodology for contractor evaluation and selection in third-party reverse logistics. . *Expert Syst Appl;41(1)*, 50-8.
- Shanti, D. S. (2017). *Handbook of Research Methdology*. New Delhi: Education Publishing.
- Shash, A. a.-H. (1993). The effect of contractor size on mark -up size decision in Saudi Arabia. *construction Management and Economics, 11*, 421-9.
- Shumie, L. S. (2019). Contractors Incompetency vs . Performance of Water Supply. *Thesis*.
- Sidik, M. I. (2020). Contractor Selection for Construction Works in Ghana: Towards Policy and Practice. . *Civil and Enivronmental Research, 12(7)*, 59-69.
- Siferaw, B. (2019). Development of Fuzzy Decsion Model for Ethiopian Construction Contractor Selection. *Thesis*.
- Siraj, J. A. (2021). Application of Analytical Hierarchy Process (AHP) in Construction Works. *International Journal of Engineering Research & Technology (IJERT, 9(3)*, 134-137. doi:<https://www.researchgate.net/publication/349534515>
- Suliman, H. A. (2017). Causes and Effects of Cost Overrun on Construction Project in Bahrain: Part I (Ranking of cost overrun factors and risk mapping). *Causes and Effects of Cost Overrun on Construction Project in Bahrain: Part I (Ranking of cost overrun factors and risk mapping)*. Retrieved from <https://doi.org/10.5539/mas.v11n7p20>
- Sürücü, L. &. (2020). VALIDITY AND RELIABILITY IN QUANTITATIVE RESEARCH. *BUSINESS & MANAGEMENT STUDIES: AN INTERNATIONAL JOURNAL, 2694-2726*. doi:<https://doi.org/10.15295/bmij.v8i3>
- Tam, M. a. (2014). An Application of the AHP in vendor selection of a telecommunication system. *Omega 29(2)*, 171-182.

- Tarawneh, S. (2004). Evaluation of Pre-qualification Criteria: Client Perspective; Jordan Case Study. *Journal of Applied Sciences*, 4(3), 354-363.
- Topcu, Y. I. (2004). A decision model proposal for construction contractor selection in Turkey. *Building and Environment*, 39(4), 469-481.
- Tran Thanh Ha, L. L. (2015). A Fuzzy AHP Model for Selection of Consultant Contractor in Bidding Phase in Vietnam. *KICEM Journal of Construction Engineering and Project Management*, 35-43. doi:<http://dx.doi.org/10.6106/JCEPM.2015.5.2.035>
- Turskis, Z. T. (2008). Contractor selection of construction in a competitive environment. *Journal business economics and management* 3:181-187, 181-187.
- Virendra, B. a. (2023). KEY CONTRACTOR SELECTION CRITERIA FOR DB-EPC PROJECTS IN CONSTRUCTION. *Industrial Engineering Journal*, Volume : 52(Issue 4), 1986-1999.
- Walker, D. H. (2016). “Reflecting on 10 Years of Focus on Innovation, Organisational Learning and Knowledge Management Literature in a Construction Project Management Context. *Construction Innovation* 16, no. 2, 114-126. doi:10.1108/ci-12-2015-0066
- Wang W-C, Y. W.-d.-T.-C.-T.-Y. (2013). Applying the AHP to support the best-value contractor selection – lessons learned from two case studies in Taiwan. *Journal of Civil Engineering and Management*, 19(1), 24–36, 24-36. doi:<https://doi.org/10.3846/13923730.2012.734851>
- Watt, D. K. (2010). ‘The relative importance of tender evaluation and contractor selection criteria’. *International Journal of Project Management*, Vol. 28, No. 1,, 51-60.
- Wong, C. H. (2003). Developing a contractor classification model using a multivariate discriminate analysis approach, *Engineering Construction and Architectural Management* 4(20). 247-255.
- WUBE, M. D. (2019). *Assessment of Tender Evaluation System for Public Building Project Works in Ethiopia*. Addis Ababa.
- Yang I-T, W. W.-C.-I. (2012). Automatic repair of inconsistent pairwise weighting matrices in analytic hierarchy process. *Automation in Construction*, 22,, 290-297. doi:<https://doi.org/10.1016/j.autcon.2011.09.004>
- Zavadskas, E. K. (2008). Contractor selection of construction in a competitive environment. *Journal of Business Economics and Management*, 9(3),. 181-187.
- Zerfu, T. (2021). *Assessment of Bidders qualification Criteria in Tender Evaluation Process, A case of Jimma City Public Building Projects*. Jimma.
- Zhao J, Y. X.-Y.-C.-M. (2017). An extended VIKOR method using intuitionistic fuzzy sets and combination weights for supplier selection. . *Symmetry* 9(9), 169.
- Zubair, M. F., & Hassan, M. ., (2024). Framework for Strategic Selection of Maintenance Contractor. *Suitability*, 16. doi:<https://doi.org/10.3390/su16062488>

