An Alternative Low-Bid Awarding System Based on Multi-Criteria Decision Making for Public Building Construction Projects

Abdurehim Kemal Hassen

A Thesis Submitted to the department of Civil Engineering

for the Partial Fulfillment of The Requirement for The Degree of Masters

(Specialization in Construction Engineering and Management)

School of Civil Engineering and Architecture

Office of Graduate Studies

Adama Science and Technology University

June, 2023

Adama, Ethiopia

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Declaration

I hereby declare that this Master thesis entitled "**An Alternative Low-Bid Awarding System Based on Multi-Criteria Decision Making for Public Building Construction Projects**" is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

Abdurehim Kemal Hassen		
Name of student	Signature	Date

Recommendation

I/we, the advisor(s) of this thesis, hereby certify that I/we have read the revised version of the thesis entitled **"An Alternative Low-Bid Awarding System Based on Multi-Criteria Decision Making Approach for Public Building Construction Projects"** prepared under my/our guidance by **Abdurehim Kemal Hassen** submitted in partial fulfillment of the requirements for the degree of Masters of Science in **Construction Engineering and Management.** Therefore, I/we recommend the submission of a revised version of the thesis to the department following the applicable procedures.

Major Advisor/Supervisor	Signature	Date
Co-advisor/Co-supervisor	Signature	Date

Approval Sheet

I/we, the advisors of the Thesis entitled **"An Alternative Low-Bid Awarding System Based on Multi-Criteria Decision-Making Approach for Public Building Construction Projects"** developed by **Abdurehim Kemal Hassen**, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the Thesis.

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Co-advisor/ Co-supervisor	Signature	Date

Approval of Board of Reviewers

We, the undersigned, members of the Board of Reviewers of the Thesis by **Abdurehim Kemal Hassen** have read and evaluated the Thesis entitled "**An Alternative Low-Bid Awarding System Based on Multi-Criteria Decision-Making Approach for Public Building Construction Projects"** and assessed the understanding of the candidate about the proposed research. This is, therefore, to certify that the Thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in **Construction Engineering and Management.**

Chairperson	Signature	Date
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Finally, approval and acceptance of the Thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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Office of Postgraduate Studies, Dean	Signature	Date

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ACRONYMS

ALB	Abnormally Low Bid
CC	Closeness Coefficient
DB	Design Build
DBB	Design Bid Build
DM	Decision Makers
DMS	Decision Making System
ETB	Ethiopian Birr
FPPA	Federal Public Procurement Agency
ICB	International Competitive Bidder
ITB	Instruction To Bidders
LBBAS	Lowest Bidder Bid Awarding System
MCDM	Multi- Criteria Decision Making
NCB	National Competitive Biddings
NIS	Negative Ideal Solution
PIS	Positive Ideal Solution
PPPAA	Public Procurement Property Administration Agency
RFP	Request for Proposal
RII	Relative Importance Index
RR	Response Rate
SBD	Standard Bid Document
TOPSIS	Techniques for Order Preference by Similarity to Ideal Solution

ABSTRACT

Construction industry is a large industry that is expanding all over the world. Most public building construction projects located in Ethiopia are awarding using lowest bidder bid awarding system. However, selection of the lowest bidder and less performance of contractor may be considered as the major causes of many problems which need improvement for better contractor selection and to deliver better service for community. This research was conducted with the aim of alternative multi-criteria decision making based low-bid awarding system for public building construction project, through analyzing the effect, assessing the selection criteria and develop low-bid awarding system using fuzzy Techniques for Order Preference by Similarity to Ideal Solution Multi- Criteria Decision-Making approach. For this purpose, questionnaire and case study was conducted to analyze the effect in public building construction project which is awarded on the basis of lowest bidder bid awarding system and to assess the selection criteria. Case study was conducted to develop low-bid awarding system using Techniques for Order Preference by Similarity to Ideal Solution Multi- Criteria Decision Making. In addition, the finding was analyzed using Microsoft excel and Techniques for Order Preference by Similarity to Ideal Solution model. From considered effects, relatively five high negative effect of lowest bidder bid awarding system in public construction projects were identified. These are; delay on project completion, increase claims and disputes between contracting parties, Selection of inefficient contractors, unsatisfactory quality of work and cost overrun. The selection main criteria for contractors' bid evaluation were ranked as technical qualification, financial qualification, legal qualification, and other required qualification respectively. Therefore; from the study findings, it can be concluded that the issue of Ethiopia being a developing country has a significant effect on selecting contractors based on a mindset of saving money, all partiers in the construction sector should realize selecting contractor based on only the least bid method is causing problems such as delay, claim and dispute, inefficient contractor, poor quality and cost overrun. So, focusing on project objectives parallel with money is required by using Techniques for Order Preference by Similarity to Ideal Solution method to select qualified contractors, optimizes the decision and to achieve the stated project objectives of the lowest bidder bid awarding system.

Keywords: *low-bid, public building, construction project, Multi-Criteria, Decision Making, awarding system*

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CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

The construction sector is vast and growing internationally. Construction is one of Ethiopia's most important industries, contributing significantly to the country's growing economy. Due to the time, cost overruns, and quality of work associated with construction projects, the bid system and contractor performance are a significant and integral component in the success of public building construction projects. Contracts was be awarded to the lowest bidder to ensure the lowest cost of completion of a project. Lowest bidding is one of the bidding tactics, in which the bidder with the lowest price is declared the winner. (Woo et al., 2017)

This strategy is nearly commonly recognized since it not only assures a low price but also gives a method to minimize fraud and corruption; yet, 1 this procedure may have resulted in a great number of difficulties in terms of projects not being finished on time and under budget. The low bid can be used for 2 almost all types of projects, including those that are large in size and/or include a high number of risks and are considered complex. However, low bid procurement may not be the best procurement method, and alternative methods should be considered (Singh & Ahmad, 2017) .

The kind of bid and a contractor's performance have a significant impact on the achievement of construction projects; the progression of inviting and evaluating bids should be based on the type of project and financial capacity. Contracts are less likely to be allocated to the best-performing contractors that provide the highest-quality projects if they are based on the lowest price. Engineering estimating reduces project costs significantly, posing financial challenges for contractors who are evaluated and held accountable through the lowest responsive bidder mechanism. A down payment is required (Quezon, 2016). For a public building construction project Some contractors do not use this payment for the intended purpose, so instead of paying in cash, it should acquire the necessary building supplies to have better performance. (Alexandersson & Hultén, 2006). To ensure successful project completion, it is more important to identify and use an appropriate bid assessment process that considers contractor performance. The purpose of this thesis is to examine the impact of the lowest bidder bid awarding system, as well as the current state of bid and procurement strategies, with a focus on contractor performance in Adama's construction industry

1.2. Statement of the Problem

Competitive low bidding is one of the contract award procedures which are practicing in public building construction project. Contracting authorities in Adama to award tenders more often based on the lowest price criterion than other methods. A contractor submits a bid that is significantly lower than the client's estimate and the other bidders; it is difficult to understand how that contractor could complete the job profitably. In the lowest price selection process, it gives more attention on price rather than performance of contractors. After the contract awarded there are so many problems are happening in public building construction project because of selection of the lowest bidder and less performance of contractor may be considered as the major bases. (Enshassi et al., 2014) three cases of the study were awarded to lowest price contractors; the results show the existence of the following problems: Considerable delay in the project handover, disputes between the project partners, contractor's claims against the client which led to disputes issues, Low level of quality in some items and increase of the total project cost. The financial evaluation of the bid is considered as the most important class, being ranked in the first position, with a weight equal to 40.10%. The remaining other classes are all related to technical criteria, with a total weight of 59.90%. It was discovered that proper planning, credit worthiness, transition plans, plant and equipment holding, financial stability, past performance, and quality, are the most imperative factors, influencing the contractor's selection procedures used by clients and consultants (Maqsoom et al., 2019).Financial problem has mainly resulted in the procurement system used to select the bidders, which focuses only on lowest price. Delays in meeting the contract duration, increment of the final project cost due to high variations, tendency to compromise quality and adversarial relationship among contracting parties are the major drawback s associated with responsive low-bid award procedure

Competitive low bid method has been highly criticized for its negative impact on disputes/claims, coordination, quality control and project duration and most of the projects have been suffering in material and equipment shortages, Manpower shortage was also encountered in many projects (S. Shrestha, 2014). Moreover, the low-bid award system encourages unqualified bidders in the competition and on contrary; it discourages qualified contractors to participate. As per PPA stated that "the contracting authority shall award the Contract to the Bidder whose bid has been determined to be the lowest evaluated bid and is substantially responsive to the Bidding Documents, provided further that the Bidder is determined to be

qualified to perform the Contract satisfactorily". There is lack of study which addresses implementation of Low-Bid awarding system for public building project using model. Therefore, the main aim of this study was an alternative low-Bid awarding system based on multi-criteria decision-making approach for public building construction projects.

1.3. Objectives of the Study

1.3.1. General objective

The general objective of the study is to develop a multi-criteria decision making based low-bid awarding system for public building construction project.

1.3.2. Specific objectives

The research has the following specific objectives:

- To analyze the negative effects low-bid awarding system on the success of public building construction projects which are awarded on the basis of lowest bidder bid awarding systems.
- To assess the selection criteria for contractors' prequalification bid evaluation, in lowest bid awarding system.
- To develop a multi-criteria decision making based low-bid awarding system for public building construction project using fuzzy TOPSIS approach.

1.4. Research Questions

The research question:

- What are the negative effects in public building construction projects which are awarded on the basis of lowest bidder bid awarding systems?
- What are current selection criteria for contractor's prequalification and bid evaluation, in lowest bid awarding system?
- How to develop multi-criteria decision making based low-bid awarding system for public building construction projects using fuzzy TOPSIS MCDM approach?

1.5. Significance of the Study

The significance of this research paper is expressed as follows. First and foremost, it should be a topic of discussion in the construction industry because of the time, cost, and quality of work associated with the construction project. As a result, many projects awarded based on the lowest bidder fail to meet their targets and objectives. Second, it assists the country in

providing information about the effect of the lowest bidder bid award system on improving competitive low bidding selection main criteria for contractors' prequalification and bid evaluation in the lowest bidder bid awarding system, in order to achieve success of public building construction projects awarded using the low-bid awarding system. Third, it is used by policymakers, government agencies such as Public Procurement Agency, and researchers.

1.6. Scope of the Study

This study's scope is defined by five major characteristics: geographical location, method, cost, sector, and project. The research was primarily concentrated on the development of a multi-criteria decision making based low-bid awarding system for public building construction projects in Ethiopia by identifying the effect of the lowest bidder bid awarding system and assessing prequalification and bid evaluation in Adama. Only competitive low bidding from various contract award procedures in construction is considered for the study. The research was be conducted at the City Government of Adama Construction Authority, the East Showa Construction Authority, the East Showa Urban Development Bureau, and the Adama City Municipality Office. The cost of the project under consideration for the study was be between twenty million and one billion birrs. Other sectors and the private sector

1.7. Organization of the Thesis

The thesis is presented in 5 chapters. The remaining four chapters are organized as follows. Chapter 2 presents the literature review, with special reference to the topic that

Chapter 3, the research methodology is discussed. After presenting the study's overall research methodology, the methodology adopted in individual objectives is discussed in this chapter.

Chapter 4 aims to involved analysis and discussion of the results that have been collected from questionnaire and case study. To realize this aim, the study presents the findings and associated discussion in relation to Analysis of Data from the Questionnaires In this section, the data were statistically analysed using micro soft excel with other necessary tests. General Information of Respondents sub-objectives in this chapter.

In the first section of Chapter 4, the Information about Competitive Low Bidding

In this chapter, initially, the Fair and transparence of bidding procedure that is made in the Competitive low bidding are identified. In addition, Effect of Lowest Bidder Bid Awarding System are identified. Then, underlying The Selection criteria for Contractors' Prequalification and Bid Evaluation are presented by concept mapping.

Chapter 5 summarises methodology followed and the findings of the various chapters and the study's conclusions. The chapter closes with this study's contributions to the literature, its limitations, and suggestions for further research.

1.8. Summary

In this chapter, the background and statement of the problem (motivation of the research) have been presented. Further, the study aim, associated objectives, scope of the study, significance of the study and the organization of the thesis to achieve these objectives have briefly been presented. In the next chapter, the literature review and the gaps in the prior research have been presented.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Introduction

Many organizations that want to take advantage of the competitive nature of bidding was keep procurement costs low during the procurement process. Construction industry participants have begun to recognize that accepting the lowest price bid does not guarantee maximum value, and that this is the primary cause of stalled construction projects and failure to meet standards on publicly financed building construction projects (Khan & Khan, 2015a). Continuous problems with poor construction quality, a high incidence of claims and litigation, frequent cost overruns, and the use of low-quality materials have become the hallmarks of Ethiopian public building construction work contracts (Quezon, 2016).

As an alternative to other traditional awarding criteria such as the lowest price, the best value or most economically advantageous tender is becoming a popular approach for contractor selection (Ballesteros-Pérez et al., 2015). Commonly applied methods of contractor selection may not minimize the costs of contracting. Research evidence suggests that although competitive tendering typically results in the lowest bidder winning the contract this may not represent the lowest project cost after completion (Lingard et al., 1998). Low bidding, itself is not a problem whereas it has got wide uses in all over the world with acceptance as more scientific and reliable process (Bista & Dahal, 2018).

Achieving a value-based procurement approach is a challenge, particularly for the public sector clients, who are limited in their ability to evaluate the competitive bids based solely on the lowest-bid award system. The sources of cost overruns did not entirely reveal contractor selection as a main source of cost overrun; although from the explanations given for causes of cost overruns, one would be able to see how wrong contractor selection does play a part. Literature review on the various approaches to contractor selection on the other hand, did little to show the effect of contractor selection on the outcome of construction projects (Eke et al., 2017)

Persisting problems of inferior quality of constructed facilities, high incidence of claims and litigation, and frequent cost and schedule overruns have become the main features of public construction works contracts (Khan & Khan, 2015a). Public contracts are awarded to the low-

est bidder or to the bidder with the economically most advantageous tender; the latter requiring that a scoring rule be specified (Bergman & Lundberg, 2013). The low bid award system fosters competition amongst contractors attempting to secure the project. This competition can have both positive and negative effects for the client. As the public sector client is accountable to the public, an open competitive bidding process that is awarded based only on price is highly transparent (Bedford, 2009).

Selection of the lowest bidder may be considered as the major causes of problems (Naji et al., 2022). The success of a construction project is the sole goal of project investors, including the owners, and contractors, and is the subject of many researches analyzing the factors that affect the success of a construction project (Cho et al., 2009).

2.2. Lowest Bidder Bid Awarding System

Lowest bidder bid awarding system is the most commonly used procedure to obtain and select contractors/ construction firms for execution of construction projects. In broad-spectrum, the aim of competitive bidding (price-based) is to obtain the least possible price for a particular project, service or facility. The Competitive bidding method tries to ensure that everyone gets an equal chance to bid, minimizes collusion, and saves the public money (Khan & Khan, 2015a). It is also the practice of bidding in construction work where the contractors submit lowest price possible for completion of given plans and specifications and such the lowest quoted price is accepted for execution of the project. The award of contract is made to the lowest responsive bidder and an agreement is reached between the client and the contractor (Bista & Dahal, 2018).

Formerly, contractors were, in most cases, selected based on price alone, but in the 1 8 ’s the idea of selecting contractors based on value, not price, emerged, which led to contractors being selected based on non-price criteria in addition to the evaluation of price. Since then, multiple researchers have pondered the question of which method used for contractor selection results in the most successful project outcome. Lowest bid method has established in the U.K. public sector in the 19th century in order to provide the lowest price to the public while ensuring fair competition between contractors. Since then, the method has become well establish for selection of contractors and is widely used. However, the method has received a lot of criticism for increasing the likelihood of hiring an incompetent contractor,

which can lead to higher overall costs. Researchers have pointed out that choosing a contractor based on value, not price was result in better project outcome, and therefore contractors should be select based on other criteria than price. Nevertheless, the lowest-bid method remains in use, more so though in the public sector (Singh & Ahmad, 2017).

If the bid specifications have written to favor one bidder over another, or if there was an ambiguity in the specifications that, intentionally or inadvertently, favored one bidder over another or misled the bidders, then there was not a "common basis" for the bids, and there is a basis for challenging the award. If bidders "are misled by anything which the [municipality] may have done, or the notice [concerning the bid] may have required, the bidding was not on a common basis; the lowest figures submitted would not, in law, be the lowest bid, because its lac ed fair competition." In short, "no scheme or device promote of favoritism or unfairness or which imposes limitations, not applicable to all bidders alike, was be tolerated (Gisleson, 2003).

2.3. Factors Causing Negative Effect of Competitive Low Bidding

According to Bista and Dahal (2018), some of the major factors causing low bidding are described as follows. Imprecise and ambiguous contract documentation (including incomplete drawings) may cause a contractor to make a serious omission in calculating costs, Preparing tenders by using estimates of historical data and traditional norms causes errors in estimation and usually, prices are under estimate, with increasing number of contractors and competition among them, bidders quote low prices to get the contract anyhow to remain in business, to have utilization of their ideal resource machine, equipment's and vehicles enforces contractors to bid in low price in construction business of public sector, work in hand and favorable location of site may affect the bid price, if no work in hand, lower is the bid price and if the new site is adjoining in current site of the contractor, this can be a big factor for low bid, nature of work i.e. lower bid in works only with earthworks and simple structures than in works with major structural works, contractor's perception on variation, Contractors initially go for abnormally low bid with the intention of recovering their losses through change orders and claims, also known as predatory bidding, weak contract administration of client leading to assumption that specified work quality has not maintained, no site visits before bidding and no understanding of detail scope of work by contractor. Contractors have to bid low to increase annual turnover, engage and train staff and utilize equipment and they

claim that they manage their company effectively so that there was be optimum use of resources and they was be benefited even if the bid low.

2.4. Effect of Lowest Bidder Bid Awarding System

The Selection of an inappropriate contractor for the job increases the chance of dispute and dissatisfaction amongst stakeholders (Singh & Ahmad, 2017) . Excessive time overrun, compromise quality and hindering profitability of contractors as the top ranked effects of low bid award system (Reta & Alyew, 2022). Bidding with lower value even below the engineer's estimate has often seen as normal practice. Nowadays, bidding trends can be seen as getting bid at very low cost which provides winning feeling but not on completing project (Bista & Dahal, 2018). Most contractors intentionally submit low bid in anticipation of making their profit through change orders and claims. Some bidders carefully review the bid documents searching for mistakes and ambiguity in areas that could lead to change orders and claims during the project. These bidders can then use this knowledge to submit a lower bid with the expectation of recouping the money later. This practice can be equating to a gambit strategy in chess: making a small sacrifice early to setup up the opponent to be in a vulnerable position later. In all cases, the abnormally low bid is not reflective of the final contract cost or the hidden costs incurred by the client when dealing with numerous change orders and claims (S. K. Shrestha, 2014).

Other problems associated with the competitive lowest evaluated bid method is that when the number of bidders is as large as is the case in a slow economy, and owner runs a significant risk of selecting a contractor that has either accidentally or deliberately submitted an unrealistically low price.

A contractor cannot adhere to such a low price and at the same time expect to complete the project according to plans and specifications, and make a reasonable profit. This often results in excessive claims and disputes during construction that lead to schedule delays, compromises in quality, and increased costs. The low bid award system encourages unqualified bidders to state that international construction projects performance is affected by more complex and dynamic factors than domestic projects; frequently being exposed to serious external uncertainties such as political, economic, social, and cultural risks, as well as internal risks from within the project. The following are the major risks associated with lowest evaluated bid awarding system; cost overrun, time over run, insolvency, damage to reputation, legal

challenge, poor lifecycle performance, no repeat business and legal cost. In public construction works, this practice almost universally accepted since it not only ensures a low price but also provides a way to avoid fraud and corruption. Moreover, the traditional approach tends to promote more adversarial relationships rather than cooperation or coordination among the contractor, the designer and the client, and the client generally faces increased exposure to contractor claims over design and constructability issues (Singh & Ahmad, 2017).

The most common method of awarding the contract as per government of India recommendation is the Least Responsive Bidder or Price Based method, which has inherent flaws of high competition and minimum performance. These incompetent practices pose constraints like: Schedule delays, increase in total cost of the project, resulting in bankruptcy of companies, poor construction quality, serious question on public safety, and overall project failure. Under this low-bid system, contractors submit bids based on plans and specifications prepared by the public agency or a consulting firm hired by the agency, except in case of low-priced works, the contractor submitting the lowest responsive bid has awarded the contract. Generally, experience levels of the contractor, quality issues, and other criteria not taken into consideration in awarding these contracts (Singh & Ahmad, 2017).

There are definite risks associated with the lowest evaluated bid award system. Many studies have shown that the lowest evaluated bid does not guarantee the lowest cost. The contractor with the lowest evaluated bid is the one most likely to have underestimated the cost of the project and it is difficult to understand how that contractor could complete the job profitably. Lowest bidders are required to complete a construction project that no one else was washing to do at that price (Decarolis, 2014).

There are definite benefits and drawbacks to the lowest evaluated-bid award system. Promoting competition amongst contractors is a clear benefit to the process. It compels the contractors to lower their costs, usually through innovation, to ensure they win bids and maintain their profit margins. In addition, the process is beneficial, specifically to the public sector because of the transparency, an important criterion of public policy. However, allowing contracts to be awarded based on the least price has inherent flaws. Delays in meeting the contract duration, increment of the final project cost due to high variations, tendency to compromise quality, and adversarial relationship among contracting parties are the major drawbacks associated with lowest evaluated bid award procedure (Bedford, 2009).

Some of the major impacts of low bidding are; Delay on project completion (more severe than cost), Cost overrun, Low quality work, Claims and Disputes, Financial difficulty in effective contract management. Searching loop holes for omitting some items or quantities of work and Compromising quality and making unnecessary claims makes intended result in terms of project constraints difficult to achieve (Bista & Dahal, 2018)). According to Farooqui & Ahmed (2008), the negative consequences of low bid system on work environment and team relationships, ranked as; Increased No. of Claims, Increased No. of Disputes, Work Suspensions, and Increased No. of Change Requests/ orders and higher cost of contract administration were the factors that could affect the project outcome, and work environment and team Relationships.

2.5. Legal Aspects of the Lowest Bidder Bid Awarding System

The Adama city government has statutes requiring submission of competitive bids for construction projects. This statute requires public organizations to award such contracts to the lowest responsive bidder. The word responsive is inserted to require that a successful bid must also be adequately responding to the requirements of the project as specified. This requires public organizations to award such contracts to the "lowest responsive bidder". The word "responsive" inserted to require that a successful bid must have also been adequately responding to the requirements of the project as specified (PPA, 2011).

While it is not too difficult to determine whether a bid is responsive because responsiveness is evaluated based on the documents submitted by contractors, it takes considerable amount of time and effort to ascertain whether a bid is responsive. Responsible generally refers to the apparent low bidder's quality fitness, and capacity to perform the proposed work satisfactorily. Responsible means more than simply financially responsible (Quezon, 2016).

For two reasons application of this requirement becomes difficult. First, there is generally a narrow window of time available between a bid opening and the award of the bid. Second, although the law allows public organizations to reject any or all the bids, the rejection cannot be done arbitrarily or in bad faith. When it is the low bid which is rejected, particularly close scrutiny of the reasons given for the rejection is warranted. For these reasons, the decision to reject a low bid on the ground that the bidder was not responsive enough is dependent on the discretion of the organization. In most cases some degree of subjectivity gets involved in the process of determining whether a particular bidder is responsible. As a consequence, these kinds of rejections frequently give rise to resentment and may end up in court.

2.5.1. Procurement Law

The Ethiopian Federal Government Procurement and Property Administration proclamation no 649/2009 article 33 (1) states six methods of procurement for public goods and services, viz. open bidding, request for proposal (RFP), two stage tendering, restricted tendering, request for quotation and direct procurement. The proclamation, however, limits public bodies to use open bidding as the preferred procedure of procurement except as otherwise provided in the proclamation to use other options (article 33(2)). Restricted tendering is allowed only when the required object of procurement is available only with limited suppliers and the cost of the procurement does not exceed the limit in the directive issued by the Bureau; or where a repeated advertisement of the invitation to bid fails to attract bidders in respect of a procurement subject to the directive to be issued by the Bureau (article 49).

The total contract value of procurement made by restricted bidding is limited by the regional public procurement directive to 2 million birrs for works (article 23.3). Direct procurement is allowed when there is no competitions for technical reasons and if the required service can be supplied or provided only by one candidate. Or when there is a need of similar service or repetition of works from one supplier and when the total contract 8 value is not exceeding the limit stipulated in the directives (The FDRE Proclamation no 649/2009 article 51).

The maximum contract amount allowed in the directive for direct bidding for works is similar to the restricted bidding (article 9). The third type of procurement for public bodies is request for thesis (RFP). RFP is allowed only when the public body seeks to obtain consultancy services or contracts for which the component of consultancy services represents more than 50% of the amount of the contract (article 53). The other two types of procurements are request for quotation and two stage bidding. Request for quotation is allowed when there are readily available goods or for procurement of works or services for which there is an established market, so long as the estimated value of the contract does not exceed an amount stated in the procurement directives issued by the Bureau (article 55).

Two stages bidding on the other hand is permitted when it is not feasible for the public body to formulate detailed specifications for the goods or works such as, contract for the purpose of research, experiment, study or development. (Article 57). The maximum contract amount provided for works in the directive to use request for quotation is 250 thousand birr (article 24.2). In general, alternative procurement procedures other than the open bidding cannot be applicable for most public bodies' construction contracts as most public bodies construction

contracts are more than the limits specified in the maximum limit provided in the directive. In addition, the conditions set forth for the use of other alternatives are not usually fulfilled for construction work contracts except in rare cases (Quezon, 2016).

2.6. Evaluation Criteria and Weights for Contractor Selection

Based on the standard bid document (SDB) section three the following results were obtained in regards to contractor evaluation criteria weights for different projects. The following qualification criteria will be applied to Bidder

2.6.1. Legal Qualifications of Bidder

Legal Qualification of bidders included points as such as Nationality, Conflict of interest, Registration in the FPPA's suppliers list, Debarred by the decision of the FPPA, Valid trade license or business organization registration certificate, Government owned entity. Accordingly, PPPAA SBD 2011 section three legal qualifications to be very important criteria for bid evaluation.

2.6.2. Professional Qualification of Bidders

This includes number of stuff and personnel for the key position (staff experience and qualification). This evaluation criterion is important. From the experience of the researcher, most of the time bidding contractors rent. Construction licenses and proposes personnel that are not employed by the company for the purpose of winning the bid only. This in turn can have a significant effect in the execution of the project since the specific personnel required by the contract for the job does not really exist in the winning company.

2.6.3. Technical Qualification

Technical qualification includes general experience, specific experience, history of non-performing contracts, Pending litigation and Equipment for the implementation of the contract. According to PPPAA SBD 2011 section three technical qualifications seem to fall in middle between being considered important and very important.

2.6.4. Financial Standing

The criteria Include historical financial performance, Average annual turnover and financial resources of the bidder. The SBD confirmed that contractor financial stability is a critical factor in the contractor selection process. Different people have different outlook toward

these criteria usually bid evaluators are limited to the use of specific points provided to financial standing evaluations provided by the client or consultant guided by the SDB.

2.6.5. Financial Offer

This is to mean the tender price offered by the bidding contractor for the execution of the project. The standard bid document further proof to the fact in the document review stating the majority of public building construction bids are evaluated based on the financial offers submitted by the bidder. The SBD show the financial offers are very important and highly important as an evaluation criterion for bids. This shows the level of impact of the traditional low bid evaluation system on the mind set of professionals in the construction industry. These evaluation criteria are categorized as cost criteria whereas the others categorized as beneficiary.

2.6.6. Main Criteria and Sub-criteria for Contractor Evaluation

Normally the contractor's capability to fulfill the terms and conditions of the bid satisfactorily is an element more important now in awarding the tender. According to Alptekin & Alptekin (2017), the prequalification criteria of previous studies in the literature review. Previous studies showed that contractor selection should not be based solely on obligations specified in the tender such as tender price but also Main criteria and sub-criteria for contractor evaluation (MoWUD, 1994))highlighted the prequalification criteria of previous studies in the literature review. Previous studies showed that contractor selection should not be based solely on obligations specified in the tender such as tender price but also on other criteria as shown in Table (2.2)

Table 2. 1 The Selection of Main criteria and sub-criteria for contractor evaluation

NO	Criteria	Sub-criteria	A	B	C	D	E	F	G	H
1	Financial stability	Financial soundness	×	×	×	×	×		x	×
		Credit rating / Credit	-	x	x	x	x		x	
		history Yearly turnover	-	X	x	x			x	
		Leverage	-		x	x			x	
		Profitability	-		x	x			x	
		Liquidity	-		x	x		x		
2	Management ability	Management knowledge	-			x	x			
		Management capability	-			x	x			
		Quality management System	-			x	x			
		Project management system	-			x	x			
		Risk management	-			x	x			
3	Technical capacity	Qualification of staff	-	X	X	x	x			
		Experience of staff	-	X	X	x	x			
		Knowledge of particular	-	X	X	x	x			
		construction Method	-			x	x			
		Contractor's IT knowledge	x			x	x			
		Qualification of contractor	-			x	x			
4	Experience	Type of past project	x			x	x			
		Size of past project completed	x			x	x		x	
		Number of projects completed	x			x	x		x	
		Experience in the local area	x			x	x		x	
		Overall experience Proposed	x			x	x	x		
		project time schedule	x			x	x	x		
5	Past performance	Quality level of projects performance	x			x	x	x	x	
		Projects completed on time	x			x	x		x	
		Projects completed on budget	x			x	x		x	
		Past record of conflict and disputes	x	x		x	x	x	x	

		Present workload and capability to support the current project	-			x	x	x	x	
		Lack of communication	-			x	x			
6		Relationship with sub-contractors	-			x	x	x		
		Cooperation with contractors				x	x	x		
	Reputation	Client satisfaction	x	x		x		x		
7		Labor and equipment	-	x	x	x			x	
	Resources	Number of staff	-	x	x	x				
		Adequacy of plant resources	-		x	x				
		Number of direct workers	-		x	x				
		available for the Project	-		x	x				
8		Management safety accountability	x		x	x	x			
		Health and safety management system	x		x	x				
	Occupational health and safety	Health and safety records	x		x	x				
		Safety performance	x		x	x	x		x	
		Insurance policy	x		x	x				
		Occupational safety and health administration rate (OSHAIR	x		x	x	x			
9		Quality control			x	x		x		
	Quality	Quality assurance	x			x				
		Tender quality Safety initiatives record	x		x	x		x		
		Query response timeliness				x				
10		Waste disposal during construction	x			x				
	Environmental	Environmental plan during construction	x	x		x		x		
		Materials and substances used in the project	x			x				
11		Age in business	-		x	x	x			
	Organization capability	Size of the company	-		x	x				
		Company image	-		x	x				
		Skilled manpower	x		x	x	x			
		Organizational structure	-		x	x	x	x		

12	Planning and control	Plant maintenance programs	-			x		x		
		Flexibility in the critical paths	-			x		x		
		Failure to comply with quality specifications	-		x	x	x	x	x	
		Tender price and estimates Control plan	x	x	x	x		x	x	

Table 2. 2 The selected Main criteria and sub-criteria for contractor evaluation

NO	Criteria	Sub-criteria
1	Financial stability	Financial soundness Credit rating / Credit history Yearly turnover Leverage Profitability Liquidity
2	Management ability	Management knowledge Management capability Quality management system Project management system Risk management
3	Technical capacity	Qualification of staff Experience of staff Knowledge of particular construction Method Contractor's IT knowledge Qualification of contractor
4	Experience	Type of past project Size of past project completed Number of projects completed completed Experience in the local area Overall experience Proposed project time schedule
5	Past performance	Quality level of projects performance Projects completed on time Projects completed on budget Past record of conflict and disputes Present workload and capability to support the current project Lack of communication

6	Reputation	Relationship with sub-contractors Cooperation with contractors Client satisfaction Relationship with supplier Past failures in completed projects Number of years in construction Claims and litigation
7	Resources	Labor and equipment Number of staff Adequacy of plant resources Number of direct workers available for the Project
8	Occupational health and safety	Management safety accountability Health and safety management system Health and safety records Safety performance Insurance policy Occupational safety and health administration rate (OSHAIR
9	Quality	Quality control Quality assurance Tender quality Safety initiatives record Query response timeliness
10	Environmental	Waste disposal during construction Environmental plan during construction Materials and substances used in the project
11	Organization capability	Age in business Size of the company Company image Skilled manpower Organizational structure
12	Planning and control	Plant maintenance programs Flexibility in the critical paths Failure to comply with quality specifications Tender price and estimates Control plan

Criteria Factors with their references

Cost: Proposed tender price, Low project life cycle cost, financial capability and Additional financial resources for priority projects

Performance: Past performance and expertise of the company, Number of key personnel, Optimized resource utilization and Training and skill level of project team

Quality control: Quality control measures, Meeting design requirement**,** User expectations and satisfaction

Health and safety: Health and safety performance**,** Environmental impact

Project control: Type of project control and monitoring process, Actual schedule achieved for similar works

2.6.7. Procurement of works for national competitive biddings (NCB)

According to the proclamation article 43(3), the public body regards a bid as responsive only if it conforms to salient requirements set forth in the bidding document. And any public body should not award a contract when the bid is not responsive (article 43 (5-c)). It is also clearly stated in the PPA that The Employer will evaluate and compare only the bids determined to be substantially responsive in accordance with Clause 26 (clause 28.1). A substantially responsive Bid is one, which conforms to all the terms, conditions, and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one (a) which affects in any substantial way the scope, quality, or performance of the Works; (b) which limits in any substantial way, inconsistent with the bidding documents, the Employer's rights or the Bidder's obligations under the Contract; or c whose rectification would affect unfairly the competitive position of other bidders presenting substantially responsive bids (clause 26.2). Prior to the detailed evaluation of bids, the Employer will determine whether each Bid (a) meets the eligibility criteria defined in ITB Clause 3; (b) has been properly signed; (c) is accompanied by the required securities; and (d) is substantially responsive to the requirements of the bidding documents (clause 26.1).If a Bid is not substantially responsive, it will be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the nonconforming deviation or reservation (clause 26.3). The employer will award the Contract to the Bidder whose Bid has been determined to be substantially responsive to the bidding documents and who has offered the lowest evaluated Bid price (clause 30.1). However, the employer reserves the right to accept

or reject any Bid, and to cancel the bidding process and reject all bids, at any time prior to the award of Contract, without thereby incurring any liability to the affected Bidder or bidders or any obligation to inform the affected Bidder or bidders of the grounds for the Employer s action (clause 31.1).

2.7. Contract-Award Procedures in Construction

Bidding procedures are basically of two types: competitive and negotiated. Most of the other procedures are either variation of, or somewhere between these two extreme types. In pure competitive method, the contract is awarded to the lowest-bidder, if the bidder is found to be responsive. In pure negotiated method the price is negotiated with a selected 15 contractor. To minimize the shortcomings of these two extreme types, modifications have been proposed and tried in many countries. For the purpose of this research, only Competitive Low Bidding (Price based) contract-award procedure is considered:

2.7.1. Competitive low bidding (price-based)

Competitive bidding is the most widely used method of obtaining and selecting contractors for construction projects. In general, the purpose of price-based competitive bidding is to obtain the lowest possible price. It is believed that Competitive bidding gives everyone an equal chance to bid, eliminates collusion, and saves taxpayers money. It fosters honest competition in order to obtain the best work and supplies at the lowest possible price. It is also necessary to guard against favoritism, imprudence, extravagance, fraud and corruption. For this procedure to work it is essential to have a set of well-defined criteria to help the officials determine that the bids are responsive and the bidders are responsible. Under the competitive low-bid method, the qualified (responsive) bidder who submits the lowest bid that meets the specifications must be awarded the contract. As stated earlier, pursuant to article 33(2), proclamation no. 649/2009, and this method of competitive bidding is the one method for awarding Public owned construction contracts in Addis Ababa.

2.8. Summary of Literature Review and Research Gap

The method of procurement of construction works has a significant role in the successful completion of the project. According to (S. Shrestha, 2014). Competitive low bid method has been highly criticized for its negative impact like disputes/claims, coordination, quality control and project duration.

Most of the projects have been suffering in material and equipment shortages. Manpower shortage was also encountered in many projects. (Enshassi et al., 2014). three cases of the

study were awarded to lowest price contractors; the results show the existence of the following problems: Considerable delay in the project handover, Disputes between the project partners, Contractor's claims against the client which led to disputes issues, Low level of quality in some items and Increase of the final project cost. Here is a need to change the traditional system for contractor selection and awarding contracts from the "lowest price" to "multi-criteria selection" practices.

When selecting a contractor, a client must not only compare bid prices but also set other criteria for evaluation of qualification and determine their weight. A contractor must be selected according to both quantitative and qualitative criteria, and bids should be compared. Only on the basis of quantitative and qualitative evaluation criteria and by comparing bids of contractors it is possible to select a qualified, competent and reliable contractor, to evaluate its qualification, economic and financial condition and technical capability and skills and to achieve relevant results in a construction project (Banaitienė & Banaitis, 2006). According to (Enshassi et al., 2014).incorporating 38 factors that are believed to be related to contractors' selection. These factors were identified through a rigorous literature review, and grouped into 10 classes.

The results show that the financial evaluation of the bid is considered as the most important class, being ranked in the first position, with a weight equal to 40.10%. The remaining nine classes are all related to technical criteria, with a total weight of 59.90%. It was discovered that proper planning, credit worthiness, transition plans, plant and equipment holding, financial stability, past performance, and quality, are the most imperative factors, influencing the contractor's selection procedures used by clients and consultants (Maqsoom et al., 2019) The basic criterion for selecting a tender for construction projects is usually the price.

Public building construction procurement, the process by which contractors are chosen for public building construction projects, has traditionally been based on selecting the lowest bidder. This process, although designed with good intentions, has several shortcomings (Enshassi et al., 2014).

This paper is to rank the identified problems in the public building construction projects like delay, which are awarded on the basis of lowest bidder bid awarding systems and assess the selection main criteria for contractor's prequalification and bid evaluation in Adama public building construction project.

The research gap:(Enshassi et al., 2014) identify the major problem such as delay, Cost overran, and quality issue problem, Claim and disputes between project partners then project suspension are occurred in public building construction project which are awarded on the

basis of lowest bidder (Khan & Khan, 2015b). According to (S. Shrestha, 2014) Competitive low bid method has been highly criticized for its negative impact like disputes/claims, coordination, quality control and project duration; So, adopting the average bid method of awarding contracts among responsive bidders are supported by many construction professionals. lowest bidder bid awarding system needs to be improved (Mechegiaw, 2012).

There is lack of study which addresses improvement required in Low-Bid awarding system for contractor's prequalification and bid evaluation by analyzing the mostly happening problem in lowest bid awarding system which requires well formulated improvement in public building construction project to deliver better service for community.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Introduction

The literature review in the previous chapter has discussed various past studies and research gaps in relation to project delivery methods. Based on the identified research gaps, Chapter 1 outlines the research objectives set for this study. This chapter elucidates the methodology adopted in order to achieve specific objectives of this research clearly defined methods and procedures was be implemented based on type of study and outcome expected. The study mainly was focus on three core objectives analyze the problems; assess the selection main criteria for contractors' prequalification and bid evaluation and develop a Low-Bid awarding system for public building construction projects using TOPSIS MCDM approach for better contractor selection. In the following sections study area, research design, population of the study, sample technique, sample size, data collection instruments, data analysis techniques was include. This research was be conducted with the aim of developing multi-criteria decision making based low-bid awarding system for public building construction project in Adama. The collected data was be analyzed using Microsoft excel and Techniques for Order Preference by Similarity to Ideal Solution model.

3.2. Study Area

The study area selected for this particular study is Adama, Ethiopia. Adama has 6 sub cities, located at 8°32′N 39°16′E / 8.54°N 39.27°E / 8.54; 39.27 at an elevation of 1712 meters, 99 km southeast of Addis Ababa. The city sits between the base of an escarpment to the west, and the Great Rift Valley to the east. Climate ranges from the month with the highest relative humidity.

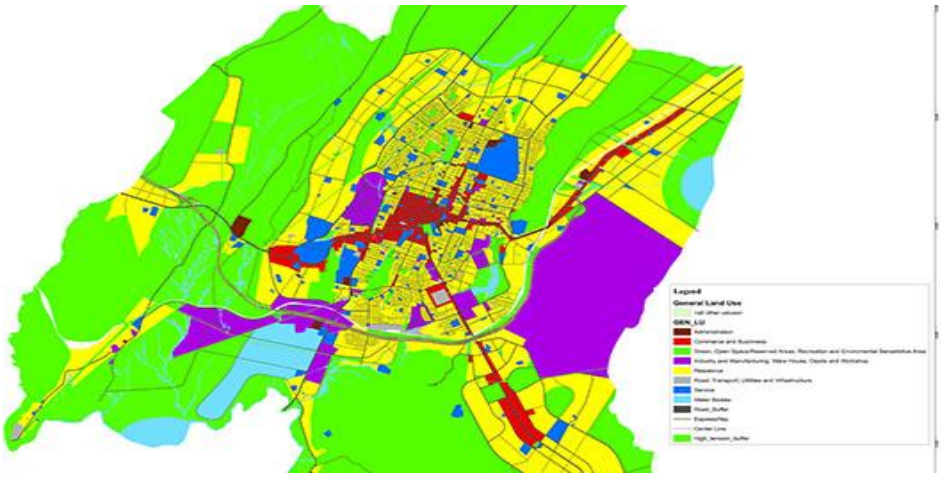


Figure 3. 1 Adama city structural plan

3.3. Research Design

A mixed approach of both qualitative and quantitative methods was be used in the study. The rationale for selecting mixed approach for this study is because the nature of the research problem, require both qualitative and quantitative data sets. Therefore, qualitative as well as quantitative data was collected in the form of questionnaires, and case study from building construction project which greater than 50% of work is completed. The quantitative methods in this research used for ranking, and making generalizations; the qualitative methods were used particularly in this study for identifying, interpreting and gaining in depth insight into specific concept of the research since the interpretation required for this research based on research questions. This study uses both descriptive survey research design and explanatory research design to help identify, rank, access, and describe the collected data from the relevant population (public agencies, consulting firms, contractors, and experts) and Case study for an alternative Low-Bid awarding system based on multi-criteria decision-making approach for public building

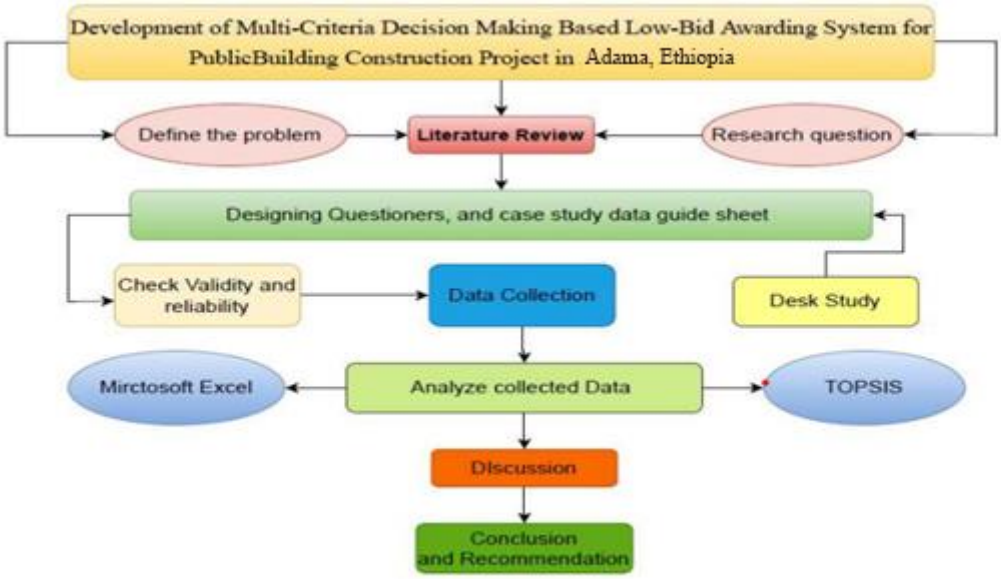


Figure 3. 2 Research design

3.4. Population of the Study

The target population of this study was be all public building construction projects that are constructing in Adama city.

3.5. Sample Technique

This research was adopting the purposive sampling technique, also called judgment sampling, the deliberate choice of an informant due to the qualities the informant possesses. It is a nonrandom technique that does not need underlying theories or a set number of informants. Simply put, the researcher was deciding what needs to be known and sets out to find people who can and were wising to provide the information by virtue of knowledge or experience in projects. Therefore, the most experience Engineers within the organization of owners, contractors and consultants to be purposively sampled as respondents for the study. From client-side procurement engineer and contract admiration, from contractor side project management, Contractor, Office engineer and site engineer are considered, from consultant side supervise/consultant is considered for all projects which are under construction and more than 50% work were completed.

3.6. Sample Size

The sample size for this study was 15 projects which include all building projects with a cost of (twenty million to one billion) that are under construction and more than 50% work is completed in City Government of Adama Construction Authority.

The numbers of respondents are described in table 3.1. The numbers are decided to highlight the effect in depth and on the basis of the time available for conducting the research work, available fund for the study (project), and the reliability of the respondents so that the overall research work would indicate the reality.

Table 3. 1 Questionaries

projects	Target population	Remark	Respondent	Remark
On progress projects	15	Greater than 50% of the work completed	Public -client	Engineers
			contractors	Engineers
			consultants	Engineers
Total	**15**			

3.7. Response Rate

The concept of response rate refers to the percentage of individuals who responded to a survey that has administered to them. It is calculated as, the number of survey responses divided by number of individuals to whom the survey was administered. The level of response rate (RR) is an important, sometimes crucial, issue in relation to validity of results. When determining a true response rate, the number of unusable questionnaires must also be determined and taken into consideration. Unusable questionnaires are the result of missing data, usually negligible. The useable number of surveys is the relevant RR. The average and reasonably acceptable response rate are 60% +/-20 meaning that anything below 40% has not reasonably acceptable and would generate validity issues. If the RR is an extreme case, either above or below, justification for usage and accountability must made (James T Croasmun & Lee Ostrom, 2011). As shown in the table 3.2, from the total distributed questionnaire 93.3% of the public sector clients returned the questionnaire, 76.9% of the contractors and 73.33% of the consultants returned the questionnaire, so the response rate is acceptable for all the three categories of the respondents.

Table 3. 2 Response rate

Respondents	Questionnaire Distributed	Questionnaire Received	Response Rate %
client	15	14	93.3%
Contractor	26	20	76.9%
consultants	15	11	73.33%
total	**56**	**45**	**80.35%**

3.8. Sources of Data

Both primary and secondary sources of data was use for this study. The study uses questionnaires to collect primary data. Secondary data sources were be collected from written materials including, Standard Bid document, case study, journal articles, government's policy and strategy documents, statistical evidences, bid awarding document and published reports that relate to this study.

All the information concern on effect of project awarded on the basis of low bidder bid

awarding system in public building construction project. Development of Multi-Criteria Decision-Making Based Low-Bid Awarding System for Public Building Construction Project.

3.9. Data Collection Instruments

Both primary and secondary sources of data was use for this study. The study deploys a mixed data collection methods, techniques and tools to ensure the information gathered is valid and reliable. The mixed method was allowing the study to validate the collect information.

3.9.1 Questionnaire Design

The questionnaire design was taken out from local publications, reviewing previous studies in several countries and these directly related to the subject of this research; numerous interviews with projects' owners, consultants, and contractors to obtain different points of views, which can be useful for creating the questionnaires. After reading, searching, consulting, modifying and reviewing by the supervisor and experts the questionnaire was establish and ready for distribution. The questionnaire was design in English only. The first page of the questionnaire was a covering letter that explain the study Title, aim and the information security. The questionnaire consisted of close- ended (multiple choice) and open- ended items. Closed-ended questions are the foundation of all statistical analysis techniques applied to questionnaires and surveys. The questionnaire divided into four main parts, which included (i) general information, (ii) Information about competitive low bidding, (iii) Effect of lowest bidder bid awarding system and (v) The Selection Main Criteria and Sub-criteria for Contractors‟ Prequalification and Bid Evaluation.

The first questionnaire draft was designed and reviewed by pilot study and experts, the questionnaire framework was modified and refined (refer to Appendix I for the final questionnaire design in English).

Section #1: Personal information for respondents (Owner, Contractor and consultant).

Section #2: Questions related to general information about the competitive low bidding.

Section #3: Effect of LBBAS (lowest bidder bid awarding system).

Section #4: The Selection Main Criteria and Sub-criteria for Contractors Prequalification and Bid Evaluation.

3.9.2. Case study

Here the case study was focus on recent bid evaluation of public building project and actual data was collect from the city government of Adama construction Authority. After the collection of sample data required for the work, the case study was use for try out and was validate and propose contractor evaluation model.

3.10. Data Analysis Techniques

The classifications of the mass of data based on the main characteristics of the questionnaire and case study have been made. To this end, both qualitative and quantitative methods of data analysis to be employ. In this study, the collected data from the projects and respondents was analyzed by using of micro soft excel to analyze simple data and to develop frame work using TOPSIS model.

3.10.1. Relative Importance Index (RII)

Quantitative data which was gather from the respondents was analyze to enable discussions to be made on the subjects. Basically, the questions on general information of the respondents and all the necessary questions required to achieve the aim of the study was analyze using descriptive statistics such as frequencies, and percentages. The results were further present in graphs, charts and tables. The other types of questions were analyzed to obtain the relative importance of the factors on the effect of lowest bidder bid awarding system on public building construction projects and criteria for contractor prequalification and bid evaluation. A Likert scale rating of 1 to 5 with (1) Very low (2) Low (3) No Idea (4) High (5) Very High and (1) Unimportant (2) little of important (3) moderately important (4) Important (5) Very important and this 5-point scale was chosen to prevent respondents from providinneutral answers.

$$RII = \frac{\sum W}{A * N'}$$

……. equation 3.1

The relative importance index (RII) was determined by:

Where: RII = is relative importance index,

W = is the weight given to each factor by the respondents and ranges from 1 to 5

A = the highest weight = 5

N = the total number of respondents.

3.10.2. Model

Improper selection of contractors may lead to problems such as quality of work and delay in project duration(Khoso & Md Yusof, 2019). The research was proposing a model that can be use and help to develop a framework for analyzing contractor selection criteria and arriving at a selection decision among bidding contractors.

The tool involves a multiple criteria decision making (MCDM) process and is comprised of two composite methods called fuzzy TOPSIS (Technique for Order Performance by Similarity to Ideal Solution). TOPSIS was used to identify and rank the best contractor and the worst contractor.

3.10.3. Fuzzy Analytic Hierarchy Process

The second and the third specific objectives of this study were done by using multi-criteria decision-making methodology stated that analytic hierarchy process is one of the types in MCDMM which is a predominant approach to determine the preference weights of the key selection criteria and sub criteria in contractor selection The following steps were used to implement the fuzzy analytic hierarchy process technique (Sagar et al., 2013)

Step 1: Analyzing Problems selection criteria and sub criteria in contractor selection were determined based on the review of prior literature and structured questionnaires were undertaken for 10 contractor experts, 6 client experts and 6 consultant experts. Those experts were invited to survey hierarchical structures of Prepared By: - analytic hierarchy process was established by identifying 5 main- criteria and 15 sub-criteria, and seven contractor alternatives.