APPENDIX A: QUESTIONNAIRE

Letter of Introduction

Dear Respondent,

RE: Research Questionnaire

Hello, my name is Eden Mershaye, and I am currently engaged in a graduate program at Addis Ababa University Institute of Technology. Right now, I am working on a research paper as part of my MSc study on “**Analytical Hierarchy Process-Based Multi-Criteria Decision Analysis for Contractor Selection: A Case of Ethiopian Road Administration.**” The purpose of this research is to create a thorough framework for decision-making that will aid in the selection of contractors. To achieve this, the study will employ the Analytical Hierarchy Process (AHP) to identify and assess the critical selection criteria that used to choose contractor, ultimately improving the effectiveness and efficiency of contractor selection within the Ethiopian Road Administration. As part of this research, a questionnaire has been developed to collect insightful feedback from professionals and stakeholders who are involved in the contractor selection process. Your knowledge and experience in this area would be greatly helpful to the success of this research, so I kindly ask for your assistance in answering the enclosed questionnaire.

I would like to assure you that your response will be kept totally confidential and will be used for academic research purpose only. Furthermore, your prompt answer is critical in order to complete the research paper on time.

Lastly, I would like to take this chance to express my gratitude for your cooperation and the time you took to complete the enclosed questionnaire.

Sincerely,

Eden Mershaye

MSc. Student AAiT, AAU

E-mail: edenmershaye@gmail.com

Section A: Demographic Information

Kindly indicate your response by marking “X” in the designated space when applicable. Please fill in the designated space with your response if it differs from the one that is requested. When required and necessary, you may mark multiple responses. If the area allotted is insufficient, you may also use extra paper.

1. General Information about the respondents.

1.1.Name of organization/company (optional).....

1.2.In which company are you currently engaged?

Contractor

Employer

Consultant

Individual Expert

1.3. How old is your organization?

<5 Years

5-10Years

10-15 Years

>15 Years

1.4.What is your educational qualification?

Master’s Degree (MSc)

Bachelor degree

Advanced Diploma

Other (please specify)

1.5. What is your field of specialization?

Civil Engineer

Architecture

Construction Technology and Management

Other (Please Specify)
.....

1.6.What is your status in your organization?

Managing director

Director

Manager

Senior Staff

Supervisor

1.7.For how long has your organization been involved in the road construction sector (years of experience in road projects)?

<5 Years

5-10Years

10-15 Years

>15 Years

1.8.How long is your overall work experience?

<5 Years

5-10Years

10-15 Years

>15 Years

1.9.How long have you served your organization in the road construction sector (Year of service)?

<5 Years

5-10Years

10-15 Years

>15 Years

Section B: Contractors' Selection Criteria during Tender Evaluation

This section tries to show list of different contractors' selection criteria. Using a Likert scale, indicate which of the following statements you agree or disagree with: 5: strongly agree (SA), 4: agree (A), 3: neutral (N), 2: disagree (D), and 1: strongly disagree (SD). Please mark (X) the option on the following list that best fits your response.