Step 2: Construct a Hierarchical Model: Using criteria, sub-criteria, and the alternatives, a hierarchical structure is constructed to apply analytic hierarchy process and fuzzy TOPSIS algorithms. Then relationships among criteria and sub-criteria are determined and reflected in the hierarchical model shown in Figure 3.3. The hierarchical structure of the maintenance strategy selection problem, which includes four levels. The first level of the hierarchy represents the ultimate goal of the problem, while the second level of the hierarchy consists of five main criteria selection criteria. These criteria are decomposed into various sub-criteria. Finally, the bottom level of the hierarchy represents the seven alternative contractors.

Step 3: Questionnaire Design and Survey Based on the established hierarchical structure, design a questionnaire to reflect the importance levels of criteria and sub-criteria were conducted to the responses of experts from contractor, client and consultant experts were identified based on their experience. After the Criteria and sub-criteria were determined, it can used linguistic variables to reflect the expert's rating of importance. To compare the importance of each evaluation criterion, it can used nine linguistic terms on a scale as shown in table 3.1. The linguistic scale in the fuzzy AHP method was used to categorize the criteria (C) based on their importance.

Table 3. 1 Fuzzy linguistic term determined for the criterion weights comparison

Importance Intensity	Linguistic Terms for Alternatives	Triangular Fuzzy Scale
1	Equally important (EI)	(1, 1, 1)
2	Equal to moderate important (EMI)	(1, 2, 3)
3	Moderate important (MI)	(2, 3, 4)
4	Moderate to strong important (MSI)	(3, 4, 5)
5	Strong important (SI)	(4, 5, 6)
6	Strong to very strong important (SVSI)	(5, 6, 7)
7	Very strong important (VSI)	(6, 7, 8)
8	Very strong to absolute important (VSAI)	(7, 8, 9)
9	Absolute important (AI)	(9, 9, 9)

Step 4: Building pair-wise comparison matrices with fuzzy scales

Pair-wise comparisons are done among related criteria and sub-criteria following the scale suggested by (Ayalew et al., 2022). A special questionnaire form is used to complete the pair-wise comparison matrix. In this comparison criteria, sub-criteria are used for comparing alternative contractor by experts in the field (Kou et al., 2016). The pair-wise comparisons are members of the set: {1/9, 1/8, 1/7, 1/6, 1/5, 1/4, 1/3,1/2, 1,2,3,4,5,6,7,8,9}. The pair-wise comparison judgments are represented by fuzzy triangular numbers denoted by ãij = (lij, mij, uij) and n(n-1)/2 judgments are required for each comparison group for a level to construct a positive fuzzy reciprocal comparison matrix Ă = {ãij} (Basahel & Taylan, 2016).
The matrix is expressed as follows.

$$\check{A} = \{\tilde{a}_{ij}\} = \begin{bmatrix} 1 & a_{12}\ldots. & .. & .. & a_{1n} \\ a_{21} & 1\ldots. & .. & .. & a_{2n} \\ a_{31} & a_{32} & 1 & \ldots & a_{3n} \\ .. & .. & .. & .. & \ldots \\ .. & .. & .. & .. & \ldots \\ a_{n1} & a_{n2}\ldots.. & .. & .. & 1 \end{bmatrix} = \begin{bmatrix} 1 & a_{12}\ldots. & .. & .. & a_{1n} \\ 1/a_{12} & 1\ldots. & .. & .. & a_{2n} \\ 1/a_{13} & 1/a_{23} & 1 & \ldots & a_{3n} \\ .. & .. & .. & .. & \ldots \\ .. & .. & .. & .. & \ldots \\ 1/a_{1n} & 1/a_{2n}\ldots.. & .. & .. & 1 \end{bmatrix} \quad \text{.....equation 3.2}$$

Where,

$$\tilde{a}_{ij} = \begin{cases} \tilde{1}, \tilde{2}, \tilde{3}, \tilde{4}, \tilde{5}, \tilde{6}, \tilde{7}, \tilde{8}, \tilde{9} & \text{Criterion i is relative importance to criterion j} \\ 1 \quad \forall i{=}j & \text{criterion i is equal importance to criterion j} \\ \tilde{1}^{-1}, \tilde{2}^{-1}, \tilde{3}^{-1}, \tilde{4}^{-1}, \tilde{5}^{-1}, \tilde{6}^{-1}, \tilde{7}^{-1}, \tilde{8}^{-1}, \tilde{9}^{-1} & \text{Criterion i is relative l} \\ & \text{criterion j} \end{cases}$$

Step 5: The consistency test (Huang & Ho, 2013) stated that consistency ratio (CR) was used to assess the reliability and credibility of the questionnaire. The consistency ratio for each decision experts was calculated by using an excel template through using the general formula. When the value of CR ≤ 10% indicates a good level of consistency in the comparative judgments represented in that matrix and it is acceptable. CR value greater than 10% has resulted in the inconsistency of judgments within that matrix. This suggests that the evaluation process needs to be reviewed and repeated to improve the consistency of the questionnaire. As proposed by (Nefros & Loupasakis, 2022) the consistency ratio is calculated as per the following steps.

i) Calculate the eigenvector and largest Eigenvalue (λmax) for each matrix of order n. Principal Eigenvalue (λmax) is obtained from the summation of products between each element of the Eigenvector and the sum of columns of the reciprocal matrix.

ii) Compute the consistency index and consistency ratio for each matrix of order, n' by the formula

$$CI = \frac{\lambda max - n}{(n-1)} \quad \text{.....equation 3.3}$$

$$CR = \frac{CI}{RI} \ldots\ldots \quad \text{.....equation 3.4}$$

Where, RI is random consistency index obtained from a large number of simulations runs and varies depending upon the number of criteria as shown in table 3.2. n= number of criteria

Table 3. 2 Random Consistency Index (RI) [111]

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

Step 6: Transforming fuzzy scales into triangular fuzzy numbers the fuzzy nine-scale linguistic scaling to weigh the importance of each main-criterion and sub criteria were transformed in to triangular fuzzy numbers as shown in table 3.3.

Table 3. 3 The triangular fuzzy number of linguistic variables and fuzzy scales (Sagar et al., 2013)

Importance Intensity	Linguistic Variable	Fuzzy Scale	Triangular Fuzzy Number
1	Equally important (EI)	1˜	(1, 1, 1)
2	Equal to moderate important (EMI)	2˜	(1, 2, 3)
3	Moderate important (MI)	3˜	(2, 3, 4)
4	Moderate to strong important (MSI)	4˜	(3, 4, 5)
5	Strong important (SI)	5˜	(4, 5, 6)
6	Strong to very strong important (SVSI)	6˜	(5, 6, 7)

7	Very strong important (VSI)	$7^{\sim}$	(6, 7, 8)
8	Very strong to absolute important (VSAI)	$8^{\sim}$	(7, 8, 9)
9	Absolute important (AI)	$9^{\sim}$	(9, 9, 9)

Step 7: Aggregating the experts‟ decision to aggregate the decision of experts the fuzzy geometric mean was the most common operation used in fuzzy multiple criteria decision making. The following formula can be used to transfer expert opinions into triangular fuzzy numbers (Fu et al., 2020).

$a_{ij} = (a_{ij}\ 1 \otimes a_{ij}\ 2 \otimes a_{ij}\ 3 \ldots\ldots\ldots\ldots \otimes a_{ij}\ N)\ 1/n$ ……. equation 3.5

Where, aij -is the integrated triangle fuzzy Number by N experts.

$a_{ij}^{\ k}$ is the i-th to the j-th factor pair comparison by expert k.

$\otimes$- is the symbol of matrix multiplication.

$a_{ij} = (a_{ij}\ 1 \otimes a_{ij}\ 2 \otimes a_{ij}\ ^{3} \ldots\ldots\ldots\ldots \otimes aij\ ^{10})^{\ 1/n}$

$^{a}{}_{ij} = (a_{ij}\ 1 \otimes a_{ij}\ 2 \otimes a_{ij}\ ^{3} \ldots\ldots\ldots\ldots \otimes aij\ ^{10})^{\ 1/10}$

Step 8: Calculating fuzzy geometric mean and fuzzy weight of criteria to find the results of the fuzzy geometric mean and fuzzy weight the fuzzy analytical operation can be done by using MS-excel for the calculation of importance coefficient the formula was presented in below.

$ri = (ai1\ 1 \otimes ai2\ 2 \otimes ai3\ 3 \otimes \ldots\ldots\ldots\ldots \otimes ain)\ 1/n$……. …..…… equation 3.6

$wi = ri \otimes (r1 \oplus r2 \oplus r3 \oplus \ldots\ldots\ldots\ldots \oplus rn)\ -1$……..... equation 3.7

Where, a_{in} is fuzzy comparison value of criterion i to criterion n

r_i is the geometric mean of fuzzy comparison value of criterion i to each criterion,

wi is the fuzzy weight of the i^{th} criterion, can be indicated by a triangular fuzzy number.

⊕ is the symbol of matrix plus

Hence wi = (Lwi, Mwi, Uwi). Lwi, Mwi, and Uwi stand for the lower, middle, and upper values of the fuzzy weight of the i-th criterion respectively.

Step 9: Weight priority by defuzzification

Defuzzification is used to renew the fuzzy number into a single crisp value (Fu et al., 2020) The Center of the area converts a fuzzy weight into a non-fuzzy value and has been extensively applied in defuzzification by the following equation

BNPi = [(Uwi- Lwi) + (M wi- Lwi)]/3 +Lwi……..…….... equation 3.8

After calculating the non-fuzzy value, it can perform normalization to obtain the local weights for each criterion. The sum of local weights of the main criteria, and sub-criteria on the same hierarchy was 1.00.

BNPw1 = BNP1/ (BNP1 + BNP2 ….…. + BNPn) ……equation3.9

Step 10: Calculate the global weights of all criteria.

According to (S. Kil, D. K. Lee, J. Kim, M. Li, and G. Newman, 2016.) the value of global weight equaled the value of the local weight within each main criteria multiplied by the value of local weight within each sub-criterion. The sum of global weights was also 1.00. The ranking was arranged according to the order of the global weight.

Global weight = value of the local weight within each main criteria * value of local weight within each sub-criterion…….....equation 3.10

3.10.4. Fuzzy Technique for Order Preference by Similarity to Ideal Solution Method

The third objective of this study is the Evaluation and selection of the contractors. Fuzzy TOPSIS approaches were used for the Evaluation and selection of the appropriate contractors for improving the gaps of alternatives between real performance values in each criterion and sub-criterion and finding out the best alternatives for achieving the desired levels. Under (Ayalew et al., 2022) the steps for implementing the fuzzy TOPSIS methodology are described below.

Step 1: Determine the weighting of each evaluation criteria. In this study, it can employ fuzzy AHP to find the fuzzy preference weights, these is because the analysis was done by integrating fuzzy AHP and fuzzy TOPSIS methods.

Step 2: Construct the fuzzy decision matrix and choose the appropriate linguistic variables for the alternatives to criteria. The experts have their range for the linguistic variables employed in this study according to their subjective judgments.

Table 3. 4 Linguistic terms and their numerical intervals for fuzzy TOPSIS

Attribute Grade	Fuzzy Linguistic Terms for Decision Making	Triangular Fuzzy Number
1	Very Low Important (VLI)	(1,2,3)
2	Low Important (LI)	(2, 3, 4)
3	Moderately Important (MI)	(3, 4, 5)
4	Highly Important (HI)	(4, 5, 6)
5	Extremely Important (EI)	(5, 7, 9)

Step 3. Aggregate the fuzzy judgment values of different evaluators regarding the same evaluation dimensions to get the aggregated fuzzy rating of alternative under (Asuquo et al., 2019)

$$D = \begin{matrix} A_1 \\ A_2 \\ A_3 \\ \dots \\ \dots \\ A_m \end{matrix} \begin{bmatrix} C_1 & C_2 & \dots & C_n \\ x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} \dots . & & x_{21} \\ x_{31} & x_{32} \dots . & & x_{31} \\ \dots . & \dots . & & \dots \\ \dots . & \dots . & & \dots \\ x_{m1} & x_{m2} \dots . & & x_{mn} \end{bmatrix} \dots .$$

……equation 3.11

i = 1, 2..., m; j=1, 2, n

Xij = 1/k (Xij 1 + Xij 2 + Xij 3 + Xij K)

Where, Xij = is the rating of alternative Ai with respect to criterion Cj evaluated by K expert and

Xij K = (lij + mij + uij)

Step 4: It is possible to avoid complex calculations; a linear normalization is used to convert the various measurement scales into comparable scales, and that the range of each component of the normalized triangular fuzzy numbers lies within [0, 1]. Therefore, it is possible to obtain the normalized fuzzy decision matrix denoted by

Rij.= [r_{ij}] m*n ……..equation 3.12

i = 1, 2..., m; j=1, 2..., n

Then the normalization process can be performed by following formula:

Xij K = (lij + mij + uij) (), and j = 1, 2. . . n is equal one.

Step 5: Construct the weighted normalized fuzzy decision matrix. The weighted fuzzy normalized decision matrix is shown as following matrix V

$\tilde{V}$ = [$\tilde{}$Vij] m*n, i = 1, 2..., m; j=1, 2..., n……equation 3.13

Where, Vij=rij$\tilde{}$ (.)$\tilde{}$wj

Step 6: Determine the fuzzy positive-ideal solution (FPIS) and fuzzy negative-ideal solution (FNIS). According to the weighted normalized fuzzy decision matrix, the elements$\tilde{}$ are normalized positive triangular fuzzy numbers and their ranges belong to the closed interval [0, 1]. Then, it can define Fuzzy Positive Ideal Solution (FPIS, A+) and Fuzzy Negative Ideal Solution(FNIS,A-)as the following formula.

$A^+ = (\tilde{v}_1^+, \tilde{v}_2^+, \tilde{v}_3^+ \dots \dots \dots \tilde{v}_n^+)$ ..... equation 3.14

$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \tilde{v}_3^- \dots \dots \dots \tilde{v}_n^-)$ ..... equation 3.15

Where, $\tilde{v}_j^+ = (1, 1, 1)$ and $\tilde{v}_j^- = (0, 0, 0)$, j=1, 2,...,n

Step 7: Calculate the distance of each alternative from FPIS and FNIS. The distance of each alternative from can be calculated as

$d_i^+ = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^+), \quad i = 1, 2,..., m; j=1, 2,...,n$..... equation 3.16

$d_i^- = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^-), \quad i = 1, 2,..., m; j=1, 2,...,n$..... equation 3.17

Where, $d(d_i^+, d_i^-)$ is the distance measurement between two fuzzy

numerical values

Let ā = (a1, a2, a3) and b = (b1, b2, b3) be two triangular Fuzzy numbers. If $\tilde{}$ = $\tilde{}$ then = ∀ = 1,2,3. If $\tilde{\alpha}$ is a triangular fuzzy number and > 0 and ≤ 1 for A fuzzy set$\tilde{}$ [0, 1], then$\tilde{}$ is called a normalized positive triangular fuzzy number. Let ā = (a1, a2, a3) and b = (b1, b2, b3) be two triangular Fuzzy numbers. The distance between them is given using the vertex method by (Asuquo et al., 2019).

$$d(\tilde{a}, \tilde{b}) = [{}^{1}/_{3}((a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2))]^{0.5}$$

$$d(\tilde{a}, \tilde{b}) = \sqrt{{}^{1}/_{3}((a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2))}$$ ……equation 3.18

Step 8: Calculate the closeness coefficient of each alternative.

The CCi is defined to determine the ranking order of all alternatives once the a of each alternative have been calculated. Calculate similarities to ideal solutions. This step solves the similarities to an ideal solution by the formula:

$CC_i = \frac{d_i^-}{d_i^- + d_i^+}, \quad i = 1, 2,..., m$ ..... equation 3.19

Step 9: Ranking the alternatives

3.9. Statistical Data Analysis and Presentation Technique

The statistical package was used to analyses the data collected for this study is SPSS version 23 The data collected by the questionnaires were converted into numerical codes representing measurement of variables using the statistical package for social sciences and Microsoft excel. Descriptive statistics was used to describe the population surveyed. This is represented in form of statements, tables, and numerical summary in form of relative importance index. This study used descriptive statistics for identifying the current practice of road maintenance management practice in Ethiopian road authority and MS-excel used for doing fuzzy AHP and Fuzzy TOPSIS.

3.10. Ethical Considerations

The research study was honestly and confidentially ethical from preparing the from collecting the data and until interpreting of the results. Even the questionnaire survey provides detail information to the study participants regarding the purpose, objective, and then verbal and written consent was obtained from each participant. Moreover, privacy and confidentiality of information was kept properly and names were not recorded

3.10.4. Bidding Contractors and Decision criteria relationship

The number of decision makers might vary according with the type and size of the industry and each individual of the committee can establish contractor evaluation criteria and meet to discuss and determine the set of global criteria appropriate to the given project at hand and the company's requirements Later, a subjective ranging of this research is actual data from the relative weight of contractor selection criteria for application of TOPSIS model to rank contractors against the qualification criteria and select the winning contractor. The algorithm of the multi-criteria decision making (MCDM) with TOPSIS for dealing with contractor selection given as follows:

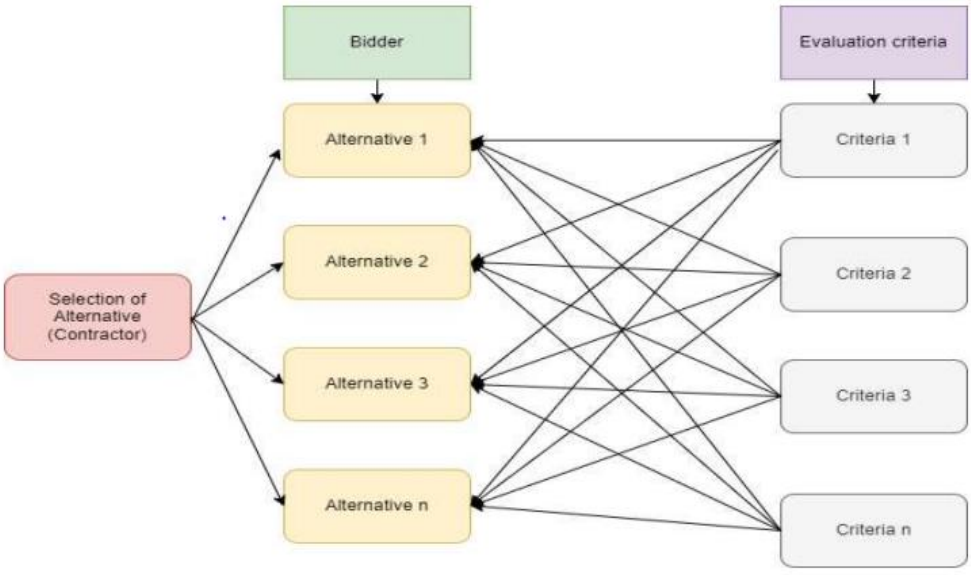


Figure 3. 3 Bidding Contractors and decision Criteria relationship

3.10.5. Proposed Systematic Model

However, steps from one up to three of the proposed models can be neglected by adapting the evaluation criteria and their weights obtained by this research in order to save time and energy by the decision makers for cases when it is needed. the proposed model began with the identification of factors that influences the contactor selection process i.e., the selection of a committee of decision makers (DM) familiarized with the company's needs and qualification requirements. The number of decision makers might vary according with the type and size of the project. Then each individual of the committee can establish contractor evaluation criteria and meet to discuss and determine the set of global criteria appropriate to the given project at hand and the company's requirements. Later, a subjective ranking of these criteria is made by the DMS so that Standard bid document was used to calculate the relative weight of contractor selection criteria application of TOPSIS model comes into place to rank contractors against the qualification criteria and select the winning contractor.

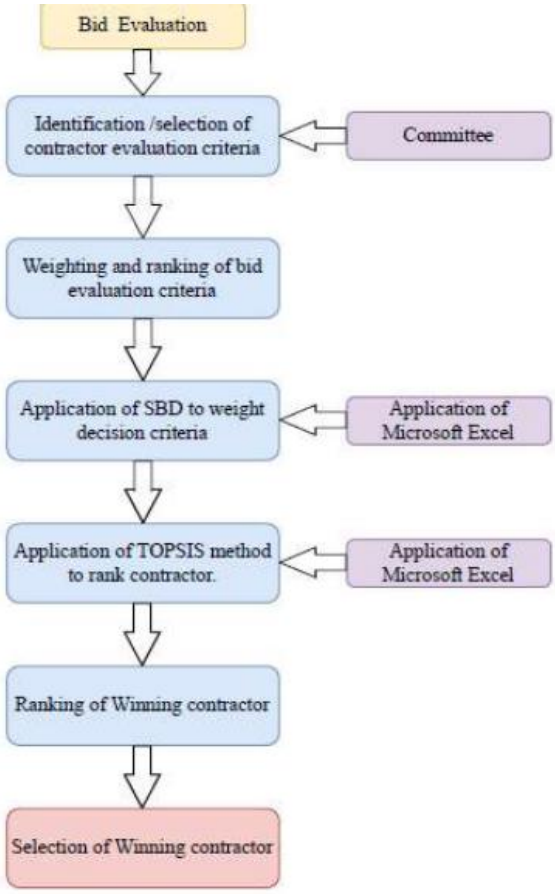


Figure 3. 4 Developed flow chart model

Finally, TOPSIS algorithm was used to optimize the given task and select the winning contractor. The algorithm of the multi-criteria decision making (MCDM) with TOPSIS and with contractor selection is given as follows:

Step 1: Select a group of decision makers

Step 2: Identify and select bid evaluation criteria.

Step 3: Weighting of evaluation criteria as per the needs of the project

Step 4: Construct the decision matrix and use Entropy model to normalize decision matrix

Step 5: Construct the weighted normalized decision matrix by multiplying weight and normalized decision matrix.

Step6: Determine the Positive ideal solutions (PIS) and negative ideal solutions (NIS) using TOPSIS method.

Step7: Determine the distance of each alternatives form PIS and NIS.

Step8: Evaluate the closeness coefficient of each alternative.

Step9: Using the closeness coefficient, obtain ranking of alternative. However, steps from one up to three of the proposed models can be neglected by adapting the evaluation criteria and their weights obtained from PPPAA Standard Bid Document 2011-part -1 section-3 in this research in order to save time and energy by the decision makers for cases when it is needed. Standard bidding document evaluation criteria carefully reviewed. For a test to be reliable, it also needs to be valid here the researcher used sampling validity to ensure that the measure covers the concept under study which is the practice of bid criteria setting here all evaluation criteria listed in PPPAA 2011 SBD was address through standard bidding document review and summarize.

3.11. Validity of the Research

In order to test the appropriateness, validity of the questionnaires, it provides a trial run for the questionnaire, which involves testing the wordings of the question, identifying ambiguous questions, testing the techniques that used to collect data, and measuring the effectiveness of standard invitation to respondents.

3.12. Reliability of the Research

The reliability of questionnaire data was check by Cronbach's alpha. Cronbach's coefficient alpha test functional to measure the internal consistency of questionnaire that is, how closely related a set of items are as a group. Cronbach's alpha reliability coefficient normally ranges between 0 and 1. The closer Cronbach's alpha coefficient is to 1.0 the greater the internal consistency of the items in the scale. Koonce & Kelly, (2014) provide the following rules of thumb: ≥. 0.9– Excellent, ≥ .0.8– Good, ≥ 0.7– Acceptable, ≥ 0.6– Questionable, ≥ 0.5– Poor, and ≤0 .5 – Unacceptable". Cronbach's alpha most commonly used to assess the internal consistency of a questionnaire (or survey) that is made up of multiple Liker-type scales and items (Gliem & Gliem, 2003). Cronbach's alpha was calculated using the formula:

$$\alpha = \frac{K}{K-1}\left[1 - \frac{\sum s^2_y}{s^2_x}\right] \qquad \text{……equation 3.20}$$

Where

K= is the number of test item

$\sum S^2$ y= is the sum of the item variance

S^2 x = is the variance of total score.

α =is Cronbach's alpha

Results in Table 3.3 clarifies that values in the range from (>0.9), which considered high; so, it can be said the result guarantees the reliability of the questionnaire. Cronbach's alpha nearest to 0.88 and 0.89 for the whole questionnaire, which shows as good reliability of the whole questionnaire.

Table 3. 3 Cronbach's Alpha for each field of the questionnaire

Field	Cronbach's Alpha			
	client	contractor	consultant	All field
Effect of LBBAS (Lowest Bidder Bid Awarding System)	0.89	0.91	0.83	0.88
The Selection Main Criteria and Sub-criteria for Contractors' Prequalification and Bid Evaluation	0.912	0.96	0.79	0.89

CHAPTER FOUR

4. RESULTS AND DISCUCION

This chapter involved analysis and discussion of the results that have been collected from questionnaire and case study. The method used was discussed in Chapter 3. Data were analyzed using Micro soft excel and FuzyTOPSIS including descriptive and inferential statistical tools. In this study, a total of 45 questionnaires respondents from the study sample and one case study were considered. This chapter included reviews and explains the outcomes and the discussion of the results.

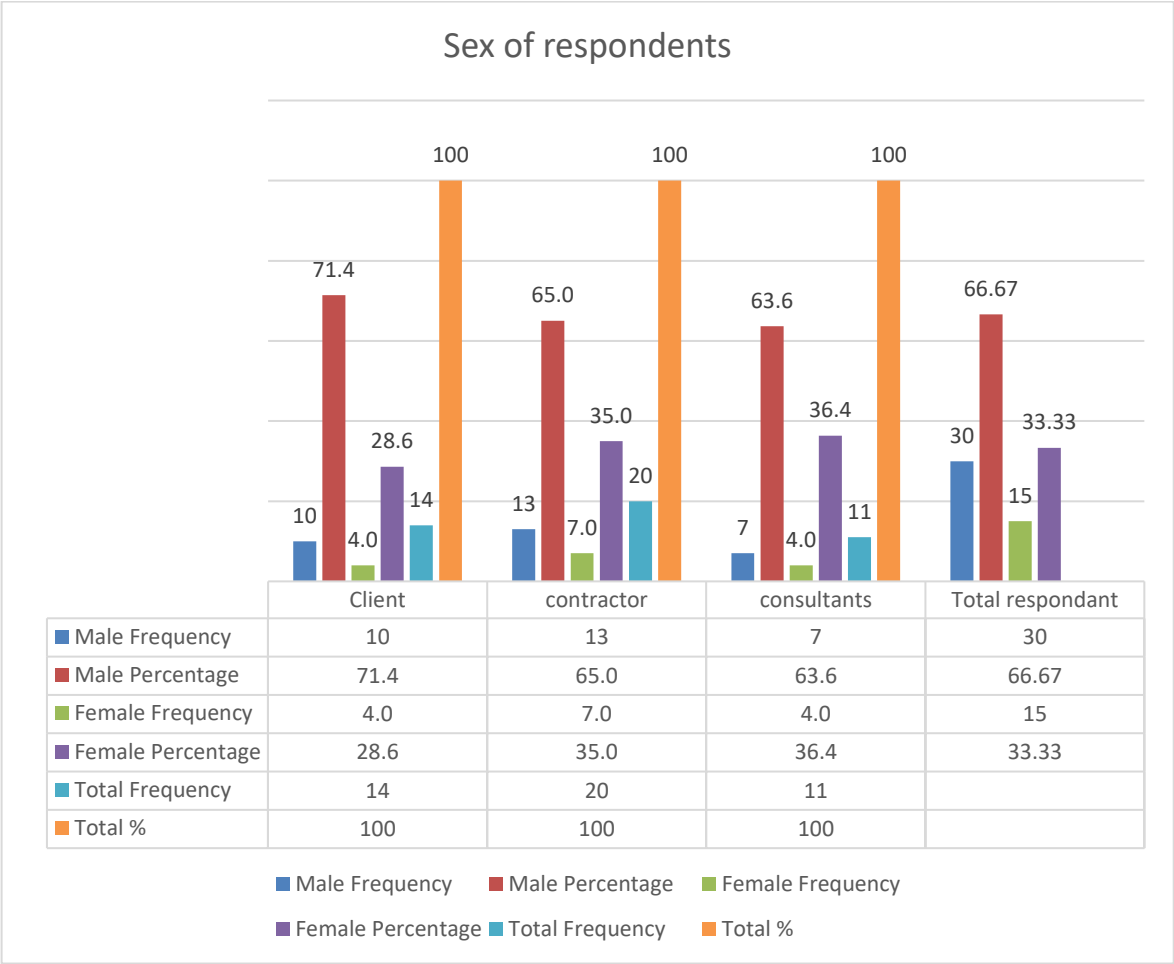
4.1. Analysis of Data from the Questionnaires

In this section, the data were statistically analyzed using micro soft excel with other necessary tests. This section describes results that gathered from a field survey of 45 questionnaires. The questionnaire was organized to be done by the owner, contractors, and consultants construction projects which are more than 50%of construction work is completed. The questionnaire involved three parts, the first part included general information, the second part included effect of lowest bidder bid awarding system, and the third part was the selection main criteria and sub-criteria for contractors‟ prequalification and bid evaluation. These achieved results will be compared with the relevant literature in addition to the researcher comments. In addition, the researcher conducted an analysis of the study dimension by finding relative importance index.

4.2. General Information of Respondents

Persons who complete the entire questionnaire were used for the data analysis. The following are the general information obtained f44rom the survey result for the public sector clients participated in this research study.

I. Sex of respondent

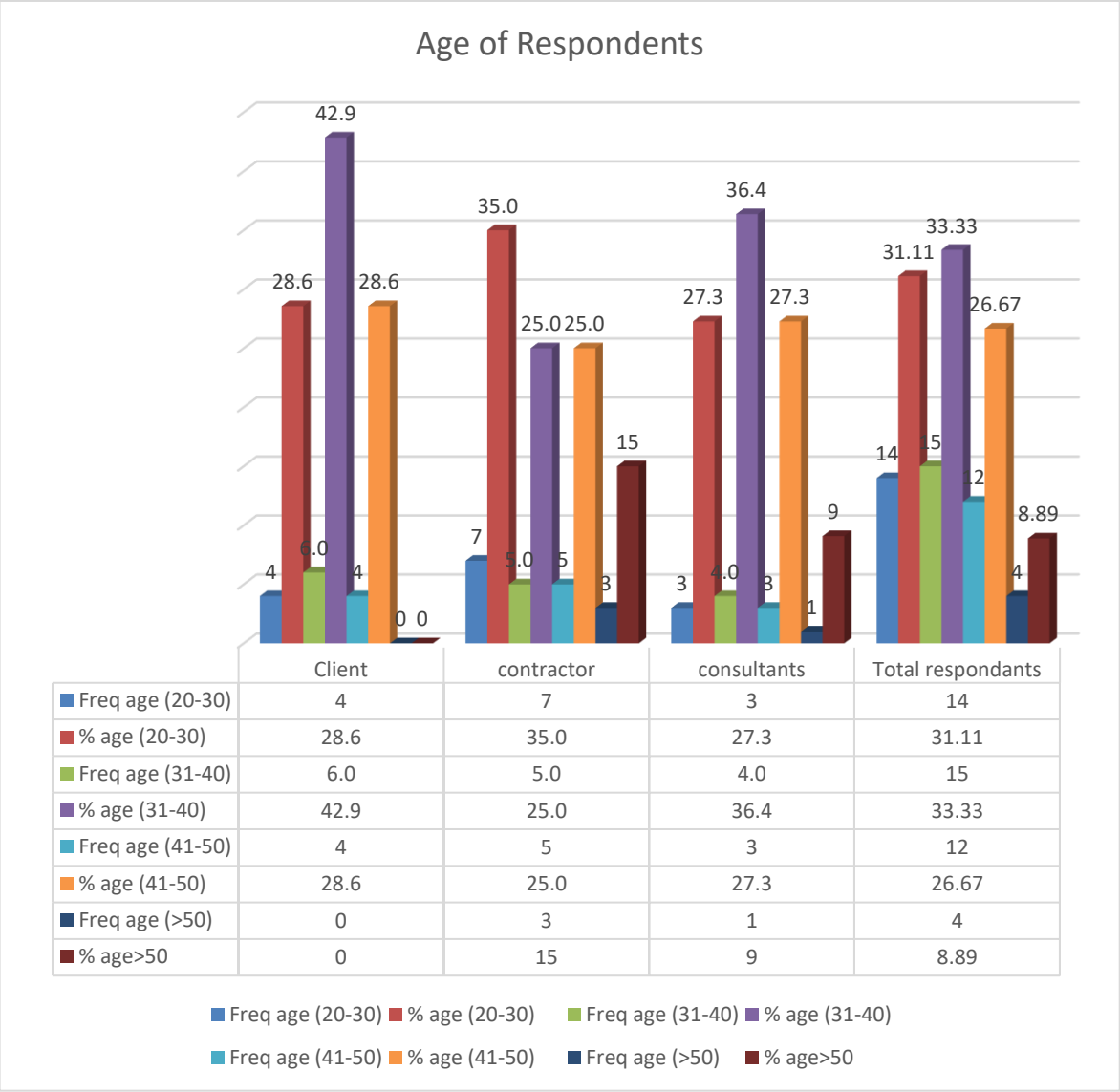


	Client	contractor	consultants	Total respondant
Male Frequency	10	13	7	30
Male Percentage	71.4	65.0	63.6	66.67
Female Frequency	4.0	7.0	4.0	15
Female Percentage	28.6	35.0	36.4	33.33
Total Frequency	14	20	11	
Total %	100	100	100	

Figure 4. 1 Sex of respondent

Figure 4.1 shows sex of respondents form the client, contractor and consultant's side that participated in the survey study. From the total 45 participants, 66.67 % of the respondents were male, and 33.3 % were female. From the above result client respondent were 71.4 % male and 28.6 % female, contractor respondent were 65 % male and 35 % female and consultant respondent where 63.6 %male and 36.4% female. Most of the respondents in this study were contractor.

II. Age of respondents

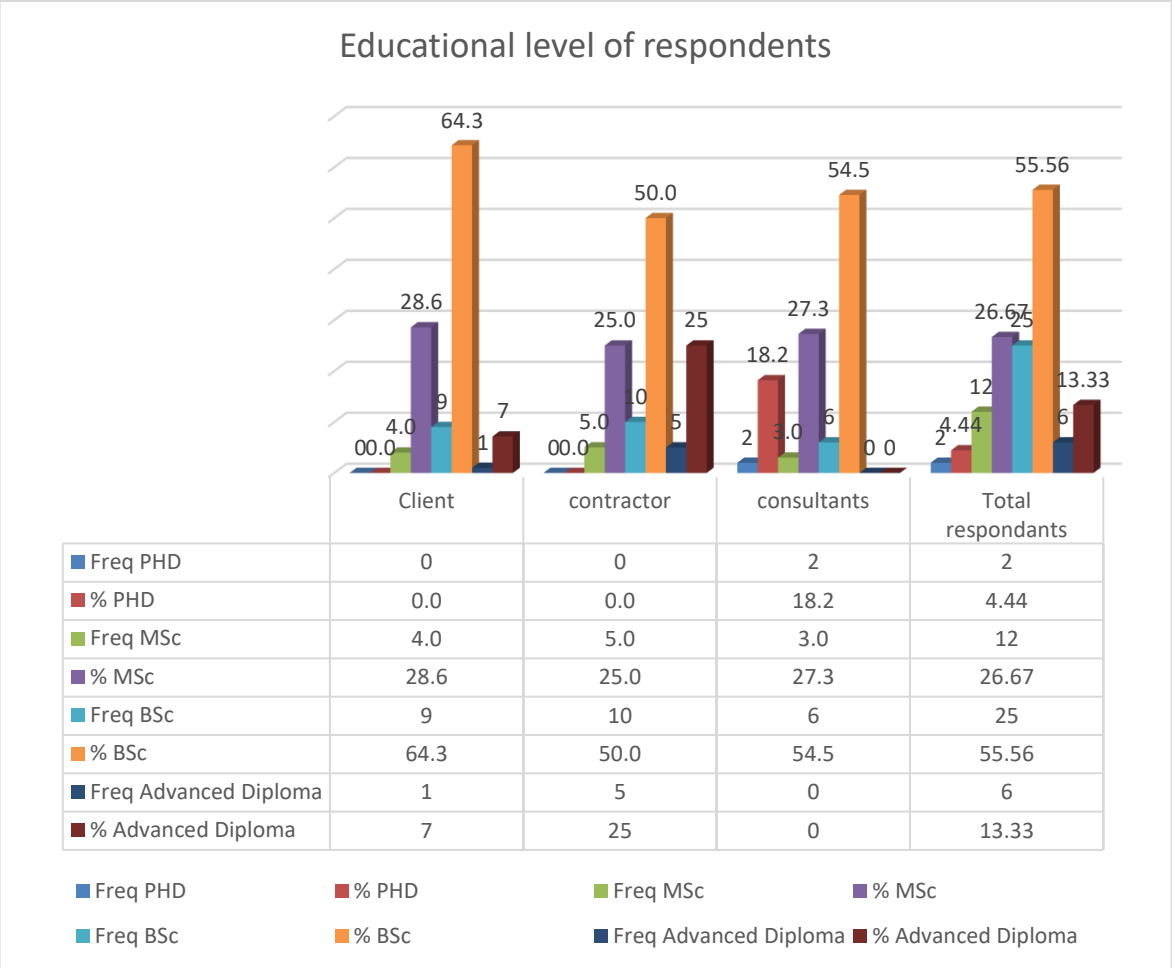


	Client	contractor	consultants	Total respondants
Freq age (20-30)	4	7	3	14
% age (20-30)	28.6	35.0	27.3	31.11
Freq age (31-40)	6.0	5.0	4.0	15
% age (31-40)	42.9	25.0	36.4	33.33
Freq age (41-50)	4	5	3	12
% age (41-50)	28.6	25.0	27.3	26.67
Freq age (>50)	0	3	1	4
% age>50	0	15	9	8.89

Figure 4. 2 Age of respondent

Figure 4.2 shows Age of respondents form the client, contractor and consultant's side that participated in the survey study. From the total 45 participants, 42.9% of the respondents were between (31-40) of client, 35 % of the respondents were between (20-30) of contractor, 36.4 % of the respondents were between (31-40) of consultants, and 0% of the respondents were above 50 years old of client. The result obtained from the survey indicates that the respondents with an age between 31-40 years old were higher in number.

III. Education level of respondent



	Client	contractor	consultants	Total respondants
Freq PHD	0	0	2	2
% PHD	0.0	0.0	18.2	4.44
Freq MSc	4.0	5.0	3.0	12
% MSc	28.6	25.0	27.3	26.67
Freq BSc	9	10	6	25
% BSc	64.3	50.0	54.5	55.56
Freq Advanced Diploma	1	5	0	6
% Advanced Diploma	7	25	0	13.33

Figure 4. 3 Education level of respondent

Figure 4.3 shows the result obtained from survey results of education level of respondents result shows that 64.3 %, 50%, 0 %, and 054.5% of the participants with an education level of BSc for client, contractor and consultants., respectively. 55.56%The result obtained from the survey indicates that the respondents with an education level of B.Sc were higher in number.

IV. Occupation of respondents

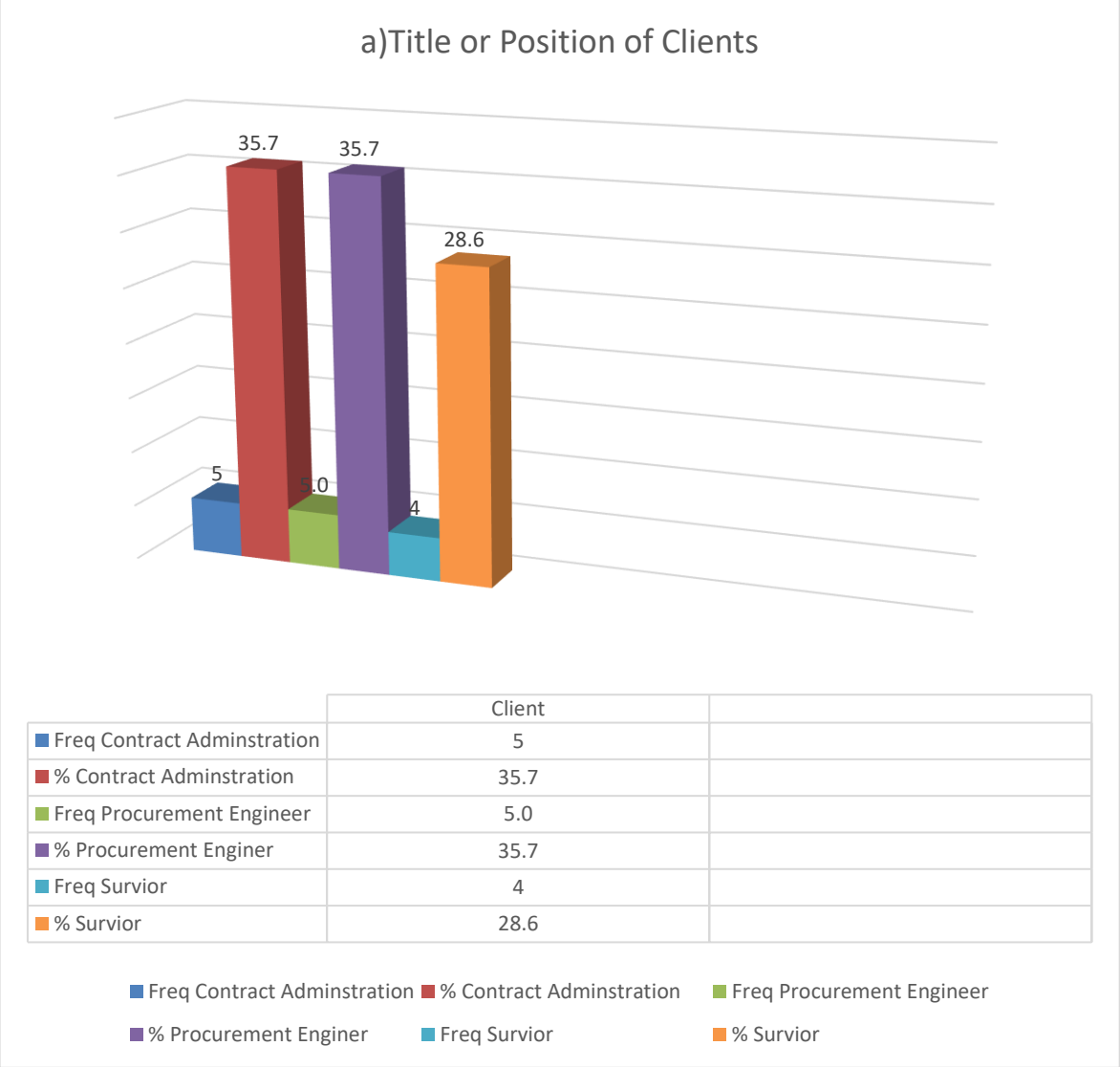
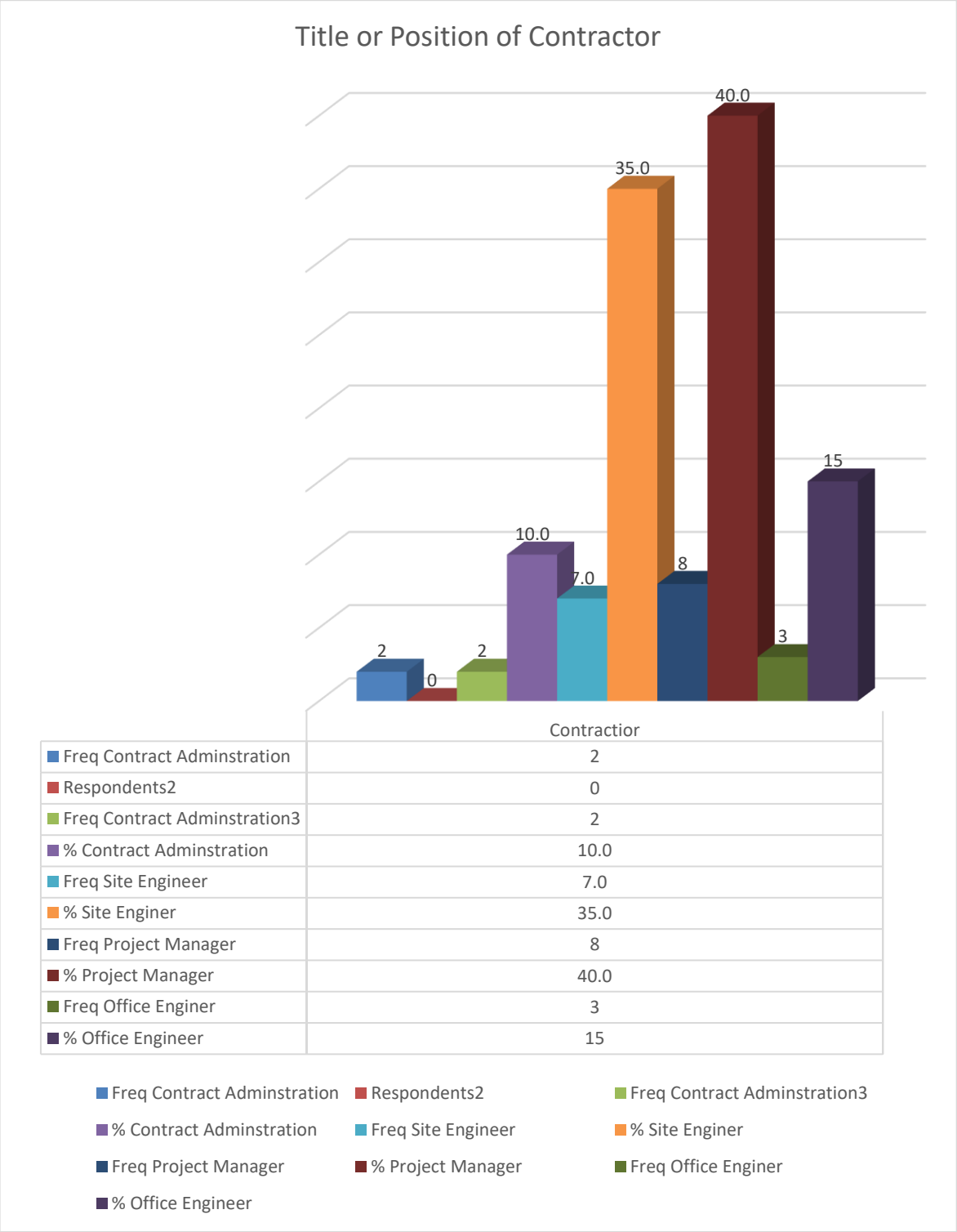


Figure 4. 4. 1 Occupation of Client respondents



	Contractior
Freq Contract Adminstration	2
Respondents2	0
Freq Contract Adminstration3	2
% Contract Adminstration	10.0
Freq Site Engineer	7.0
% Site Enginer	35.0
Freq Project Manager	8
% Project Manager	40.0
Freq Office Enginer	3
% Office Engineer	15

Figure 4. 4. 2 Occupation of Contractors respondents

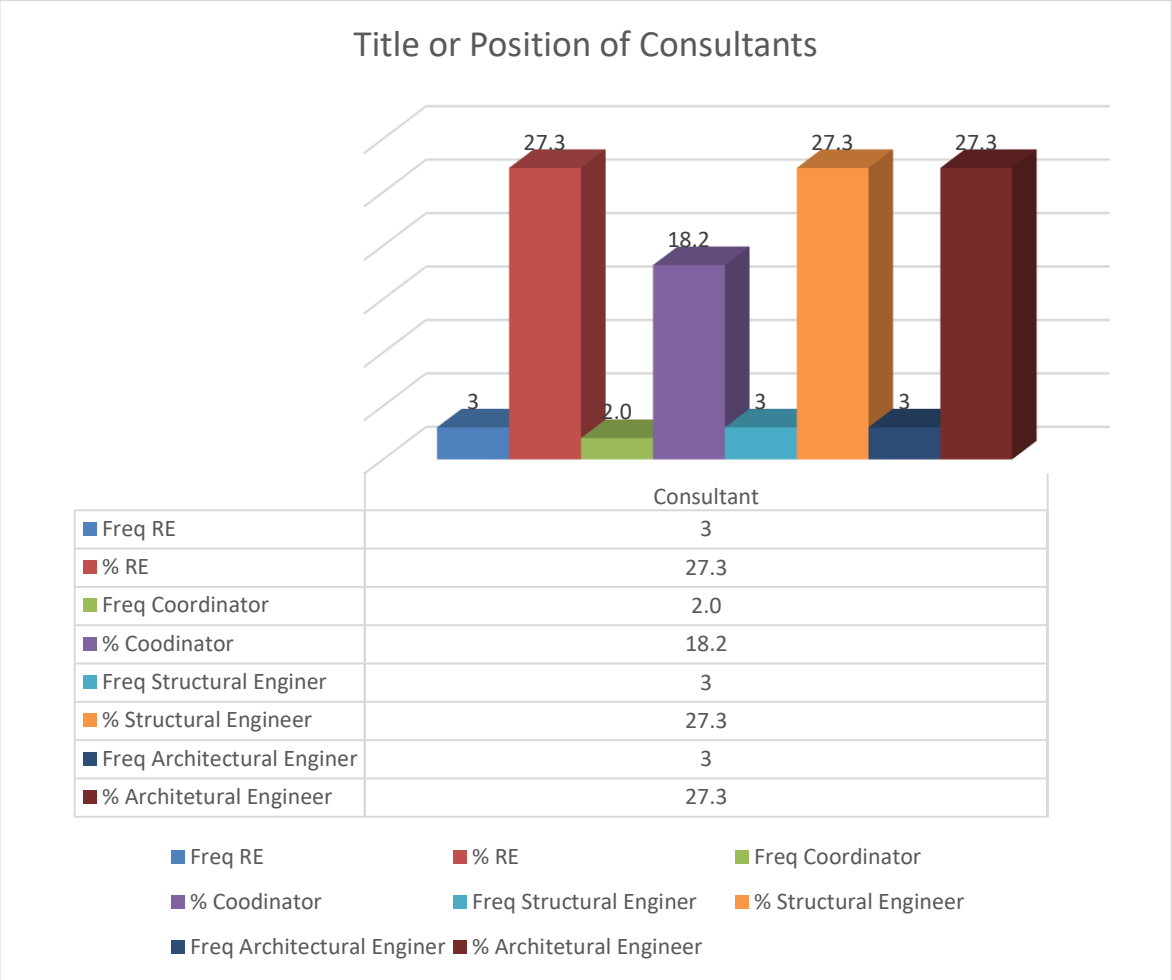


Figure 4. 4. 3 Occupation of Consultants respondents

Figure 4.4 shows position of respondent's form the owner's side that participated in the survey were 14 participants, 35.7 % were Procurement engineer, and 35.7 % of the respondents were contract administration. From the owner result, most of the respondents were Procurement engineer and contract administration. Occupation of respondent's form the contractor side that participated in the survey were 20 participants, 35 % were site engineer, 40% project manager and 15 % of the respondents were office engineer. From the contractor's result, most of the respondents were site engineer. Occupation of respondent's form the consultant side that participated in the survey were 11 participants, 27.3% Architectural Engineer, Structural Engineer and RE of them are responded.