Item	Description	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Technical competency of staff members					
2	Risk management					
3	Past record conflict and dispute					
4	Cash flow projection					
5	Bid price					
6	Number of personnel for the key position					
7	Project management skill					
8	Expertise in the Field					
9	Contractors' total working capital					
10	Contractors' knowledge regarding with work methodology					
11	Annual Turnover					
12	The extent of QA/QC programs that have been used in previous projects					
13	Managerial capability					
14	The comprehensiveness of the work technique descriptions					
15	The quality of the project facility is delivered according to the allocated time and budget					

16	Financial stability					
17	Sufficient equipment/plant					
18	Responding to tender specific requirements					
19	Subcontractors' management skills					
20	Not able to finish a contract					
21	Health and safety implementation					
22	Performance of contractor on previously completed project					
23	The quantity of comparable work completed by the contractors' team					

Please describe any other selection criteria that may represent the outcome of the project.

.....

.....

.....

.....

APPENDIX B: PAIRWISE QUESTIONNAIRE

Second Round Pairwise Questionnaire

The second-round questionnaire were asked on pairwise questions of criteria. They were organized in to two sections; pair-wise comparison between major criteria with respect to the goal and pair wise comparison between sub criteria with respect to major criteria.

Pair wise questions of main criteria with respect to main criteria

In selecting the most appropriate road contractor, given the paired main factors, which affects the contractor selection more. Then choose one which one is better one from the other. To show your response, please:

Tick on the box which of these two factors you believe is affect more according to the scale shown in the following:

- 1: Equal importance
- 3: Somewhat more importance
- 5: Much more important
- 7: Very much important
- 9: Absolutely more important
- 2, 4, 6, 8: Intermediate values

Questionnaire for criteria weight calculation																		
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Financial competency																		Past performance competency
Financial competency																		Technical competency
Financial competency																		Management competency
Past performance competency																		Technical competency
Past performance competency																		Management competency
Technical competency																		Management competency
Annual turnover																		Working capital
Annual turnover																		Financial stability
Annual turnover																		Bid price
Annual turnover																		Cash flow projection
Working capital																		Financial stability
Working capital																		Bid price
Working capital																		Cash flow projection
Financial stability																		Bid price
Financial stability																		Cash flow projection

Questionnaire for criteria weight calculation																		
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Expertise in the field																		Not able to finish a contract
Bid price																		Cash flow projection
Expertise in the field																		Past record conflict and dispute
Expertise in the field																		Qty. of work completed by the contractor
Expertise in the field																		Performance of cont. on previous projects
Not able to finish a contract																		Past record conflict and dispute
Not able to finish a contract																		Qty. of work completed by the contractor
Not able to finish a contract																		Performance of cont. on previous projects
Not able to finish a contract																		Quality of the project
Past record conflict and dispute																		Qty. of work completed by the contractor
Past record conflict and dispute																		Performance of cont. on previous projects
Past record conflict and dispute																		Quality of project

Questionnaire for criteria weight calculation																		
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Quantity of comparable work																		Performance of cont. on previous projects
Quantity of comparable work																		Quality of project
Performance of cont. on previous projects																		Quality of project
Sufficient equipment																		Technical competency
Sufficient equipment																		Contractors knowledge on work methodology
Sufficient equipment																		HSE implementation
Sufficient equipment																		QA/QC programs used in the previous project
Sufficient equipment																		Comprehensiveness of work technique description
Sufficient equipment																		Responding to tender requirement
Technical competency																		Cont. knowledge with work methodology
Technical competency																		HSE implementation
Technical competency																		QA/QC programs
Technical competency																		Comprehensiveness of work technique description

Questionnaire for criteria weight calculation																		
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Technical competency																		Responding to tender requirements
Cont. knowledge with work methodology																		HSE implementation
Cont. knowledge with work methodology																		QA/QC programs
Cont. knowledge with work methodology																		Comprehensiveness of work technique description
Cont. knowledge with work methodology																		Responding to tender requirements
HSE implementation																		QA/QC programs
HSE implementation																		Comprehensiveness of work technique description
SE implementation																		Responding to tender requirements
QA/QC programs																		Comprehensiveness of work technique description
QA/QC programs																		Responding to tender requirements
Project management skill																		Risk management
Project management skill																		Number of personnel