V. Experience year of respondents

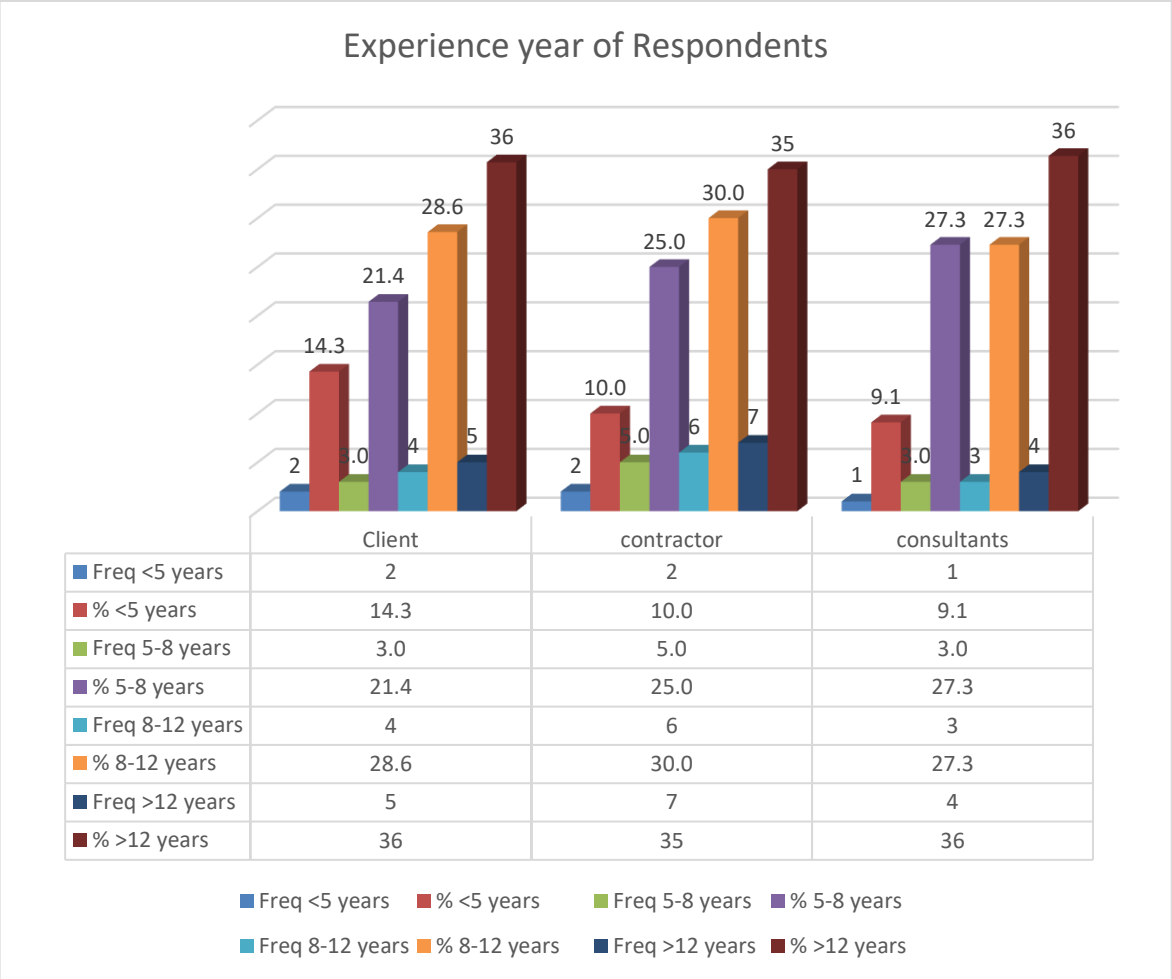
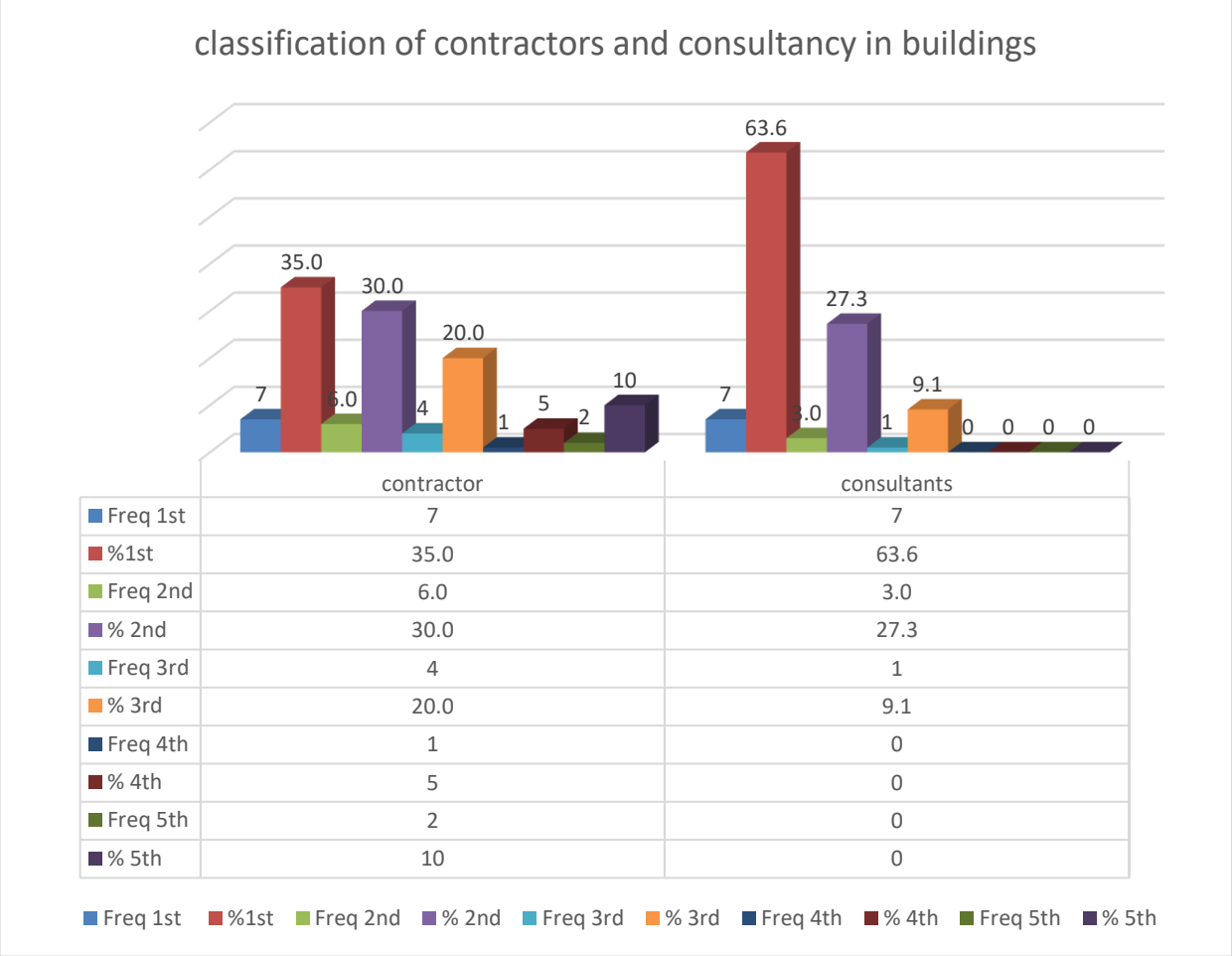


Figure 4. 4 Experience year of respondents

Figure 4.5 shows the result obtained from survey results of experience of respondents of all owner, contractor and consultant who were participated in questioners. The survey result shows that clients 36%, contractor 35%, consultants 36% of the participants with an experience are greater than 12 years. The result obtained from the survey indicates that the respondents with an experience of greater than 12years were higher in number.

VI. Classification of Contractors and consultancy in building works

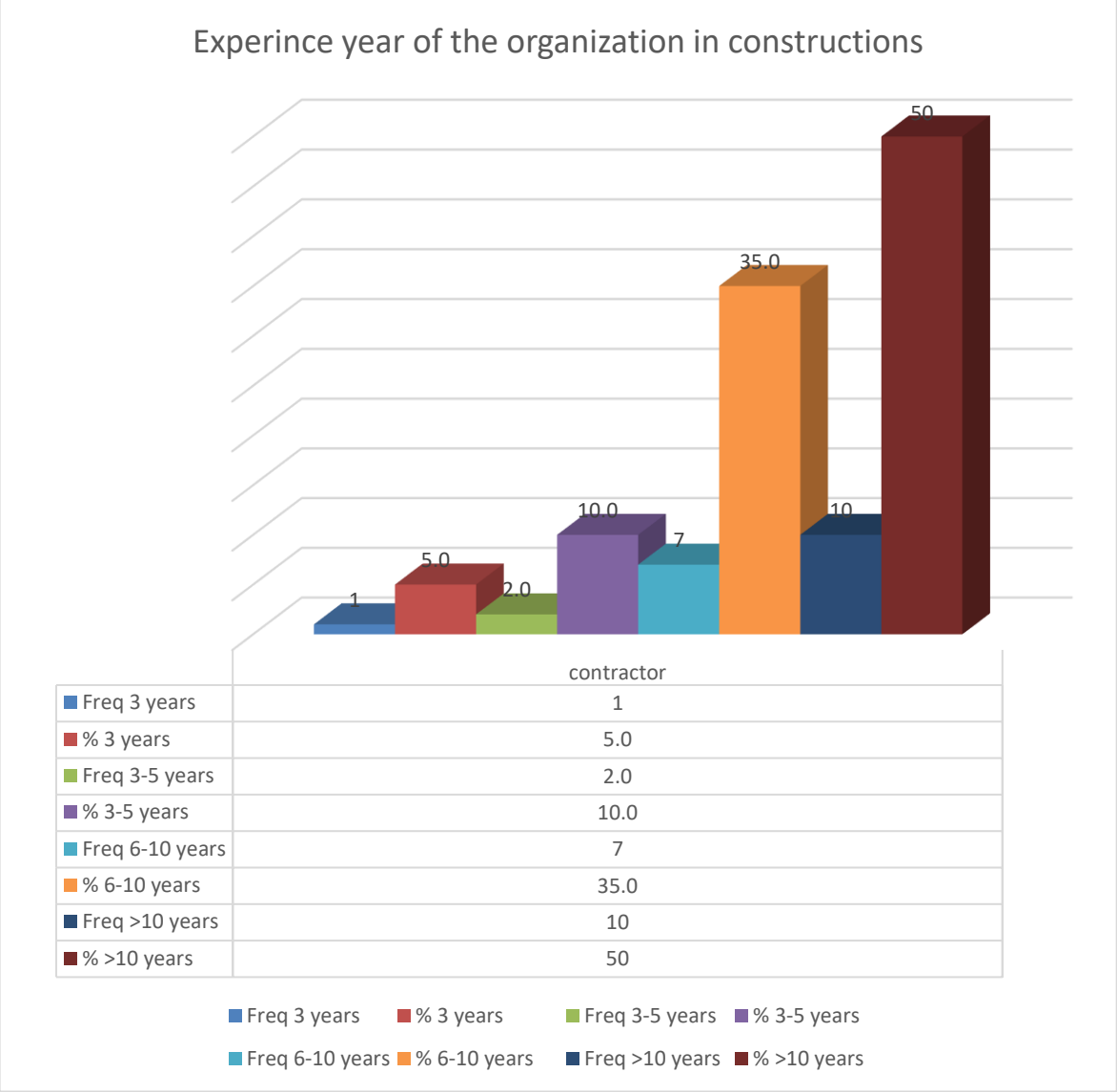


	contractor	consultants
Freq 1st	7	7
%1st	35.0	63.6
Freq 2nd	6.0	3.0
% 2nd	30.0	27.3
Freq 3rd	4	1
% 3rd	20.0	9.1
Freq 4th	1	0
% 4th	5	0
Freq 5th	2	0
% 5th	10	0

Figure 4. 5 Classification of Contractors and consultancy in building works

Figure 4.6 shows the classification of contractor working construction projects and privately employed by the contractor involved. From the total respondents participated in the survey study, 35%, 30.0%, 20%, 5% and 10% of the respondents were grade-1, grade-2, grade-3, grade-4, and grade-5 respectively for contractor and. The result shows that grade-1 contractor were higher in number who were involved constructing building projects. In addition, figure 4.6 shows the classification of consultants working under the public construction projects and privately employed by the client. 63.6%,27.3%9.1% for grade-1, grade-2, grade-3 for consultants respectively, consultants. The result shows that grade-1 consultants were higher in number than other grade of consultants.

VII. Experience years of the contractors in construction

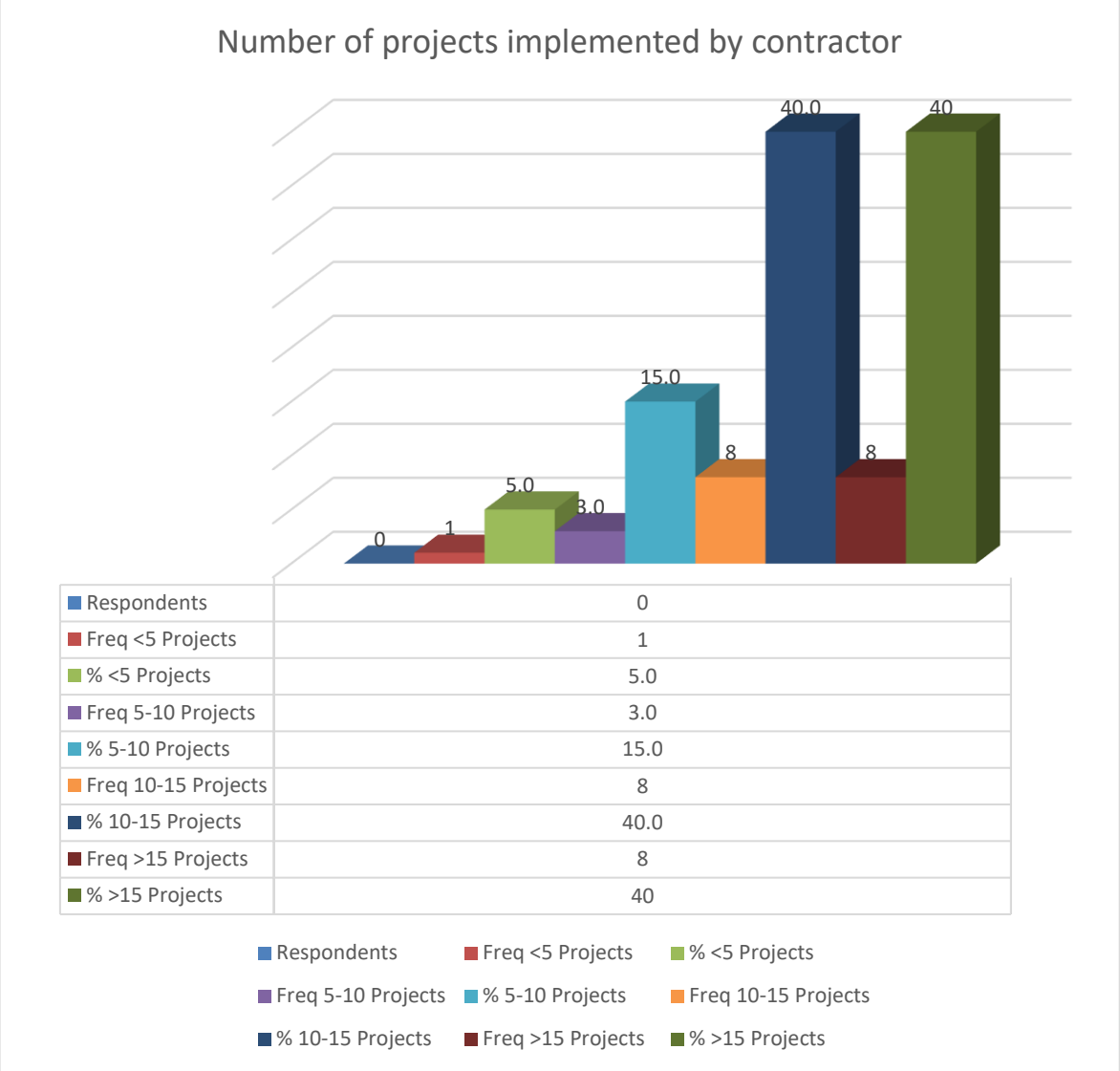


	contractor
Freq 3 years	1
% 3 years	5.0
Freq 3-5 years	2.0
% 3-5 years	10.0
Freq 6-10 years	7
% 6-10 years	35.0
Freq >10 years	10
% >10 years	50

Figure 4. 6 Experience year of contractors in the construction

Figure 4.7 shows the result obtained from survey results of experience year of contractor in construction. The survey result shows that 50%, 35% and 10% of the contractors with an experience year of are more than10 years, 6 to 10 years and 3 to 5years respectively. The result obtained from the survey indicates that the contractors with an experience of more than10 years were higher.

VIII. Number of projects implemented by contractor



Respondents	0
Freq <5 Projects	1
% <5 Projects	5.0
Freq 5-10 Projects	3.0
% 5-10 Projects	15.0
Freq 10-15 Projects	8
% 10-15 Projects	40.0
Freq >15 Projects	8
% >15 Projects	40

Figure 4. 7 Number of projects implemented by contractor

Figure 4.8 shows the result obtained from survey results of number of building projects implemented by contractor. The survey result shows that 40%, 40%, 15% and 5% of the contractors were build 10 to 15 building projects, more than 15 building projects, 5 to 10 building projects and less than 5 building projects respectively. The result obtained from the survey indicates that the building projects implemented by contractor were 10 to 15 building and greater than 15 projects were greater.

IX. Number of Consulted projects by consultant

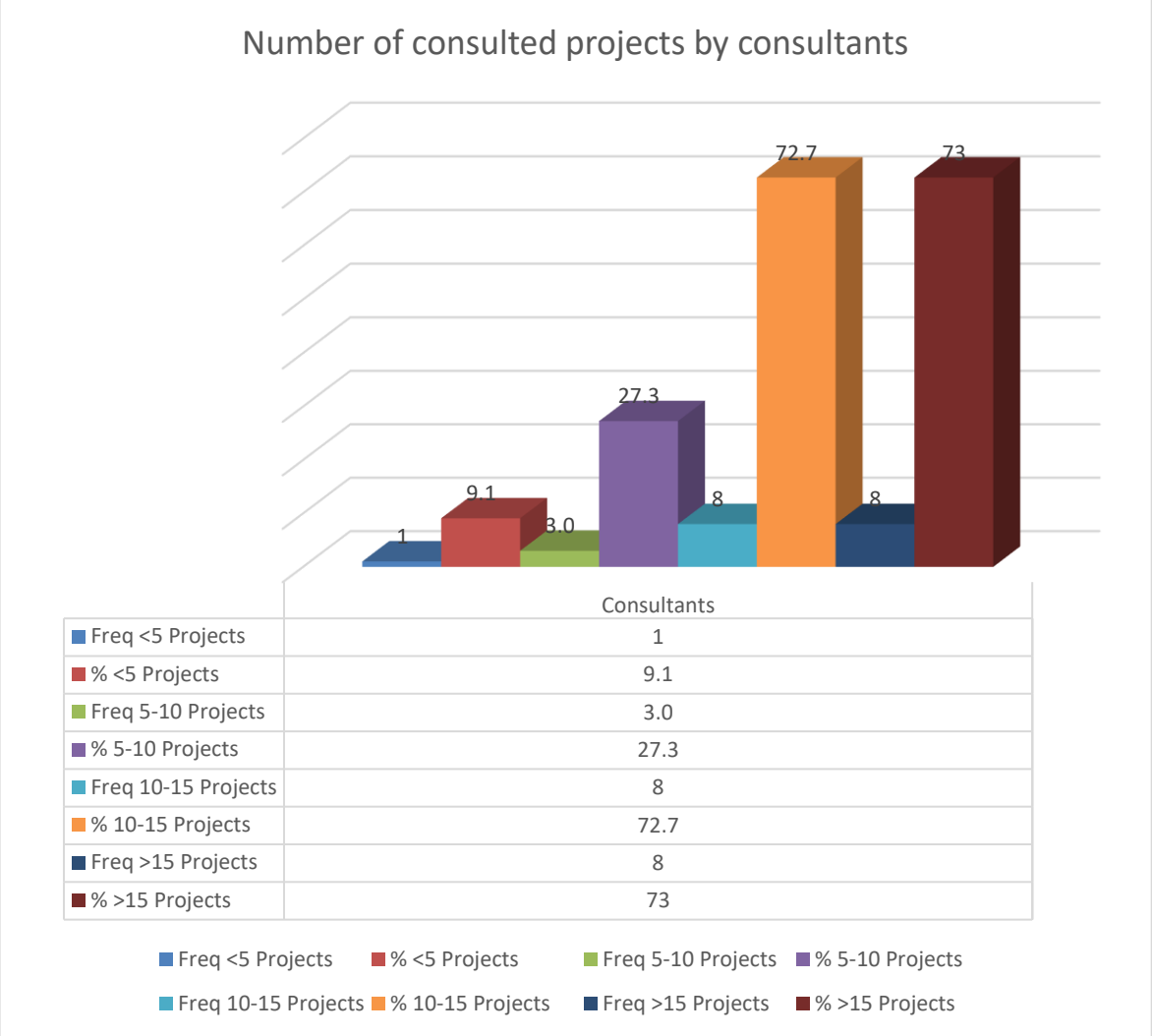
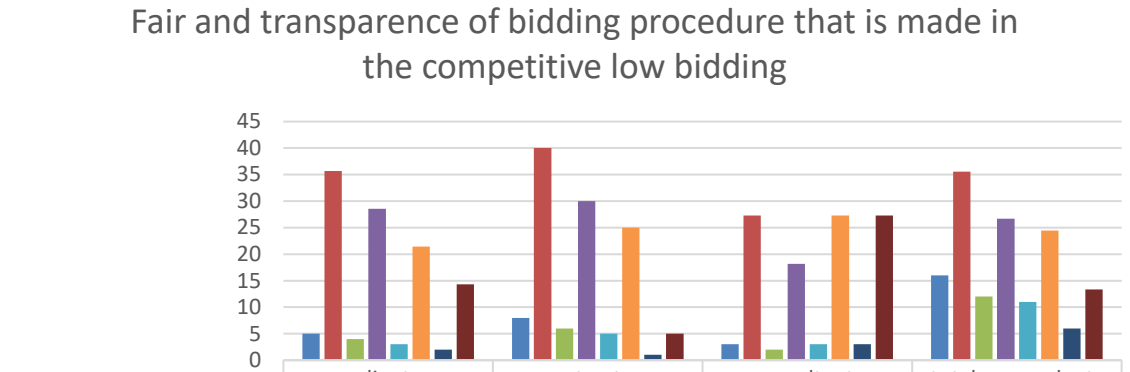


Figure 4. 8 Number of Consulted projects by consultant

Figure 4.9 shows the result obtained from survey results of number of building projects consulted by consultant organization. The survey result shows that 41.2%, 35.3 % and 23.5% of the consultant organization were consulted, more than 15 building projects, 10 to 15 building projects and 5 to 10 building projects respectively. The result obtained from the survey indicates that the consultant organization were consulted more than 15 building projects were greater.

4.3. Information about Competitive Low Bidding

I. Fair and transparence of bidding procedure that is made in the Competitive low bidding



	clients	cotractor	consultants	total respondants
ferequence of75-100	5	8	3	16
%75-100	35.71	40.00	27.27	35.56
ferequency of50-75	4	6	2	12
%50-75	28.57	30	18.18	26.67
ferequency of25-50	3	5	3	11
%25-50	21.43	25	27.27	24.44
ferequency of 0-25	2	1	3	6
%0-25	14.28	5	27.27	13.33

Figure 4. 9 Fair and transparence of Competitive low bidding

Table 4.10 shows the result obtained from the survey about level of fairness and transparency of bidding procedure that is made in from all construction stake holder participants 26.67%, 24.44 %, 35.56%, and 13.33 % of the respondents agreed that the bidding procedure is fair and transparent from (50%-75%), (25%-50%), (75%-100%), and (0%-25%) respectively. The result obtained from the survey indicates that (75%-100%) were higher

II. Level to assess contractor selection process takes place in LBBAS

Figure 4. 10 Responsibility for assessment of contractor

Table 4.11 Shows the survey result obtained from consultants about the level of assessment that will take place in public procurement procedure by whom the responsibility to select and qualify contractors in a lowest bidder bid award system. From all participants of construction stake holders, 13.33 % of the participants replied that the selection process is undertaken by committee members, 24.4% Technical department and engineering, A15.5 % of the participant replied those financial departments are responsible to select, 26.67% of the participants replied that the contractor assessment, and selection responsibility is undertaken by Project management team, 8.88 % of the participant's replied that the contractor assessment, and selection responsibility is undertaken Independent consultant and 11.11% of the participant's take the mandate for the assessment and selection of contractor in a lowest bidder bid awarding system for higher managerial level. The result above shows that project management team item has selected by the majority of the respondents.

III. Client perception on Mathematical model for bid evaluation and contractor selection process

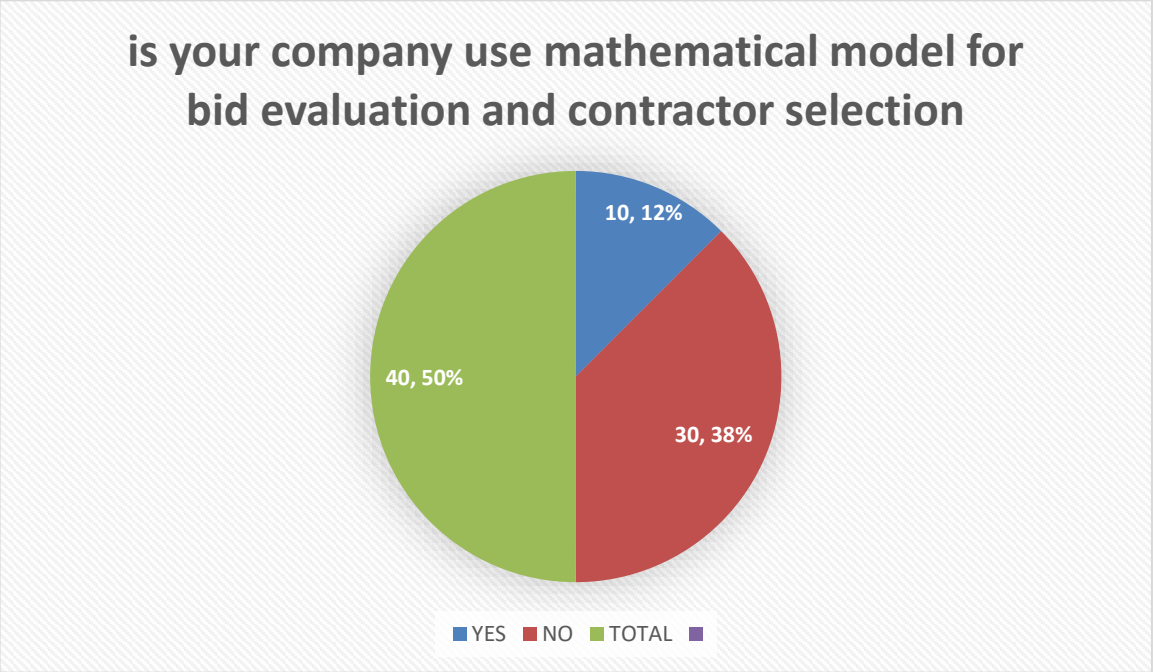


Figure 4. 11 Mathematical model

Figure 4.12 shows the result obtained from survey results of experience of respondents of client The survey results show that 12% and 38% of the participants agreed that the mathematical model was not used and used respectively. The result obtained from the survey indicates that almost all of the respondent use only Microsoft excel.