Questionnaire for criteria weight calculation																		
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Project management skill																		Sub-contractors management
Risk management																		Number of personnel
Risk management																		Managerial capability
Risk management																		Subcontractors management
Number of personnel																		Managerial capability
Number of personnel																		Sub-contractors management
Managerial capability																		Subcontractor management

APPENDIX C: AHP MODEL PAIRWISE COMPARISONS JUDGEMENTS

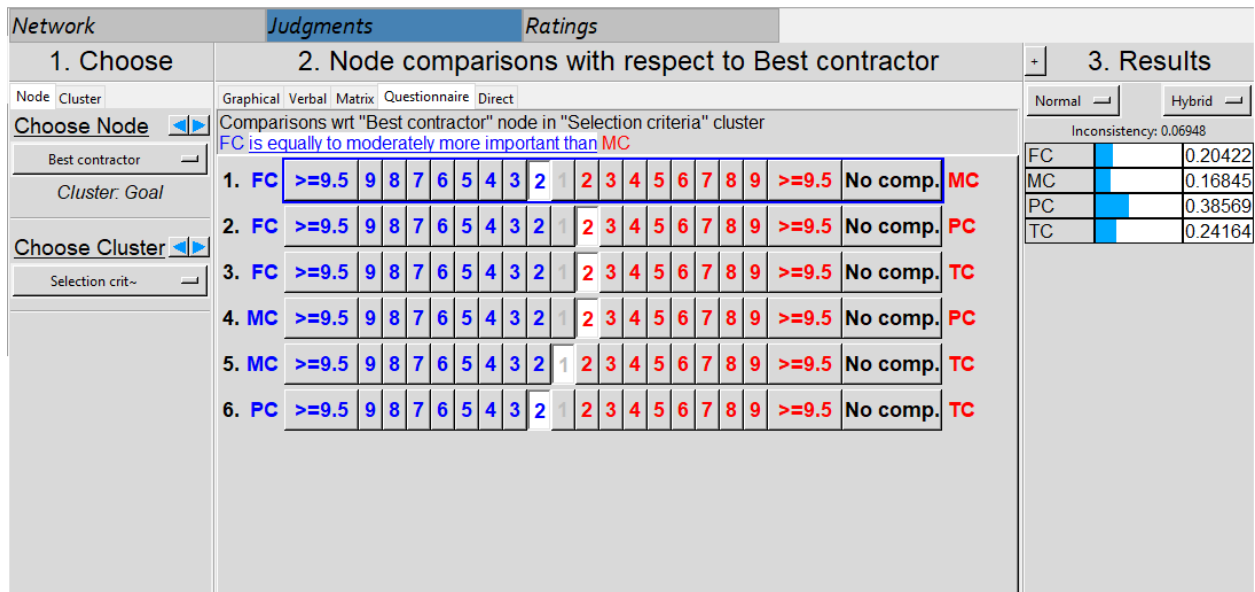


Figure 1: Pairwise Comparisons with Respect to Goal; Source: (super decision software, 2024)