Are you satisfied with the competitive low bidding evaluation procedure currently in use 91% of the respondent answered no and other 9% of the respondent answers yes. The reason why the respondents not satisfied with the competitive low bidding evaluation procedure currently in use was summarized as follow.

- It depends on price rather than performance of contractor. But it should be summation of legal, technical and financial requirement.
- Conditionally varying the quantity of work during the preparation of tender documents so that the contractors provide unbalanced rate for the execution of the specified quantity
- Lack of appropriate engineering estimate which include prediction of future material price escalation and the success of project.

- Lack of incorporating and including, the required scope of the work during design period.

IV. Quality of the project completed using lowest bidder bid system

Table 4. 1 Contractor perception on % quality of the project

% quality of the project completed using CLB	Frequency	Percent
0%-25%	6	30
25%-50%	7	35
50%-75%	5	25
75%-100%	2	10
Total	**20**	**100**

As shows in Table 4.1; the results from the participants of contractor for percentage of quality observed in a built facility of building construction project. The survey result shows that 35%, 30%, 25% and 10% of the respondents replied that the percentage of quality ranges from (25%-50%), (0%-25%), (50%-75%), and (75%-100%) respectively. The result indicates that the percentage of the defect in the built facility as ranked by contractor respondents were ranges from (25%-50 %).

Table 4. 2 % Consultant perception on quality of the project

% quality of the project completed using CLB	Frequency	Percent
0%-25%	4	36.36
25%-50%	3	27.27
50%-75%	1	9
75%-100%	3	27.27
Total	**11**	**100**

As shows in Table 4.2; the results from the participants of consultant for percentage of quality observed in a built facility of building construction project. The survey result shows that

27.27%, 36.36%, 9% and 27.27%, of the respondents replied that the percentage of quality ranges from (25%-50%), (0%-25%), (50%-75%), and (75%-100%) respectively. The result indicates that the percentage of the defect in the built facility as ranked by contractor respondents were ranges from (25%-50 %).

V. Percentage of the project cost in lowest bid system projects are exposed to change order

Table 4. 3 Contractor perception on %Cost and change order.

Percentage of cost and change order	Frequency	Percent
0%-25%	5	25
25%-50%	6	30
50%-75%	7	35
75%-100%	2	10
Total	**20**	**100**

As shows in Table 4.3; the results from participants of contractor's the percentage of project cost and change order in lowest bid system projects. From the participants of contractor, 35%, 30%, 10% and 25% replied that the projects exposed to cost deviation and change order ranges from (50%-75%), (25%-50%), (75%-100%), and (0%- 25%) respectively. The result obtained from the contractor's respondents shows that the percentage of project exposed to cost deviation and change order is ranked from (50%-75%) in public building construction projects.

Table 4. 4 Consultant perception on %Cost and change order

Percentage of cost and change order	Frequency	Percent
0%-25%	3	27.27
25%-50%	2	18.18
50%-75%	4	36.36
75%-100%	2	18.18
Total	11	100

As shows in Table 4.4; the results from participants of consultant the percentage of project cost and change order in lowest bid system projects. From the participants of contractor, 36.36%, 18.18%, 18.18% and 27.27% replied that the projects exposed to cost deviation and change order ranges from (50%-75%), (25%-50%), (75%-100%), and (0%- 25%) respectively. The result obtained from the consultant respondents shows that the percentage of project exposed to cost deviation and change order is ranked from (50%-75%) in public building construction projects

VI. Percent of defects observed in the built facilities within the warranty period

Table 4. 5 Contractor perception on % of defect in built facility

% of defect in built facility	frequency	percentage
0%-25%	8	40
25%-50%	7	35
50%-75%	5	25
Total	20	100

As shows in Table 4.5; the results from the participants of contractors for percentage of defects observed in a built facility within a warranty period in Addis Ababa building construction projects. The survey result shows that 40%, 35% and 25%, and of the respondents replied that the percentage of defect ranges from (0%-25%), (25%-50%), (50%- 75%), and respectively while none of the consultants replied that the percentage of defect ranges from

(75%-100%). The result indicates that the percentage of the defect in the built facility as ranked by contractor respondents were ranges from (0%-25 %).

Table 4. 6 Consultant perception on % of defect in built facility.

% of defect in built facility	frequency	percentage
0%-25%	4	36.36
25%-50%	3	27.27
50%-75%	3	27.27
75%-100%	1	9
Total	11	100

As shows in Table 4.6; the results from the participants of consultants for percentage of defects observed in a built facility within a warranty period in building construction projects. The survey results show that 36.36%, 27.27% and 27.27%, and 9% of the respondents replied that the percentage of defect ranges from (0%-25%), (25%-50%), (50%- 75%), and (75%-100%) respectively. The result indicates that the percentage of the defect in the built facility as ranked by consultant respondents were ranges from (0%-25 %).

VII. Summary of factors causing negative effect of competitive low bidding

The summary of client, contractor and consultant answer on factors causing negative effect occurring in competitive list bidder bid awarding system for public building construction project

Lack of carefully prepare bid document, select qualified bidders based on their technical capacity and financial capability in a way to achieve the project objective with respect to quality, cost, time and safety.

Lack of prepare accurate project cost estimate, in-depth information about the project site location and required input, Lack of make a fair and transparent procurement procedure that is free from corruption and favoritism, Lack of organized and submit post project auditing depends on reliable data and report to concerned policy maker to use as input. Lack of conduct a site visit and pre-bid meeting before deciding to participate to in the bidding process

Lack of gather detail information about the project environment like access to the project site, labor market and distance from the center, Lack of submit an estimated bid price by considering the current market condition and project cost variation to complete the project with agreed contract requirement, Lack of give effective advice and contract administration for the client to reduce the negative effects.

Lack of minimizing awarding unqualified contractors and contractual problems during the pre-construction stage, Lack of play role in handling the legal issues coming from contractors in the performance period due to financial incapability of contractor to complete the project with the standard of the contract agreement, Lack of enhance pre-cost control issue at early stage of project to reduce claim stoppage time of project.

4.4. Effect of Lowest Bidder Bid Awarding System

A list of 17 attributes related to the negative effect of lowest bidder bid awarding system was assumed from literature and pilot study. Then, these attributes were subjected to the views of public client, contractor and consultant respondents and the results of the analysis were displayed in Table 4.7a, Table 4.7b, Table 4.7c and Table 4.7

Table 4.7 1 client perception on the effect of competitive list bidder.

Table 4.7 1 reveals that professionals from public clients ranked delay on project completion

S/N	Effect (Negative) of LBBAS	Frequency given from the Respondents					Total	A*N	RII	Overall Ranking
		5	4	3	2	1				
1	Cost Overrun team	3	3	4	3	1	46	70	0.657	9
2	Delay on project completion	7	3	3	1	0	58	70	0.829	1
3	Increase disputes and claims between contracting parties	4	5	4	2	0	56	70	0.800	3
4	Select of inefficient contractors	6	4	3	1	0	57	70	0.814	2
5	Increased No. of Change Requests/ Orders	5	6	1	1	1	55	70	0.786	4
6	Change in project scope	1	2	0	5	6	29	70	0.414	15
7	Shortages in resources (labors, equipment, and materials.)	2	1	3	5	3	36	70	0.514	13
8	Underachievement in project performance	1	0	2	4	7	26	70	0.371	17
9	Serious question on public safety	2	1	8	3	0	44	70	0.629	11
10	Unsatisfactory quality of work	0	6	3	3	2	41	70	0.586	12
11	Financial loss for owner	4	7	1	1	1	54	70	0.771	6
12	Financial loss for contractor	1	7	2	4	0	47	70	0.671	8
13	Increase in maintenance, replacement and operational costs	5	6	1	1	1	55	70	0.786	4
14	Stress on the public services such as office, home and others	1	1	2	5	5	30	70	0.429	14
15	Failed Projects/ Work Suspensions	4	3	2	3	2	46	70	0.657	9
16	Failure to achieve the project objectives	1	0	2	5	6	27	70	0.386	16
17	Terminate and Re-tendering for projects several times	3	5	3	2	1	49	70	0.700	7

with relative importance index of 0.829 was ranked first, selection of inefficient contractors with relative importance index of 0.814 was ranked second, increase claims and disputes between contracting parties with relative importance index of 0.80 was ranked third, Increased No. of Change Requests/ Orders and Increase in maintenance, replacement and operational costs relative importance index of 0.786 were ranked fourth and Financial loss for owner relative importance index of 0.771 was ranked sixth. The other negative effect was ranked as Terminate and Re-tendering for projects several times, financial loss for contractor, cost overrun, failure to achieve the project objectives, serious question on public safety,

underachievement in project performance, failed projects/work suspensions, shortages in resources (labors, equipment, and materials.), stress on the public services such as office, home and others , change in project scope and Underachievement in project performance, were ranked respectively.

Table 4.7 2 Contractor perception on the effect of competitive list bidder

S/N	Effect (Negative) of LBBAS	Frequency given from the Respondents					Total	A*N	RII	Overall ranking
		5	4	3	2	1				
1	Cost Overrun team	10	2	8	0	0	82	100	0.820	4
2	Delay on project completion	12	6	2	0	0	90	100	0.900	2
3	Increase disputes and claims between contracting parties	16	2	2	0	0	94	100	0.940	1
4	Select of inefficient contractors	10	6	4	0	0	86	100	0.860	3
5	Increased No. of Change Requests/ Orders	2	16	2	0	0	80	100	0.800	5
6	Change in project scope	2	8	10	0	0	72	100	0.720	9
7	Shortages in resources (labors, equipment, and materials.)	2	6	8	2	2	64	100	0.640	13
8	Underachievement in project performance	2	10	8	0	0	74	100	0.740	7
9	Serious question on public safety	0	4	12	6	0	64	100	0.640	13
10	Unsatisfactory quality of work	6	4	8	2	0	74	100	0.740	7
11	Financial loss for owner	0	8	8	4	0	64	100	0.640	13
12	Financial loss for contractor	0	8	10	2	0	66	100	0.660	12
13	Increase in maintenance, replacement and operational costs	2	6	10	2	0	68	100	0.680	11
14	Stress on the public services such as office, home and others	0	8	6	6	0	62	100	0.620	16
15	Failed Projects/ Work Suspensions	0	12	8	0	0	72	100	0.720	9
16	Failure to achieve the project objectives	4	10	6	0	0	78	100	0.780	6
17	Terminate and Re-tendering for projects several times	6	8	6	0	0	80	175	0.457	17

Table 4.7.2 reveals that professionals from contractor ranked Increase disputes and claims between contracting parties' relative importance index of 0.94 was ranked first, Delay on project completion relative importance index of 0.9 was ranked second, selection of inefficient contractors with relative importance index of 0.86 was ranked third, Cost Overrun team with relative importance index of 0.82 was ranked fourth and Increased No. of Change Requests/ Orders with relative importance index of 0.80 was ranked fifth. The other negative effect were ranked as Failure to achieve the project objectives, Unsatisfactory quality of

work, underachievement in project performance, failed projects/work suspensions and change in project scope, increase in maintenance, replacement and operational costs, financial loss for contractor, financial loss for owner and Serious question on public safety, shortages in resources (labors, equipment, and materials.), Stress on the public services such as office, home and others and Terminate and Re-tendering for projects several times were ranked respectively. Terminate and Re-tendering for projects several times

Table 4.7 3 Consultants perception on the effect of competitive list bidder

S/N	Effect (Negative) of LBBAS	Frequency given from the Respondents					Total	A*N	RII	Overall ranking
		5	4	3	2	1				
1	Cost Overrun team	1	4	4	2	0	37	55	0.673	10
2	Delay on project completion	5	3	3	0	0	46	55	0.836	1
3	Increase disputes and claims between contracting parties	4	4	2	1	0	44	55	0.800	2
4	Select of inefficient contractors	5	2	1	3	0	42	55	0.764	4
5	Increased No. of Change Requests/ Orders	2	5	1	3	0	39	55	0.709	7
6	Change in project scope	3	3	3	2	3	43	55	0.782	3
7	Shortages in resources (labors, equipment, and materials.)	1	1	4	5	0	31	55	0.564	13
8	Underachievement in project performance	1	1	1	3	5	23	55	0.418	15
9	Serious question on public safety	2	2	5	2	0	37	55	0.673	10
10	Unsatisfactory quality of work	3	1	6	1	0	39	55	0.709	7
11	Financial loss for owner	4	4	1	1	1	42	55	0.764	4
12	Financial loss for contractor	2	3	2	4	0	36	55	0.655	12
13	Increase in maintenance, replacement and operational costs	2	2	2	3	1	31	55	0.564	13
14	Stress on the public services such as office, home and others	1	0	2	4	4	23	55	0.418	15
15	Failed Projects/ Work Suspensions	2	2	3	4	4	39	55	0.709	7
16	Failure to achieve the project objectives	1	0	2	2	6	21	55	0.382	17
17	Terminate and Re-tendering for projects several times	3	4	3	1	0	42	55	0.764	4

Table 4.7.3 reveals that professionals from consultants ranked delay on project completion with relative importance index of 0.836 was ranked first, increase claims and disputes between contracting parties with relative importance index of 0.8 was ranked second, Change in project scope with relative importance index of 0.782 was ranked third, Select of inefficient contractors , Terminate and Re-tendering for projects several times and financial loss for owner with relative importance index of 0.764 was ranked fourth. The other negative effect were ranked as failed projects/work suspensions, Unsatisfactory quality of work, Increased No. of Change Requests/ Orders , serious question on public safety, Cost Overrun team, Financial loss for contractor, shortages in resources (labors, equipment, and materials.), Increase in maintenance, replacement and operational costs, stress on the public services such as office, home and others Underachievement in project performance Failure to achieve the project objectives were ranked respectively.

Table 4.7 4 Summary of respondent perception on the effect of competitive list bidder

S/N	Effect (Negative) of LBBAS	Contractor		Client		Consultant		General Average Rank	
		RII	Overall Rank	RII	Overall Rank	RII	Overall Rank	RII	Overall Rank
1	Cost Overrun team	0.820	4	0.657	9	0.673	10	0.717	6
2	Delay on project completion	0.900	2	0.829	1	0.836	1	0.855	1
3	Increase disputes and claims between contracting parties	0.940	1	0.800	3	0.800	2	0.847	2
4	Select of inefficient contractors	0.860	3	0.814	2	0.764	4	0.813	3
5	Increased No. of Change Requests/ Orders	0.800	5	0.786	4	0.709	7	0.765	4
6	Change in project scope	0.720	9	0.414	15	0.782	3	0.639	13
7	Shortages in resources (labors, equipment, and materials.)	0.640	13	0.514	13	0.564	13	0.573	14
8	Underachievement in project performance	0.740	7	0.371	17	0.418	15	0.510	16
9	Serious question on public safety	0.640	13	0.629	11	0.673	10	0.647	11
10	Unsatisfactory quality of work	0.740	7	0.586	12	0.709	7	0.678	8
11	Financial loss for owner	0.640	13	0.771	6	0.764	4	0.725	5
12	Financial loss for contractor	0.660	12	0.671	8	0.655	12	0.662	10
13	Increase in maintenance, replacement and operational costs	0.680	11	0.786	4	0.564	13	0.676	9
14	Stress on the public services such as office, home and others	0.620	16	0.429	14	0.418	15	0.489	17
15	Failed Projects/ Work Suspensions	0.720	9	0.657	9	0.709	7	0.695	7
16	Failure to achieve the project objectives	0.780	6	0.386	16	0.382	17	0.516	15
17	Terminate and Re-tendering for projects several times	0.457	17	0.700	7	0.764	4	0.640	12

As summarized in Table 4.7.4 shows the survey results obtained from summary of public client, contractor and consultants about the effects of lowest bidder bid awarding system were on public building construction projects currently under construction and 50% of work were completed. Delay on project completion with relative importance index of 0.855 was ranked first, increase claims and disputes between contracting parties with relative importance index of 0.847 was ranked second, Selection of inefficient contractors with relative importance index of 0.813 was ranked third, Increased No. of Change Requests/ Orders relative importance index of 0.765 forth and financial loss for owner with relative importance index of 0.725was ranked fifth. The other negative effect were Cost Overrun team, stress on the public services such as office, home and others, Unsatisfactory quality of work, Increase in maintenance, replacement and operational costs, Financial loss for contractor, Serious

question on public safety, Terminate and Re-tendering for projects several times, Change in project scope, Shortages in resources (labors, equipment, and materials.), Failure to achieve the project objectives, Underachievement in project performance and Stress on the public services such as office, home and others were ranked respectively. Most public sector construction projects have not completed with the contracted duration because of contractor's incapability to finance the project with agreed contract amount. This criterion was considered a critical class, which leads to project termination. Further, the result is in line with (Khan & Khan, 2015b) findings that high incidence of delay, claims and litigation, and frequent cost and schedule overruns have become the main features of public construction works contract. (Enshassi et al., 2014) also confirmed that the major problem such as delay, cost overran, and quality issue problem, claim and disputes between project partners then project suspension are occurred in public building construction project which are awarded on the basis of lowest bidder. (S. Shrestha, 2014)also confirmed that Competitive low bid method has been highly criticized for its negative impact like disputes/claims, coordination, quality control and project duration. (Berihu et al., 2023) also confirmed that the major effect of competitive list bidder are excessive time and cost overrun, compromise quality of contractors as the top ranked effects of low bid award system. The reason back to this was the contact amount was unrealistic and abnormally low to complete the project with targeted cost, quality and time period. cost overrun, increase in number of change/request orders and compromising quality and making unnecessary claims" were the other most effecting factor that contributes to the poor performance public construction projects in case of contractors selected with lowest bidder bid award system (Bin Seddeeq et al., 2019)

4.5. The Selection criteria for Contractors' Prequalification and Bid Evaluation

Table 4.8 1 Aggregated fuzzy decision matrix of the main-criteria with respect to the goal

CRITERIA	C1			C2			C3			C4			C5		
	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U
C1	1.000	1.000	1.000	0.315	0.492	0.712	2.132	2.987	3.757	1.304	1.864	2.453	2.629	3.518	4.438
C2	1.335	2.430	3.483	1.000	1.000	1.000	4.328	5.426	6.489	2.130	3.028	4.058	4.434	5.528	6.499
C3	0.259	0.322	0.438	0.159	0.192	0.248	1.000	1.000	1.000	0.253	0.316	0.423	1.252	1.864	2.781
C4	0.376	0.486	0.677	0.246	0.330	0.470	2.268	3.078	3.870	1.000	1.000	1.000	1.550	2.502	3.537
C5	0.225	0.284	0.380	0.154	0.181	0.226	0.360	0.536	0.799	0.269	0.373	0.578	1.000	1.000	1.000

Where, C1= Cost, C2= Performance, C3= Quality control, C4= Health and safety, C5= Project control

Based on the results of the aggregated fuzzy decision matrix the results of fuzzy geometric mean of the criterion for the experts were presented in the following Table 4.8. b.

Table 4.8 2 Fuzzy Geometric Mean for main-criteria

Criteria	Fuzzy geometric mean (ri)		
	L	M	U
Cost (C1)	1.181	1.573	1.962
Performance (C2)	2.225	2.943	3.589
Quality control (C3)	0.419	0.515	0.662
Health and safety (C4)	0.799	1.043	1.342
Project control (C5)	0.320	0.400	0.524

Depending on the results of fuzzy geometric mean the results of the fuzzy weights (w_i) of criterion and the local weight value were determined. Finally, the normalized local weights for each criterion were determined and the results were presented in following Table 4.8.3

Table 4.8 3 Local and Normalized weights for main-criteria

Fuzzy Weights of Criteria.	Fuzzy Weights(wi)			Local weights	Normalized Local weights	Rank
Cost (C1)	0.146	0.243	0.397	0.262	0.242	2
Performance (C2)	0.275	0.454	0.726	0.485	0.448	1
Quality control (C3)	0.052	0.080	0.134	0.088	0.082	4
Health and safety (C4)	0.099	0.161	0.271	0.177	0.164	3
Project control (C5)	0.040	0.062	0.106	0.069	0.064	5

Depending on the results of normalized local weight as it could be observed in Table 4.8.3 among the contractor selection criteria Performance and cost were identified as the most important selection criteria considered by the decision experts. The decision experts suggested that Health and safety was the 3rd most selection criteria followed by Quality control. In the contrary project control was identified as the least important selection criteria.

The aggregated fuzzy decision matrix of decision experts of the triangular fuzzy numbers given for each sub-criterion with respect to cost considered by the decision experts were presented in following Table 4.8.4.

Table 4.8 4 Aggregated fuzzy decision matrix of sub-criteria with respect to cost

Criteria	C21			C22			C23			C24		
	L	M	U	L	M	U	L	M	U	L	M	U
C21	1.000	1.000	1.000	0.534	0.692	0.954	2.456	3.144	4.049	3.016	4.077	5.116
C22	1.048	1.446	1.874	1.000	1.000	1.000	2.526	3.022	3.542	2.045	2.583	3.152
C23	0.247	0.318	0.407	0.271	0.322	0.387	1.000	1.000	1.000	0.431	0.602	0.836
C24	0.195	0.245	0.332	0.317	0.387	0.489	1.196	1.661	2.319	1.000	1.000	1.000

Where, C11= Proposed tender price, C12= Low project life cycle cost, C13= Financial capability, C14= Additional financial resources for priority projects

Based on the results of the aggregated fuzzy decision matrix the results of fuzzy geometric mean (r_i) of the criterion for the decision experts are presented in following Table 4.8.5

Table 4.8 5 Fuzzy geometric mean of the sub-criteria with respect to cost

Criteria	Fuzzy geometric mean (ri)		
	L	M	U
Proposed tender price	1.410	1.726	2.109
Low project life cycle cost	1.525	1.833	2.139
Financial capability	0.412	0.498	0.602
Additional financial resources for priority projects	0.522	0.630	0.783

Depending on the results of fuzzy geometric mean the results of the fuzzy weights (w_i) of criterion and the value of local weigh for each sub criteria with respect to cost were determined. Finally, the values of normalized local weights for each sub-criterion were determined as it was presented in the following Table 4.8.6.

Table 4.8 6 Local weights and normalized local weights for sub-Criteria with respect to Cost

Fuzzy Weights of Criteria.	Fuzzy Weights(wi)			Local weights	Normalized Local weights	Rank
Proposed tender price	0.250	0.368	0.545	0.388	0.370	2
Low project life cycle cost	0.271	0.391	0.553	0.405	0.386	1
Financial capability	0.073	0.106	0.156	0.112	0.107	4
Additional financial resources for priority projects	0.093	0.134	0.202	0.143	0.137	3

Depending on the results of normalized local weight as it was observed in Table 4.8.6. that Low project life cycle cost is the most important selection criteria considered by the decision experts followed by proposed tender price, additional financial resources for priority projects. In the contrary financial capability was identified as the least important selection criteria.

The aggregated values of fuzzy decision matrix judgments of decision experts of the triangular fuzzy numbers given for each sub-criterion with respect to performance considered by the decision experts can be determined and their results were presented as shown in Table 4.8.7 below.

Table 4.8 7 Aggregated fuzzy decision matrix of sub-criteria with respect to performance

Criteria	C21			C22			C23			C24		
	L	M	U	L	M	U	L	M	U	L	M	U
C21	1.000	1.000	1.000	0.475	0.694	1.084	3.542	4.577	5.598	2.294	3.402	4.459
C22	0.922	1.441	2.107	1.000	1.000	1.000	2.888	3.653	4.429	2.227	2.908	3.794
C23	0.179	0.218	0.282	0.226	0.274	0.346	1.000	1.000	1.000	0.429	0.707	1.048
C24	0.224	0.294	0.436	0.264	0.344	0.449	0.954	1.414	2.088	1.000	1.000	1.000

Where, C21= Past performance and expertise of the company, C22= Number of key personnel, C23= Optimized resource utilization, C24= Training and skill level of project team

Based on the results of the aggregated fuzzy decision matrix the results of fuzzy geometric mean (r_i) of the criterion for the decision experts are presented in Table 4.8.8 below.

Table 4.8 8 Fuzzy geometric mean of the sub-criteria with respect to performance

Criteria	Fuzzy geometric mean (ri)		
	L	M	U
Past performance and expertise of the company (C21)	1.401	1.813	2.281
Number of key personnel (C22)	1.560	1.978	2.439
Optimized resource utilization (C23)	0.363	0.453	0.566
Training and skill level of project team (C24)	0.487	0.615	0.800

Depending on the results of fuzzy geometric mean the results of the fuzzy weights (w_i) of criterion and the value of local weigh for each sub criteria with respect to performance were determined. Finally, the values of normalized local weights for each sub-criterion were determined as it was presented in Table 4.8.9 below.