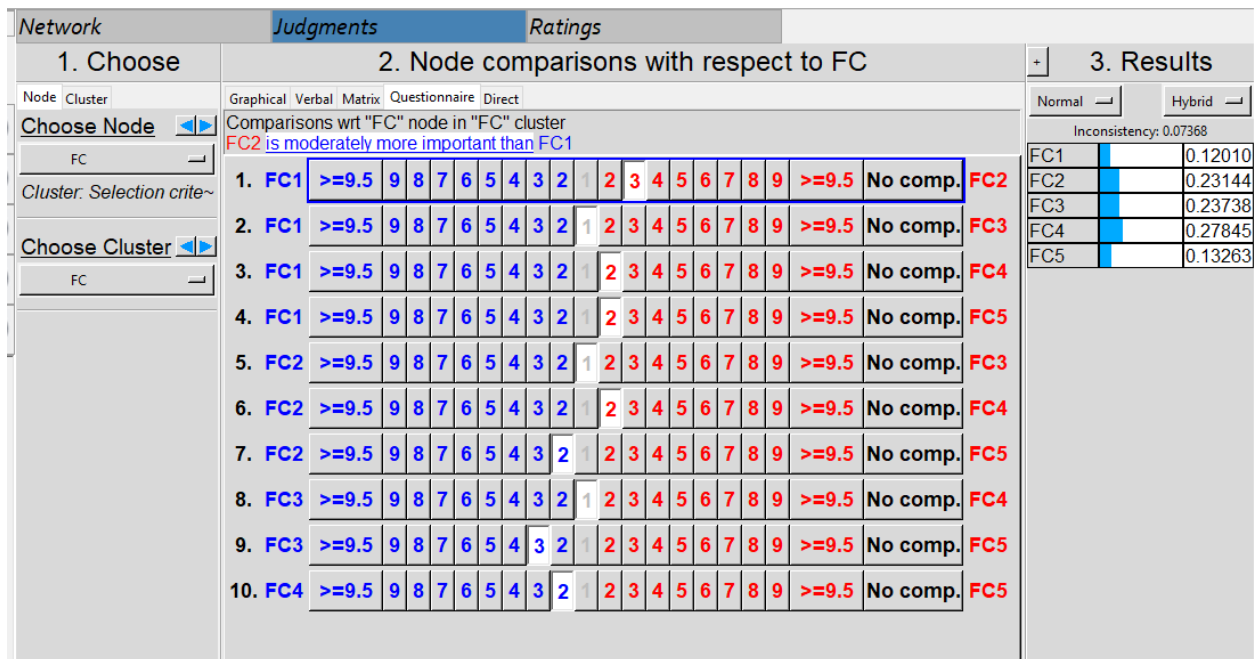


Figure 2: Pairwise Comparisons with Respect to Financial Competency; Source: (super decision software, 2024)