Table 4.8 9 Local weights and normalized local weights for sub-Criteria with respect to performance

Fuzzy Weights of Criteria	Fuzzy Weights(wi)			BNP_i	$BNPw_i$	Rank
Past performance and expertise of the company (C21)	0.230	0.373	0.598	0.401	0.373	2
Number of key personnel (C22)	0.256	0.407	0.640	0.434	0.404	1
Optimized resource utilization (C23)	0.060	0.093	0.148	0.100	0.094	4
Training and skill level of project team (C24)	0.080	0.127	0.210	0.139	0.129	3

Depending on the results of normalized local weight as it was observed in 4.8.9 that number of key personnel is the most important selection criteria considered by the decision experts followed by past performance and expertise of the company, and training and skill level of project team. In the contrary optimized resource utilization was identified as the least important selection criteria.

The aggregated values of fuzzy decision matrix judgments of decision experts of the triangular fuzzy numbers given for each sub-criterion with respect to quality control considered by the decision experts can be determined and their results were presented as shown in the following Table 4.8.10.

Table 4.8 10 Aggregated fuzzy decision matrix of sub-criteria with respect to quality control

Criteria	C31			C32			C33		
	L	M	U	L	M	U	L	M	U
C31	1.000	1.000	1.000	3.584	4.267	4.943	2.631	2.993	3.411
C32	0.202	0.234	0.279	1.000	1.000	1.000	0.676	0.827	1.016
C33	0.293	0.334	0.380	0.985	1.209	1.480	1.000	1.000	1.000

Where, C31= Quality control measures, C32= Meeting design requirement, C33= User expectations and satisfaction

Based on the results of the aggregated fuzzy decision matrix the results of fuzzy geometric mean (r_i) of the criterion for the decision experts are presented in Table 4.8.11 below.

Table 4.8 11 Fuzzy geometric mean of the sub-criteria with respect to quality control

Criteria	Fuzzy geometric mean (ri)		
	L	M	U
Quality control measures	2.111	2.335	2.562
Meeting design requirement	0.515	0.579	0.657
User expectations and satisfaction	0.661	0.739	0.826

Depending on the results of fuzzy geometric mean the results of the fuzzy weights (w_i) of criterion and the value of local weigh for each sub criteria with respect to quality control were determined. Finally, the values of normalized local weights for each sub-criterion were determined as it was presented in Table 4.8.12 below.

Table 4.8 12 Local weights and normalized local weights for sub-Criteria with respect to quality control

Criteria	Fuzzy Weights(wi)			Local weights	Normalized Local weights	Rank
Quality control measures	0.522	0.639	0.779	0.647	0.638	1
Meeting design requirement	0.127	0.158	0.200	0.162	0.160	3
User expectations and satisfaction	0.163	0.202	0.251	0.206	0.203	2

Depending on the results of normalized local weight as it was observed in Table 4.8.12 that quality control measures is the most important selection criteria considered by the decision experts followed by user expectations and satisfaction. In the contrary meeting design requirement was identified as the least important selection criteria.

The aggregated values of fuzzy decision matrix judgments of decision experts of the triangular fuzzy numbers given for each sub-criterion with respect to health and safety considered by the decision experts can be determined and their results were presented as shown in Table 4.8.13 below.

Table 4.8 13 Aggregated fuzzy decision matrix of sub-criteria with respect to Health and safety

Criteria	C41			C42			C43		
	L	M	U	L	M	U	L	M	U
C41	1.000	1.000	1.000	0.832	0.929	1.066	1.538	1.663	1.770
C42	0.938	1.076	1.202	1.000	1.000	1.000	1.404	1.507	1.602
C43	0.565	0.601	0.650	0.624	0.664	0.712	1.000	1.000	1.000

Where, C41= Health and safety performance, C42= Environmental impact, C33= Safety training

Based on the results of the aggregated fuzzy decision matrix the results of fuzzy geometric mean (r_i) of the criterion for the decision experts are presented in Table 4.8.14 below.

Table 4.8 14 Fuzzy geometric mean of the sub- criteria with respect to Health and safety

Criteria	Fuzzy geometric mean (ri)		
	L	M	U
Health and safety performance	1.086	1.156	1.236
Environmental impact	1.096	1.175	1.244
Safety training	0.706	0.736	0.774

Depending on the results of fuzzy geometric mean the results of the fuzzy weights (w_i) of criterion and the value of local weigh for each sub criteria with respect to health and safety were determined. Finally, the values of normalized local weights for each sub-criterion were determined as it was presented in Table 4.8.15 below.

Table 4.8 15 Local weights and normalized local weights for sub- Criteria with respect to Health and safety

Criteria	Fuzzy Weights(wi)			Local weights	Normalized Local weights	Rank
Health and safety performance	0.334	0.377	0.428	0.380	0.378	2
Environmental impact	0.337	0.383	0.431	0.384	0.382	1
Safety training	0.217	0.240	0.268	0.242	0.241	3

Depending on the results of normalized local weight as it was observed in Table 15 that environmental impact is the most important selection criteria considered by the decision experts followed by health and safety performance. In the contrary Safety training was identified as the least important selection criteria.

The aggregated values of fuzzy decision matrix judgments of decision experts of the triangular fuzzy numbers given for each sub-criterion with respect to health and safety considered by the decision experts can be determined and their results were presented as shown in Table 4.8.16 below.

Table 4.8 16 Aggregated fuzzy decision matrix of sub-criteria with respect to Project control

Criteria	C51			C51			C51		
	L	M	U	L	M	U	L	M	U
C51	1.000	1.000	1.000	1.334	1.444	1.548	1.294	1.400	1.498
C51	0.642	0.690	0.747	1.000	1.000	1.000	0.723	0.811	0.926
C51	0.667	0.714	0.773	1.080	1.233	1.384	1.000	1.000	1.000

Where, C51= Type of project control, C52= Project monitoring process, C53= Actual schedule achieved for similar works

Based on the results of the aggregated fuzzy decision matrix the results of fuzzy geometric mean (r_i) of the criterion for the decision experts are presented in Table 4.8.17 below

Table 4.8 17 Fuzzy geometric mean of the sub- criteria with respect to Project control

Criteria	Fuzzy geometric mean (ri)		
	L	M	U
Type of project control	1.146	1.192	1.234
Project monitoring process	0.825	0.865	0.912
Actual schedule achieved for similar works	0.921	0.969	1.017

Depending on the results of fuzzy geometric mean the results of the fuzzy weights (w_i) of criterion and the value of local weigh for each sub criteria with respect to project control were determined. Finally, the values of normalized local weights for each sub-criterion were determined as it was presented in Table 4.8.18 below.

Table 4.8 18 Local weights and normalized local weights for sub-Criteria with respect to Project control

Criteria	Fuzzy Weights(wi)			BNP	Normalized Local weights (BNP)	Rank
Type of project control	0.362	0.394	0.427	0.394	0.393	1
Project monitoring process	0.261	0.286	0.315	0.287	0.287	3
Actual schedule achieved for similar works	0.291	0.320	0.352	0.321	0.320	2

Depending on the results of normalized local weight as it was observed in Table 4.8.18 that Type of project control is the most important selection criteria considered by the decision experts followed by actual schedule achieved for similar works. In the contrary project monitoring process was identified as the least important selection criteria.

Table 4.8.19 shows that the normalized local weights and global weight and their ranking of all criteria considered by the decision experts was arranged according to the order of the global weight was presented in Table 4.8.19.

Table 4.8 19 Weighted values and rankings considered by decision experts

Main Criteria	Local Weight	Sub-Criteria	Local Weights	Global Weights	Ranking by Category	Overall Ranking
Cost	0.242	Proposed tender price	0.370	0.090	2	4
		Low project life cycle cost	0.386	0.093	1	3
		Financial capability	0.107	0.026	4	12
		Additional financial resources for priority projects	0.137	0.033	3	11
Performance	0.448	Past performance and expertise of the company	0.373	0.167	2	2
		Number of key personnel	0.404	0.181	1	1
		Optimized resource utilization	0.094	0.042	4	9
		Training and skill level of project team	0.129	0.058	3	7
Quality control	0.082	Quality control measures	0.638	0.052	1	8
		Meeting design requirement	0.160	0.013	3	17
		User expectations and satisfaction	0.203	0.017	2	16
Health and safety	0.164	Health and safety performance	0.378	0.062	2	6
		Environmental impact	0.382	0.063	1	5
		Safety training	0.241	0.040	3	10
Project control	0.064	Type of project control	0.393	0.025	1	13
		Project monitoring process	0.287	0.018	3	15
		Actual schedule achieved for similar works	0.320	0.020	2	14

4.6. Evaluation and Selection of the contractors by fuzzy TOPSIS Methodologies

Third objective of this study is Evaluation and selection of the appropriate contractors. Results and findings of the fuzzy TOPSIS for Evaluation and selection of the appropriate contractors was discuss as below. In this study it can used the integration of fuzzy analytical hierarchy processes and fuzzy TOPSIS thus, the results of fuzzy preference weights for evaluation criteria were taken from the results of fuzzy analytical hierarchy processes and table 3.4 was used to provide the appropriate linguistic variables for the alternatives with respect to criteria for each decision experts. Equation (3.11) used to determine the aggregate weight of criteria to get the aggregated fuzzy weight $\tilde{}$ of criterion to integrate the fuzzy judgment value considered by contractors, clients and consultants were presented in table 4.9, table 4.10 and table 4.101 below respectively. After aggregating the decision expert's judgment, the normalized fuzzy decision matrix for the alternative can be determined by using equation (3.12) and the research finding considered by contractors, clients and consultant experts were presented in table 4.102, table 4.103 and table 4.104 below respectively. Equation (3.13) provides the weighted fuzzy normalized decision matrixes considered by contractors, clients and consultants were presented in table 4.105, table 4.106 and table 4.107 below respectively. Table 4.41 shows that the fuzzy positive- ideal solution and fuzzy negative-ideal solution obtained by using equation (3.14) and equation (3.15). The distance of each alternative from fuzzy positive-ideal solution and fuzzy negative-ideal solution can be calculated by using equation (3.16) and equation (3.17) respectively and the results considered by contractors, clients and consultant experts were presented from table 4.108 up to table 4.109

Table 4.9 Aggregated Fuzzy Decision Matr 1 rix for Alternative by Decision experts

Criteria	Alternatives																				
	Anwar said GC			KID Con GC			ANBALET GC			MCG GC			DIRRIBA DAFARSHA GC			GIBLATORE GC			Robi bon GC		
C11	3.30	4.30	5.30	3.70	4.80	5.90	3.00	4.10	5.20	3.40	4.50	5.60	2.40	3.50	4.60	2.10	3.10	4.10	2.50	3.50	4.50
C12	4.00	5.30	6.60	3.90	5.10	6.30	2.70	3.80	4.90	2.90	4.00	5.10	2.30	3.30	4.30	2.40	3.40	4.40	2.90	4.00	5.10
C13	3.70	4.80	5.90	3.90	5.10	6.30	3.20	4.30	5.40	3.20	4.40	5.60	2.50	3.50	4.50	2.50	3.50	4.50	2.40	3.40	4.40
C14	3.50	4.70	5.90	4.00	5.30	6.60	2.60	3.60	4.60	2.90	4.10	5.30	2.20	3.20	4.20	2.00	3.00	4.00	2.40	3.40	4.40
C21	3.80	5.00	6.20	4.20	5.50	6.80	2.80	3.80	4.80	3.10	4.20	5.30	1.90	2.90	3.90	2.00	3.00	4.00	2.50	3.50	4.50
C22	3.80	4.90	6.00	4.50	6.10	7.70	2.80	3.80	4.80	3.20	4.40	5.60	2.30	3.30	4.30	2.30	3.30	4.30	2.40	3.40	4.40
C23	3.40	4.50	5.60	3.90	5.00	6.10	2.80	3.90	5.00	2.70	3.70	4.70	2.20	3.20	4.20	2.20	3.20	4.20	2.70	3.70	4.70
C24	3.50	4.60	5.70	4.20	5.40	6.60	3.00	4.30	5.60	3.30	4.50	5.70	2.20	3.20	4.20	2.40	3.40	4.40	2.50	3.50	4.50
C31	3.20	4.20	5.20	3.80	5.00	6.20	3.50	4.60	5.70	2.50	3.50	4.50	2.10	3.10	4.10	2.10	3.10	4.10	2.30	3.30	4.30
C32	3.50	4.60	5.70	4.00	5.20	6.40	3.30	4.50	5.70	2.40	3.40	4.40	2.10	3.10	4.10	2.20	3.20	4.20	2.40	3.40	4.40
C33	3.30	4.30	5.30	3.80	4.90	6.00	2.80	3.80	4.80	3.20	4.40	5.60	2.40	3.40	4.40	2.20	3.20	4.20	2.80	3.90	5.00
C41	3.60	4.80	6.00	3.80	5.00	6.20	3.00	4.30	5.60	3.40	4.70	6.00	2.40	3.40	4.40	2.20	3.20	4.20	2.50	3.50	4.50
C42	3.40	4.50	5.60	4.00	5.30	6.60	3.60	4.80	6.00	2.60	3.60	4.60	2.70	3.70	4.70	2.60	3.60	4.60	2.40	3.40	4.40
C43	3.50	4.50	5.50	3.80	4.90	6.00	3.50	4.60	5.70	2.50	3.50	4.50	1.80	2.80	3.80	1.70	2.70	3.70	2.30	3.30	4.30
C51	3.70	4.80	5.90	4.10	5.40	6.70	3.20	4.20	5.20	2.80	3.90	5.00	2.40	3.40	4.40	2.60	3.60	4.60	2.30	3.30	4.30
C52	3.80	5.00	6.20	4.30	5.70	7.10	3.30	4.50	5.70	3.20	4.30	5.40	2.60	3.60	4.60	2.50	3.50	4.50	2.70	3.70	4.70
C53	3.90	5.10	6.30	4.60	6.20	7.80	3.20	4.30	5.40	2.60	3.60	4.60	2.10	3.10	4.10	2.30	3.30	4.30	2.50	3.50	4.50

Table 4.10 Normalized Fuzzy Decision Mat 1rix for Alternative by Decision Experts

Criteria	Alternatives																				
	Anwar said GC			KID Con GC			ANBALET GC			MCG GC			DIRRIBA DAFARSHA GC			GIBLATORE GC			Robi bon GC		
C11	0.42	0.55	0.68	0.47	0.62	0.76	0.38	0.53	0.67	0.44	0.58	0.72	0.31	0.45	0.59	0.27	0.40	0.53	0.32	0.45	0.58
C12	0.51	0.68	0.85	0.50	0.65	0.81	0.35	0.49	0.63	0.37	0.51	0.65	0.29	0.42	0.55	0.31	0.44	0.56	0.37	0.51	0.65
C13	0.47	0.62	0.76	0.50	0.65	0.81	0.41	0.55	0.69	0.41	0.56	0.72	0.32	0.45	0.58	0.32	0.45	0.58	0.31	0.44	0.56
C14	0.45	0.60	0.76	0.51	0.68	0.85	0.33	0.46	0.59	0.37	0.53	0.68	0.28	0.41	0.54	0.26	0.38	0.51	0.31	0.44	0.56
C21	0.49	0.64	0.79	0.54	0.71	0.87	0.36	0.49	0.62	0.40	0.54	0.68	0.24	0.37	0.50	0.26	0.38	0.51	0.32	0.45	0.58
C22	0.49	0.63	0.77	0.58	0.78	0.99	0.36	0.49	0.62	0.41	0.56	0.72	0.29	0.42	0.55	0.29	0.42	0.55	0.31	0.44	0.56
C23	0.44	0.58	0.72	0.50	0.64	0.78	0.36	0.50	0.64	0.35	0.47	0.60	0.28	0.41	0.54	0.28	0.41	0.54	0.35	0.47	0.60
C24	0.45	0.59	0.73	0.54	0.69	0.85	0.38	0.55	0.72	0.42	0.58	0.73	0.28	0.41	0.54	0.31	0.44	0.56	0.32	0.45	0.58
C31	0.41	0.54	0.67	0.49	0.64	0.79	0.45	0.59	0.73	0.32	0.45	0.58	0.27	0.40	0.53	0.27	0.40	0.53	0.29	0.42	0.55
C32	0.45	0.59	0.73	0.51	0.67	0.82	0.42	0.58	0.73	0.31	0.44	0.56	0.27	0.40	0.53	0.28	0.41	0.54	0.31	0.44	0.56
C33	0.42	0.55	0.68	0.49	0.63	0.77	0.36	0.49	0.62	0.41	0.56	0.72	0.31	0.44	0.56	0.28	0.41	0.54	0.36	0.50	0.64
C41	0.46	0.62	0.77	0.49	0.64	0.79	0.38	0.55	0.72	0.44	0.60	0.77	0.31	0.44	0.56	0.28	0.41	0.54	0.32	0.45	0.58
C42	0.44	0.58	0.72	0.51	0.68	0.85	0.46	0.62	0.77	0.33	0.46	0.59	0.35	0.47	0.60	0.33	0.46	0.59	0.31	0.44	0.56
C43	0.45	0.58	0.71	0.49	0.63	0.77	0.45	0.59	0.73	0.32	0.45	0.58	0.23	0.36	0.49	0.22	0.35	0.47	0.29	0.42	0.55
C51	0.47	0.62	0.76	0.53	0.69	0.86	0.41	0.54	0.67	0.36	0.50	0.64	0.31	0.44	0.56	0.33	0.46	0.59	0.29	0.42	0.55
C52	0.49	0.64	0.79	0.55	0.73	0.91	0.42	0.58	0.73	0.41	0.55	0.69	0.33	0.46	0.59	0.32	0.45	0.58	0.35	0.47	0.60
C53	0.50	0.65	0.81	0.59	0.79	1.00	0.41	0.55	0.69	0.33	0.46	0.59	0.27	0.40	0.53	0.29	0.42	0.55	0.32	0.45	0.58

Table 4.10 1 Weighted Normalized Fuzzy Decision Matrix by Decision Experts

Criteria	Alternatives																				
	Anwar said GC			KID Con GC			ANBALET GC			MCG GC			DIRRIBA			GIBLATORE GC			Robi bon GC		
C11	0.6	0.95	1.43	0.67	1.06	1.6	0.54	0.91	1.41	0.61	1	1.51	0.43	0.77	1.24	0.38	0.69	1.11	0.45	0.77	1.22
C12	0.78	1.25	1.81	0.76	1.2	1.73	0.53	0.89	1.34	0.57	0.94	1.4	0.45	0.78	1.18	0.47	0.8	1.21	0.57	0.94	1.4
C13	0.2	0.31	0.46	0.21	0.33	0.49	0.17	0.27	0.42	0.17	0.28	0.43	0.13	0.22	0.35	0.13	0.22	0.35	0.13	0.22	0.34
C14	0.23	0.38	0.59	0.27	0.43	0.66	0.17	0.29	0.46	0.19	0.33	0.53	0.15	0.26	0.42	0.13	0.24	0.4	0.16	0.27	0.44
C21	0.68	1.16	1.81	0.75	1.28	1.99	0.5	0.88	1.4	0.56	0.98	1.55	0.34	0.67	1.14	0.36	0.7	1.17	0.45	0.81	1.32
C22	0.76	1.24	1.88	0.9	1.55	2.41	0.56	0.96	1.5	0.64	1.12	1.75	0.46	0.84	1.34	0.46	0.84	1.34	0.48	0.86	1.38
C23	0.16	0.26	0.41	0.18	0.29	0.44	0.13	0.23	0.36	0.13	0.21	0.34	0.1	0.19	0.3	0.1	0.19	0.3	0.13	0.21	0.34
C24	0.22	0.36	0.58	0.26	0.43	0.68	0.19	0.34	0.57	0.21	0.35	0.58	0.14	0.25	0.43	0.15	0.27	0.45	0.16	0.28	0.46
C31	0.87	1.26	1.71	1.03	1.5	2.04	0.95	1.38	1.87	0.68	1.05	1.48	0.57	0.93	1.35	0.57	0.93	1.35	0.62	0.99	1.41
C32	0.23	0.34	0.48	0.26	0.39	0.54	0.22	0.33	0.48	0.16	0.25	0.37	0.14	0.23	0.35	0.15	0.24	0.35	0.16	0.25	0.37
C33	0.28	0.41	0.56	0.32	0.46	0.64	0.24	0.36	0.51	0.27	0.42	0.59	0.2	0.32	0.47	0.19	0.3	0.44	0.24	0.37	0.53
C41	0.5	0.71	0.95	0.53	0.74	0.98	0.42	0.64	0.89	0.47	0.7	0.95	0.33	0.5	0.7	0.31	0.47	0.67	0.35	0.52	0.71
C42	0.48	0.68	0.89	0.56	0.8	1.05	0.51	0.72	0.96	0.37	0.54	0.73	0.38	0.56	0.75	0.37	0.54	0.73	0.34	0.51	0.7
C43	0.32	0.42	0.55	0.34	0.46	0.6	0.32	0.43	0.57	0.23	0.33	0.45	0.16	0.26	0.38	0.15	0.25	0.37	0.21	0.31	0.43
C51	0.54	0.73	0.93	0.6	0.83	1.06	0.47	0.64	0.82	0.41	0.6	0.79	0.35	0.52	0.7	0.38	0.55	0.73	0.34	0.5	0.68
C52	0.4	0.55	0.72	0.45	0.63	0.83	0.35	0.5	0.67	0.34	0.48	0.63	0.28	0.4	0.54	0.26	0.39	0.53	0.29	0.41	0.55
C53	0.46	0.63	0.82	0.54	0.77	1.02	0.38	0.53	0.7	0.31	0.45	0.6	0.25	0.39	0.53	0.27	0.41	0.56	0.3	0.43	0.59

Table 4.10 2 Fuzzy positive-ideal solution and fuzzy negative-ideal solution

Criteria	Alternatives																				
	Anwar said GC			KID Con GC			ANBALET GC			MCG GC			DIRRIBA DAFARSHA GC			GIBLA-TORE GC			Robi bon GC		
A+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4.10 3 Distance of Alternatives from Fuzzy positive-ideal solution by Decision Experts

Criteria	Alternatives																				
	Anwar said GC			KID Con GC			ANBALET GC			MCG GC			DIRRIBA [illegible] GC			GIBLATORE GC			Robi bon GC		
C11	0.93	0.85	0.68	0.92	0.83	0.65	0.94	0.85	0.69	0.93	0.84	0.67	0.95	0.88	0.73	0.96	0.89	0.76	0.95	0.88	0.73
C12	0.94	0.86	0.70	0.94	0.86	0.71	0.96	0.90	0.77	0.95	0.89	0.76	0.96	0.91	0.80	0.96	0.91	0.80	0.95	0.89	0.76
C13	0.93	0.85	0.69	0.93	0.85	0.67	0.94	0.87	0.72	0.94	0.87	0.71	0.96	0.89	0.77	0.96	0.89	0.77	0.96	0.90	0.77
C14	0.97	0.92	0.84	0.96	0.92	0.82	0.97	0.94	0.88	0.97	0.93	0.86	0.98	0.95	0.89	0.98	0.95	0.89	0.98	0.95	0.88
C15	0.96	0.91	0.81	0.95	0.90	0.79	0.97	0.93	0.85	0.96	0.92	0.84	0.98	0.95	0.88	0.98	0.94	0.88	0.97	0.93	0.86
C21	0.75	0.60	0.40	0.70	0.50	0.23	0.81	0.69	0.52	0.79	0.64	0.44	0.85	0.73	0.57	0.85	0.73	0.57	0.84	0.72	0.56
C22	0.94	0.91	0.86	0.94	0.90	0.84	0.95	0.92	0.87	0.96	0.92	0.88	0.96	0.93	0.89	0.96	0.93	0.89	0.96	0.92	0.88
C23	0.93	0.88	0.82	0.91	0.86	0.79	0.94	0.89	0.82	0.93	0.88	0.82	0.95	0.92	0.86	0.95	0.91	0.86	0.95	0.91	0.86
C31	0.94	0.86	0.71	0.93	0.83	0.65	0.93	0.85	0.68	0.95	0.88	0.75	0.96	0.90	0.77	0.96	0.90	0.77	0.96	0.89	0.76
C32	0.95	0.89	0.75	0.94	0.87	0.72	0.95	0.89	0.75	0.97	0.92	0.81	0.97	0.92	0.82	0.97	0.92	0.82	0.97	0.92	0.81
C33	0.95	0.88	0.74	0.94	0.86	0.71	0.95	0.89	0.77	0.95	0.88	0.73	0.96	0.90	0.79	0.96	0.91	0.79	0.95	0.89	0.76
C34	0.94	0.86	0.71	0.94	0.86	0.70	0.95	0.88	0.73	0.94	0.87	0.71	0.96	0.90	0.79	0.96	0.91	0.80	0.96	0.90	0.79
C35	0.97	0.94	0.88	0.97	0.93	0.85	0.97	0.94	0.87	0.98	0.95	0.90	0.98	0.95	0.90	0.98	0.95	0.90	0.98	0.95	0.90
C41	0.89	0.79	0.62	0.88	0.77	0.58	0.89	0.78	0.60	0.92	0.83	0.69	0.94	0.87	0.73	0.95	0.87	0.74	0.93	0.84	0.70
C42	0.87	0.76	0.58	0.86	0.73	0.53	0.89	0.79	0.63	0.90	0.80	0.65	0.92	0.83	0.69	0.91	0.82	0.67	0.92	0.83	0.70
C43	0.96	0.93	0.88	0.96	0.92	0.86	0.97	0.94	0.89	0.97	0.94	0.89	0.98	0.95	0.91	0.98	0.95	0.91	0.97	0.95	0.91
C44	0.95	0.91	0.84	0.95	0.89	0.80	0.96	0.93	0.86	0.97	0.94	0.88	0.98	0.95	0.89	0.97	0.94	0.89	0.97	0.94	0.88
	14.7	12.6	9.4	14.4	12.1	8.7	15.0	13.1	10.0	15.1	13.2	10.1	15.5	13.9	11.1	15.5	13.9	11.2	15.4	13.7	10.9
di+	36.72			35.24			38.04			38.33			40.50			40.57			39.89		

Table 4.10 4 Distance of Alternatives from fuzzy negative-ideal solution by Decision Experts