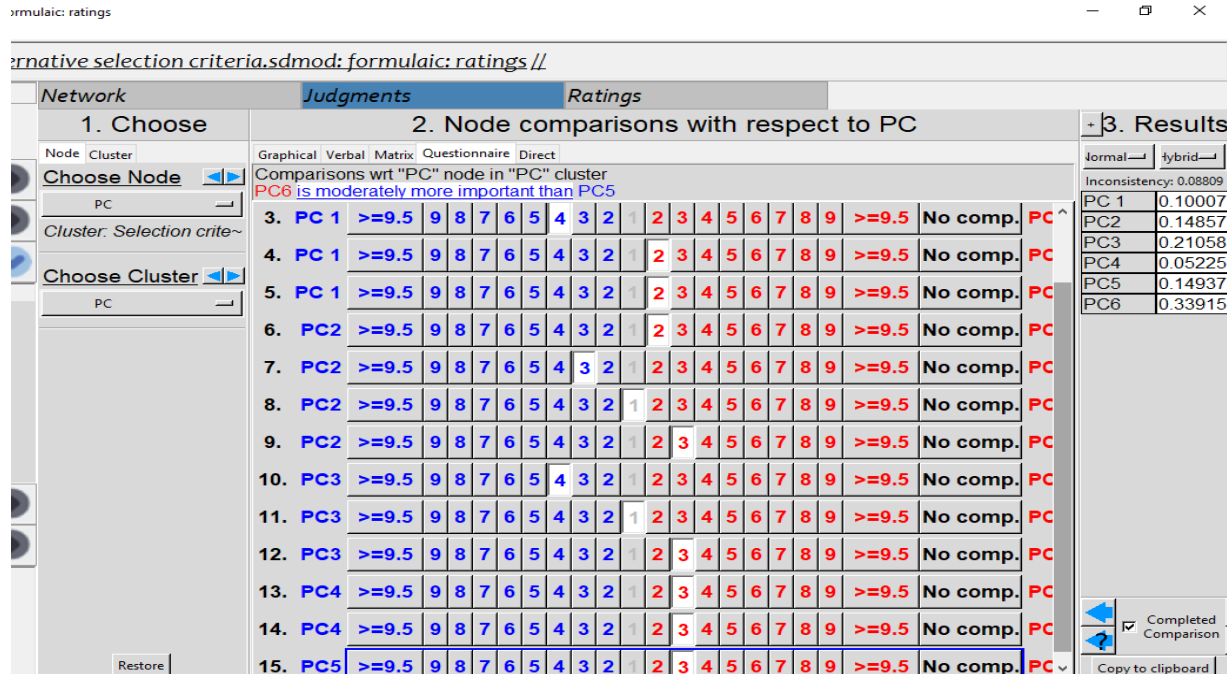


Figure 3: Pairwise Comparisons with Respect to Past Performance Competency; Source: (super decision software, 2024)

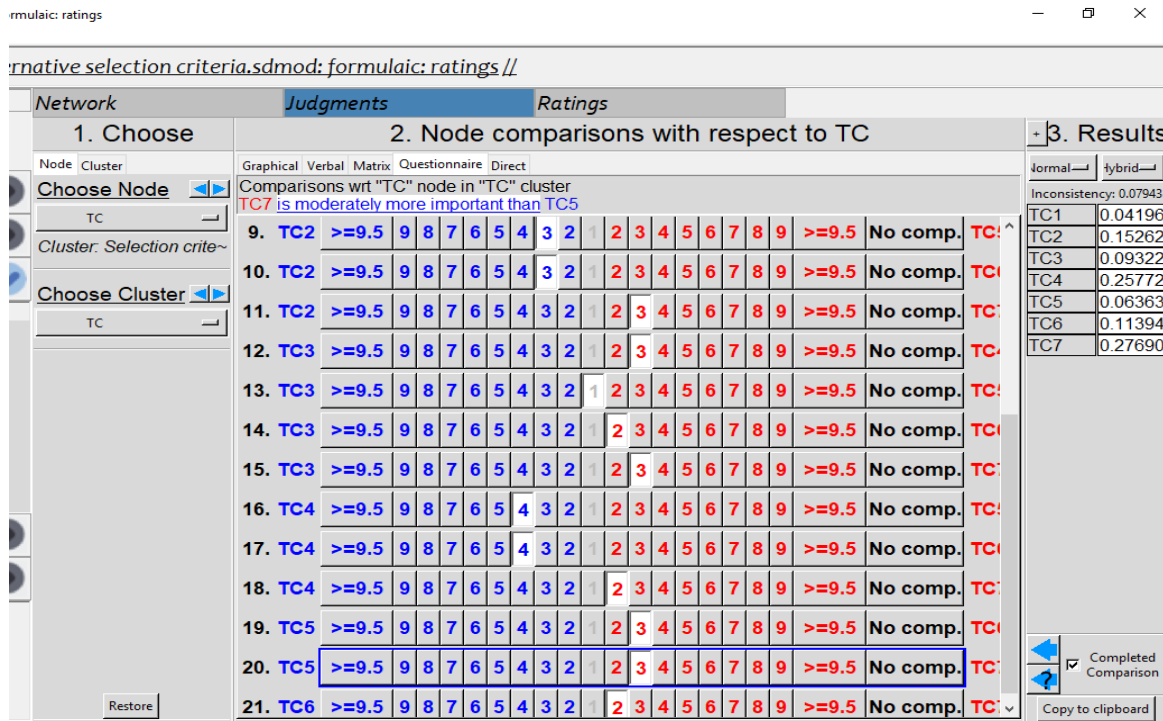


Figure 4: Pairwise Comparisons with Respect to Technical Competency; Source: (super decision software, 2024)

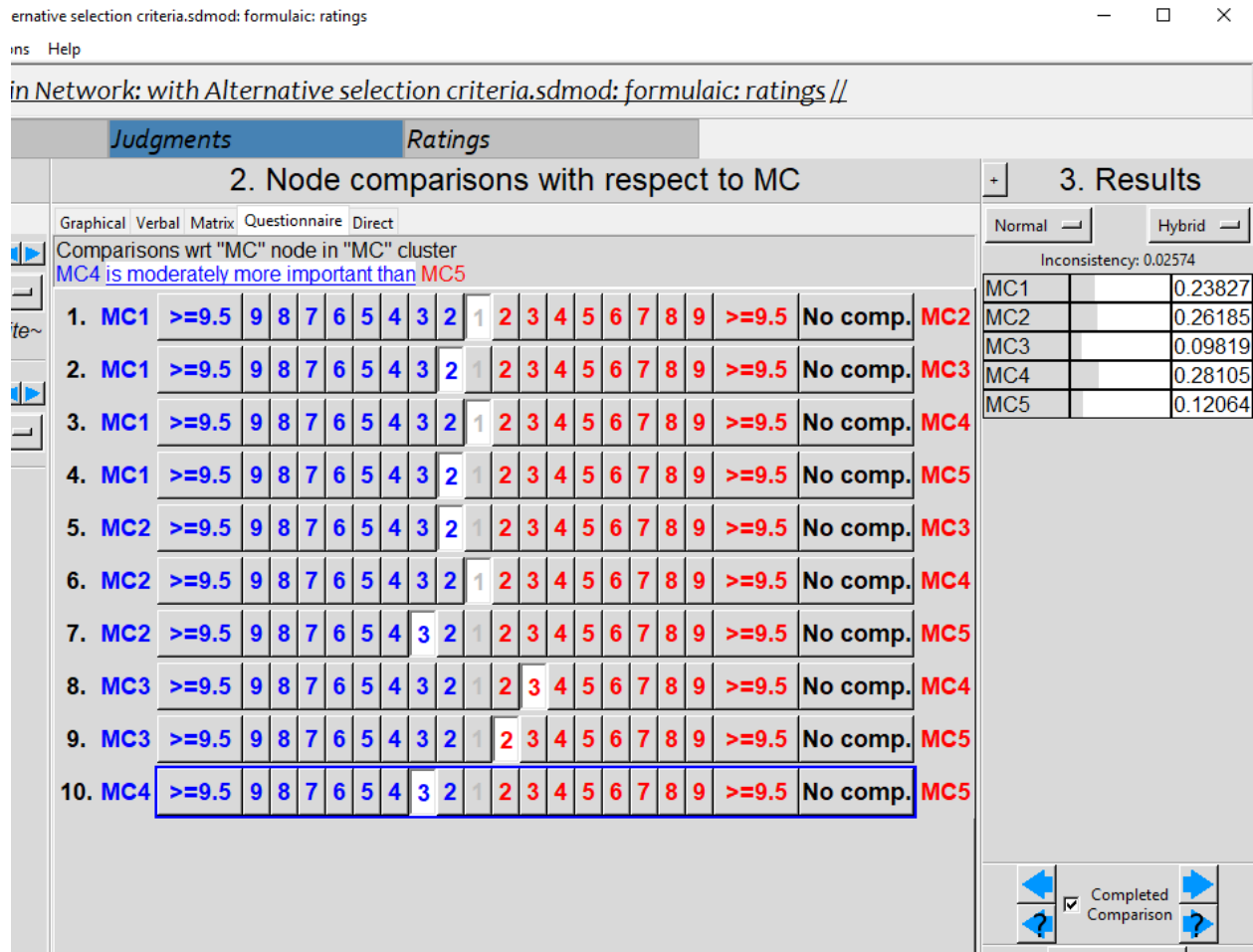


Figure 5: Pairwise Comparisons with Respect to Management Competency; Source: (super decision software, 2024)