Criteria	Alternatives																				
	Anwar said GC			KID Con GC			ANBALET GC			MCG GC			DIRRIBA DAFARSHA GC			GIBLATORE GC			Robi bon GC		
C11	-0.07	-0.15	-0.32	-0.08	-0.17	-0.35	-0.06	-0.15	-0.31	-0.07	-0.16	-0.33	-0.05	-0.12	-0.27	-0.04	-0.11	-0.24	-0.05	-0.12	-0.27
C12	-0.06	-0.14	-0.30	-0.06	-0.14	-0.29	-0.04	-0.10	-0.23	-0.05	-0.11	-0.24	-0.04	-0.09	-0.20	-0.04	-0.09	-0.20	-0.05	-0.11	-0.24
C13	-0.07	-0.15	-0.31	-0.07	-0.15	-0.33	-0.06	-0.13	-0.28	-0.06	-0.13	-0.29	-0.04	-0.11	-0.23	-0.04	-0.11	-0.23	-0.04	-0.10	-0.23
C14	-0.03	-0.08	-0.16	-0.04	-0.08	-0.18	-0.03	-0.06	-0.12	-0.03	-0.07	-0.14	-0.02	-0.05	-0.11	-0.02	-0.05	-0.11	-0.02	-0.05	-0.12
C21	-0.04	-0.09	-0.19	-0.05	-0.10	-0.21	-0.03	-0.07	-0.15	-0.04	-0.08	-0.16	-0.02	-0.05	-0.12	-0.02	-0.06	-0.12	-0.03	-0.07	-0.14
C22	-0.25	-0.40	-0.60	-0.30	-0.50	-0.77	-0.19	-0.31	-0.48	-0.21	-0.36	-0.56	-0.15	-0.27	-0.43	-0.15	-0.27	-0.43	-0.16	-0.28	-0.44
C23	-0.06	-0.09	-0.14	-0.06	-0.10	-0.16	-0.05	-0.08	-0.13	-0.04	-0.08	-0.12	-0.04	-0.07	-0.11	-0.04	-0.07	-0.11	-0.04	-0.08	-0.12
C24	-0.07	-0.12	-0.18	-0.09	-0.14	-0.21	-0.06	-0.11	-0.18	-0.07	-0.12	-0.18	-0.05	-0.08	-0.14	-0.05	-0.09	-0.14	-0.05	-0.09	-0.14
C31	-0.06	-0.14	-0.29	-0.07	-0.17	-0.35	-0.07	-0.15	-0.32	-0.05	-0.12	-0.25	-0.04	-0.10	-0.23	-0.04	-0.10	-0.23	-0.04	-0.11	-0.24
C32	-0.05	-0.11	-0.25	-0.06	-0.13	-0.28	-0.05	-0.11	-0.25	-0.03	-0.08	-0.19	-0.03	-0.08	-0.18	-0.03	-0.08	-0.18	-0.03	-0.08	-0.19
C33	-0.05	-0.12	-0.26	-0.06	-0.14	-0.29	-0.05	-0.11	-0.23	-0.05	-0.12	-0.27	-0.04	-0.10	-0.21	-0.04	-0.09	-0.21	-0.05	-0.11	-0.24
C41	-0.06	-0.14	-0.29	-0.06	-0.14	-0.30	-0.05	-0.12	-0.27	-0.06	-0.13	-0.29	-0.04	-0.10	-0.21	-0.04	-0.09	-0.20	-0.04	-0.10	-0.21
C42	-0.03	-0.06	-0.12	-0.03	-0.07	-0.15	-0.03	-0.06	-0.13	-0.02	-0.05	-0.10	-0.02	-0.05	-0.10	-0.02	-0.05	-0.10	-0.02	-0.05	-0.10
C43	-0.11	-0.21	-0.38	-0.12	-0.23	-0.42	-0.11	-0.22	-0.40	-0.08	-0.17	-0.31	-0.06	-0.13	-0.27	-0.05	-0.13	-0.26	-0.07	-0.16	-0.30
C51	-0.13	-0.24	-0.42	-0.14	-0.27	-0.47	-0.11	-0.21	-0.37	-0.10	-0.20	-0.35	-0.08	-0.17	-0.31	-0.09	-0.18	-0.33	-0.08	-0.17	-0.30
C52	-0.04	-0.07	-0.12	-0.04	-0.08	-0.14	-0.03	-0.06	-0.11	-0.03	-0.06	-0.11	-0.02	-0.05	-0.09	-0.02	-0.05	-0.09	-0.03	-0.05	-0.09
C53	-0.05	-0.09	-0.16	-0.05	-0.11	-0.20	-0.04	-0.07	-0.14	-0.03	-0.06	-0.12	-0.02	-0.05	-0.11	-0.03	-0.06	-0.11	-0.03	-0.06	-0.12
	0.14	0.45	1.44	0.18	0.60	1.91	0.09	0.26	1.18	0.09	0.34	1.18	0.05	0.21	0.78	0.05	0.21	0.77	0.06	0.24	0.86
di-	2.02			2.69			1.53			1.62			1.05			1.04			1.16		

Table 4.11 Closeness Coefficients and Ra 1

Contractors	Closeness coefficients and ranking			
	di+	di-	Cci	Rank
Anwar said GC	3.499	0.821	0.190	2
KID Con GC	3.427	0.947	0.217	1
ANBALET GC	3.561	0.714	0.167	4
MCG GC	3.575	0.734	0.170	3
DIRRIBA DAFARSHA	3.674	0.592	0.139	6
GIBLATORE GC	3.677	0.588	0.138	7
Robi bon GC	3.647	0.621	0.145	5

As it was observed in the table above that the decision experts ranked KID Con GC, Anwar said GC, MCG GC, ANBALET GC, Robi bon GC, DIRRIBA DAFARSHA GC, GIBLATORE GC as the 1st, 2nd, 3rd, 4th, 5th, 6th, and 7th with a closeness coefficient value of 0.217, 0.190, 0.170, 0.167, 0.145, 0.139, and 0.138 respectively. Table 4. 48 shows that the closeness coefficient and ranking order of the contractor selected considered by contractor experts, client and consultant experts. As it was observed in table 4.48 that the most appropriate contractors which is ranked first as perceived by the respondents were KID CON GC with a closeness coefficient value of 0.217 Hence, the results show that the higher value of closeness coefficient was obtained for KID CON GC which is closer to the ideal values for the respondents. This shows that there is similarity of the orderings of the data when ranked by experts. This could be that the ranks of each of the experts be ranked first among a set of alternatives. As such, it can be asserted that there is a positive correlation between the rankings of these respondents. Anwar Said GC is the second most appropriate, the MCG GC t experts with a closeness coefficient value of 0.170 were 3rd. ANBALET GC were ranked as the 4th by decision experts with a closeness coefficient value of 0.16 7, Robi Bon GC were ranked as the 5th by decision experts with a closeness coefficient value of 0.145 , Diriba Defarsha GC were ranked as the 6th by decision experts with a closeness coefficient value of 0.139, Giblator GC were ranked as the 7th by decision experts with a closeness coefficient value of 0.138 This indicates that the closeness coefficients Giblator GC were far from the ideal value. Therefore, Kidcon GC was selected as the best contractor among the considered ones which have the best closeness coefficient value by decision experts. this supports the

4.7. Validation of the Proposed Methodology

The validation of the proposed methodology is ascertained by respondent to ensure the validity of the results analyzed by fuzzy analytical hierarchy processes and fuzzy TOPSIS it can choose the respondents based on their experience, skill, and back ground knowledge and it can correlate the results of my study with the contractor selection criteria. Hence the results and outcomes of the priority values obtained from the finding were valid and it is valid to cost, quality, time, environment and safety. the finding of the study revealed that Kid con GC was selected as the appropriate contractor among the various Contractors The results of the proposed methodology which is suggested by respondent and the finding obtained by the analysis were positively correlated; hence the research would promote validity. The results of the research obtained from the questionnaire survey analyzed by integrating the fuzzy analytic hierarchy processes and fuzzy TOPSIS were consistent across the numbers of samples, the data becomes more reliable. So, using the fuzzy analytic hierarchy processes and fuzzy TOPSIS analysis was valid to identify the key selection criteria and select the appropriate road maintenance management strategy.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the research aims and results and provides recommendations and conclusions for the effect of lowest bidder bid awarding system in public building construction Projects. Suggested areas of future research were also discussed in this chapter.

5.1. Summary of the Research

By reviewing the research objectives, an overview will be critically discussed to assess how well the research objectives have been achieved. This was achieved through identifying a list of 17 attributes related to the negative effect of LBBAS (Lowest Bidder Bid Awarding System) and a list 5 and of 15 attributes related to the selection main and sub-criteria by decision experts. In achieving the aim of the research, three main objectives have been outlined and achieved through the analysis and discussion of the results and findings of the analyzed collected questionnaires and case study. These objectives are related to the research questions that were developed to increase one's knowledge and familiarity with the subject.

5.2. Conclusions

This study "An alternative of Multi-Criteria Decision-Making Based Low-Bid Awarding System for Public Building Construction Project": And to analyze the negative effects, to assess the selection main and sub-criteria for contractors' prequalification and bid evaluation and to develop system which improve contractors' prequalification and bid evaluation. The first objective of the research was to analyze the negative effects in the public building construction projects which are awarded on the basis of lowest bidder bid awarding systems. From considered effects, relatively five high negative effect of lowest bidder bid awarding system in public construction projects were identified. These are;

Delay on project completion, Increase claims and disputes between contracting parties, Selection of inefficient contractors, Unsatisfactory quality of work and Cost overruns.

The second objective of the research was to assess the selection criteria for contractor's prequalification and bid evaluation, in lowest bid awarding system are other important factor under mandatory criteria and included as sub-criteria.

The Third objective of the research was to develop a Low-Bid awarding system for public building construction projects using fuzzyTOPSIS MCDM approach. Literature review in

the research provided advanced knowledge and a detailed view of the method of contractor selection criteria. Thereby, after exploring the procedure that should be conducted to select the winning contractor and investigating the current practices used for contractor selection process for Building construction project, result of such investigation presented the development of an implementation method for contactor selection that fuzzyTOPSIS model for contractor selection. The model was composed of three methodologies, the first of which is used to present a relative weight to the contractor evaluation criteria, and secondly ranking was deliberated by using the fuzzyTOPSIS method used to optimize the decision and the final was select the winning contractor. The main findings that can be achieved from using the proposed mathematical model are:

The model can minimize the negative effect occurring in competitive list bidder by considering summation of both technical and financial evaluation score, even after responsive and qualified for financial opening.

Since the model is a structured technique for organizing and analyzing complex decisions, based on mathematics it saves time, energy and human errors, The ranking of the alternatives obtained by using the proposed model is flexible if a new criterion is added. Therefore, the model can be easily adjusted in accordance to the needs and demands of the user, Has good computational efficiency and ability to measure the relative performance for each alternative in a simple mathematical form and The model is easy and can be used on Microsoft excel sheet.

5.3. Recommendation

The findings of the research show an alternative of Multi-Criteria Decision-Making Based Low-Bid Awarding System for Public Building Construction Project. The author of this thesis strongly recommends competitive lowest bidder bid awarding system still need improvement to overcome the negative effects and minimize difficulty of contractor selection using Multi-Criteria Decision Making. Particularly, the researcher shared the idea of:

The issue of Ethiopia being a developing country has a significant effect on selecting contractors based on a mindset of saving money, all partiers in the construction sector should realize selecting contractor based on only the least bid method is causing problems such as delay, claim and dispute, inefficient contractor, poor quality and cost overrun. Focusing on both project objective parallel with money/price is required.

Public Procurement and Property Administration Agency take a closer look at the selection criteria and weightage currently in use for contractor's prequalification and bid evaluation, in lowest bid awarding system and categorize according to the scope of the project which will go in parallel with the country construction law to achieve a true value of money and minimize inefficient contractor issue. Development of Multi-Criteria Decision-Making Based Low-Bid Awarding System for Public Building Construction Project.

Minimize awarding unqualified contractors by using model fuzzyTOPSIS which minimize the negative effect occurring in competitive list bidder by considering summation of both technical and financial evaluation score in addition to analyzing complex decisions, based on mathematics and it saves time, energy and human errors.

Finally, the concerned government body consults professionals in this area on whether there is a need to modify/change the current legislation for procurement of works and service by quantifying the negative effect of completed project which is awarded on the basis of competitive list bidder for building construction projects.

5.4. Recommendation for future studies

Further research may also be conducted on the effect of lowest bidder bid awarding system which includes public building and road construction projects, Further research may also be conducted on the effect of lowest bidder bid awarding system, The researcher recommends fellow researchers to quantify the magnitude of the effect of the current bid evaluation and contract award system in competitive list bidder bid awarding system from completed project.

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APPENDIX

Appendix A. SBD Contractor Selection Criteria (Source: PPA, 2011)

FACTOR	CRITERIA					
	Requirement	Bidder				Documentation Required
		Single Entity	Joint Venture, Consortium or Association			
			All Partners Combined	Each Partner	At Least One Partner	
Legal Qualification of the Bidder						
1.1. Nationality	Nationality in accordance with ITB Clause 4.2.	Must meet requirement	Must meet requirement	Must meet requirement	n/a	Bid Submission Sheet
1.2. Conflict of Interest	No conflict of interest as described in ITB Clause 6.	Must meet requirement	Must meet requirement	Must meet requirement	n/a	Bid Submission Sheet
1.3. Registration in the FPPA's Suppliers List	Having been registered in the Public Procurement and Property Administration Agency's Suppliers List in accordance with ITB Clause 4.7.	Must meet requirement	Must meet requirement	Must meet requirement	n/a	Bid Submission Sheet
1.4. Debarred by decision of the FPPA	Not having been debarred by decision of the Public Procurement Agency from participating in public procurements for breach of its obligation under previous contracts in accordance with ITB Clause 4.3.	Must meet requirement	Must meet requirement	Must meet requirement	n/a	Bid Submission Sheet
1.5. Valid trade license or business orga 1.6. nization registration certificate	Having been submitted valid trade license or business organization registration certificate issued by the country of establishment in accordance with ITB Clause 4.6.	Must meet requirement	Must meet requirement	Must meet requirement	n/a	Bid Submission Sheet with attachments
1.7. VAT registration certificate	Having been submitted VAT registration certificate issued by the tax authority (in case of contract value of Birr 100,000.00 and above) in accordance with ITB Clause 4.6.	Must meet requirement	Must meet requirement	Must meet requirement	n/a	Bid Submission Sheet with attachments
1.8. Valid tax clearance certificate	Having been submitted valid tax clearance certificate issued by the tax authority (Domestic Bidders Only) in accordance with ITB Clause 4.6.	Must meet requirement	Must meet requirement	Must meet requirement	n/a	Bid Submission Sheet with attachments

<table>
<tr><th rowspan="3">FACTOR</th><th colspan="5">CRITERIA</th></tr>
<tr><th rowspan="2">Requirement</th><th colspan="4">Bidder</th><th rowspan="2">Documentation Required</th></tr>
<tr><th>Single Entity</th><th>Joint Venture, Consortium or Association</th><th></th><th></th></tr>
<tr><th></th><th></th><th>All Partners Combined</th><th>Each Partner</th><th>At Least One Partner</th><th></th></tr>
<tr><td>1.9. Valid tax clearance certificate</td><td>Having been submitted valid tax clearance certificate issued by the tax authority (Domestic Bidders Only) in accordance with ITB Clause 4.6.</td><td>Must meet requirement</td><td>Must meet requirement</td><td>Must meet requirement</td><td>n/a</td><td>Bid Submission Sheet with attachments</td></tr>
<tr><td>1.10. Government Owned Entity</td><td>Compliance with conditions of ITB Clause 4.4.</td><td>Must meet requirement</td><td>Must meet requirement</td><td>Must meet requirement</td><td>n/a</td><td>Bidder Certification of Compliance with attachments</td></tr>
<tr><td colspan="7">Professional Qualifications and Capability of the Bidder</td></tr>
<tr><td>2.1. Number of staff</td><td>At least staff currently work for the Bidder.</td><td>Must meet requirement</td><td>Must meet requirement</td><td>n/a</td><td>n/a</td><td>Bidder Certification of Compliance</td></tr>
<tr><td>2.2. Personnel for the key positions</td><td>Among the staff mentioned in Sub-Clause 2.1 Bidder must demonstrate that it will have the personnel for the key positions that meet the following requirements;
<table>
<tr><th>No.</th><th>Position</th><th>Total Work Experience</th><th>Experience in Similar Works</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table></td><td>Must meet requirement</td><td>Must meet requirement</td><td>n/a</td><td>n/a</td><td>Technical Proposal Form PER 1 with attachments</td></tr>
<tr><td colspan="7">Technical Qualifications, Competence, and Experience of the Bidder</td></tr>
<tr><td>3.1. General experience</td><td>The Bidder has successfully completed at least contracts with a budget of at least that of this contract in the past years</td><td>Must meet requirement</td><td>n/a</td><td>Must meet requirement</td><td>n/a</td><td>Bidder Certification of Compliance with attachments</td></tr>
</table>

<table>
<tr><th rowspan="3">FACTOR</th><th colspan="5">CRITERIA</th></tr>
<tr><th rowspan="2">Requirement</th><th colspan="3">Bidder</th><th rowspan="2">Documentation Required</th></tr>
<tr><th>Single Entity</th><th>Joint Venture, Consortium or Association</th><th></th><th></th></tr>
<tr><th></th><th></th><th>All Partners Combined</th><th>Each Partner</th><th>At Least One Partner</th><th></th></tr>
<tr><td>3.2. Specific experience</td><td>The Bidder has successfully participated as contractor or subcontractor, in at least contracts within the last years, each with a value of at least , that have been successfully and substantially completed and that are similar to the proposed Works..</td><td>Must meet requirement</td><td>Must meet requirement for all characteristics</td><td>n/a</td><td>Must meet requirement for one characteristic</td><td>Bidder Certification of Compliance with attachments</td></tr>
<tr><td>3.3. History of non-performing contracts</td><td>Non-performance of a contract did not occur within the last years prior to the deadline for Bid submission, based on all information on fully settled disputes or litigation. A fully settled dispute or litigation is one that has been resolved in accordance with the Dispute Resolution Mechanism under the respective contract, and where all appeal instances available to the bidder have been exhausted.</td><td>Must meet requirement by itself or as partner to past or existing JV</td><td>n/a</td><td>Must meet requirement by itself or as partner to past or existing JV</td><td>n/a</td><td>Bidder Certification of Compliance</td></tr>
<tr><td>3.4. Pending litigation</td><td>All pending litigation shall in total not represent more than percent of the Bidder’s net worth and shall be treated as resolved against the Bidder.</td><td>Must meet requirement by itself or as partner to past or existing JV</td><td>n/a</td><td>Must meet requirement by itself or as partner to past or existing JV</td><td>n/a</td><td>Bidder Certification of Compliance</td></tr>
<tr><td>3.5. Equipment for the implementation of the contract</td><td>The Bidder must demonstrate that it will have available for the implementation of the contract the following equipment listed hereafter:
<table>
<tr><th>No.</th><th>Equipment Type and Characteristics</th><th>Minimum Number Required</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table></td><td>Must meet requirement</td><td>Must meet requirement</td><td>n/a</td><td>n/a</td><td>Technical Proposal with attachments</td></tr>
</table>

FACTOR	CRITERIA					
	Requirement	Bidder				Documentation Required
		Single Entity	Joint Venture, Consortium or Association			
			All Partners Combined	Each Partner	At Least One Partner	
Financial Standing of the Bidder						
4.1. Historical Financial Performance	Submission of audited balance sheets and other financial statements as required in the BDS Clause 17, for the last years to demonstrate the current soundness of the Bidder's financial position and its prospective long-term profitability.	Must meet requirement	n/a	Must meet requirement	n/a	Bidder Certification of Compliance with attachments
4.2. Average Annual Turnover	The average annual turnover calculated as total certified payments received for contracts in progress or completed within the last years must exceed times the amount of the financial proposal of the Bid.	Must meet requirement	Must meet requirement	Must meet % of the requirement	Must meet % of the requirement	Bidder Certification of Compliance with attachments
4.3. Financial Resources	The Bidder must demonstrate access to, or availability of, financial resources such as liquid assets, unencumbered real assets, lines of credit, and other financial means, other than any contractual advance payments to meet the following cash-flow requirement:	Must meet requirement	Must meet requirement	Must meet % of the requirement	Must meet % of the requirement	Bidder Certification of Compliance with attachments

Appendix B. Questionnaire Survey

Appendix B.1. Study on the effect of Lowest Bidder Bid Awarding System in Public building Construction Projects.

ADAMA SCIENCE AND TECHNOLOGY UNIVE SITY

SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE

OFFICE OF GRADUATE STUDIES

THE DEPARTMENT OF CIVIL ENGINEERING (SPECIALIZATION IN CONSTRUCTION ENGINEERING MANAGEMENT)

Title: Study on the effect of Lowest Bidder Bid Awarding System in Public building Construction Projects.

Dear Participant, Firstly I would like to present my appreciation and thanks for your time and effort to complete this questionnaire, which considered as a basic requirement for the completion of my research, for the award of a Master of Science degree in Construction Technology and management at **Adama science and Technology yuniversty**. This questionnaire aims to Study on the effect of Lowest Bidder Bid Awarding System in Public building Construction.

Kindly, I request your assistance in attaining the required data with a level of accuracy and honesty as usual in your work, knowing that all responses and facts will remain fully confidential, and will be used for the research purposes only.

With regards,

Abdurehim Kemal

If you have any questions regarding the questionnaire, you can contact at Email: Abdikemal17@gmail.com; Cell Phone: (+251962010317)

All appreciations and thanks for your contribution to support scientific research

Part-1 General Information for Owner

1. Sex of respondent: [ ] Male [ ] Female

2. Age of respondent 20-30 31-40 41-50 Above 50

3. Please tic [√] to indicate your educational level

[ ] PhD [ ] MSc [ ] BSc [ ] Advanced diploma

4. Specify your Occupation_____

5. Experience years' respondent

[ ] Less than 5years [ ] 5 to 8years [ ] 8to 12 years [ ] More than 12 years

Part-2 Information about competitive low bidding

1. How much (in %age) fair and transparent of Bidding procedure that is made in the Competitive low bidding?

   [ ] 0%-25% [ ] 25%-50% [ ] 50%-75% [ ] 75%-100%

2. At which level the assessment of contractor selection process take place in LBBAS (Lowest Bidder Bid Awarding System). (Tick one or more)

   [ ] Technical department and engineering

   [ ] financial department

   [ ] Project management team

   [ ] High managerial level (director) Independent consultant

   [ ] by a committee member If other reasons, please specify_____

3. Is your company use mathematical model for bid evaluation and contractor selection process [ ] Yes [ ] No

4. If your answer is Yes, please specify the Model_____

5. Are you satisfied with the competitive low bidding evaluation procedure currently in use in your organization? [ ] Yes [ ] No Somewhat

Part-1 General Information for Contractor

1. Sex of respondent [ ] Male [ ] Female

2. Age of respondent [ ] 20-30 [ ] 31-40 [ ] 41-50 [ ] Above 50

3. Please tic [√] to indicate your educational level

[ ] PhD [ ] MSc [ ] BSc [ ] Advanced diploma

4.Title or position of respondent
[ ] Contractor [ ] Project Manager [ ] Site engineer [ ] Office engineer

5.Experience years' respondent
[ ] Less than 5years [ ] 5 to 8years [ ] 8to 12 years [ ] More than 12 years

6.Classification of Contractors in building works:
[ ] 1 st [ ] 2 nd [ ] 3 rd [ ] 4 th [ ] 5 th

7.Experience years of the organization in constructions:
[ ] Less than 3years [ ] 3 to 5 years [ ] 6to 10 years [ ] More than 10 years

8.Number of projects implemented.
[ ] Less than 5 [ ] 5 to 10 [ ]10 to 15 [ ] More than 15

Part-2 Information about competitive low bidding

1. How much (in %age) fair and transparent of Bidding procedure that is made in the Competitive low bidding?

[ ]0%-25% [ ] 25%-50 [ ] 50%-75% [ ] 75%-100%

2. At which level the assessment of contractor selection process take place in LBBAS (List Bid Bidder Awarding System). (Tick one or more)

[ ] Technical department and engineering

[ ] financial department

[ ] Project manager [ ] High managerial level (director)

[ ] Independent consultant [ ] by a committee member If other reasons, please specify_____

3. In your experience, how do you rate in percentage, the quality of the project completed using lowest bidder bid system?

[ ] 0%-25% [ ] 25%-50% [ ] 50%-75% [ ] 75%-100%

4. In your experience how do you rate in percentage of the project cost in lowest bid system projects are exposed to change order.

[ ] 0%-25% [ ] 25%-50% [ ] 50%-75% [ ] 75%-100%

5. How much percent defects are observed the built facilities within the warranty period?

[ ] 0%-25% [ ] 25%-50% [ ] 50%-75% [ ]75%-100%

6. What are the causes of negative effect occurring in competitive list bidder bid awarding system for public building construction project

_____

_____

Part-1 General Information for Consultants /Regulatory Body

1. Sex of respondent [ ] Male [ ] Female

2. Age of respondent [ ] 20-30 [ ] 31-40 [ ] 41-50 [ ] Above 50

3. Please tic [√] to indicate your educational level

[ ] PhD [ ] MSc [ ] BSc [ ] Advanced diploma

4.Title or position of respondence_____

5.Experience years' respondent

[ ] Less than 3years [ ] 3 to 5years [ ] 6 to 10 years [ ] More than 10 years

6. Classification of consultancy service in building works

[ ] 1st [ ] 2 nd [ ] 3 rd [ ] 4 th [ ] 5 th

7. Number of Consulted projects.

[ ] Less than 5 [ ] 5 to 10 [ ] 10 to 15 [ ] More than 15

Part-2 Information about competitive low bidding

1. How much (in %age) fair and transparent of Bidding procedure that is made in the Competitive low bidding?

[ ] 0%-25% [ ] 25%-50 [ ] 50%-75% [ ] 75%-100%

2. At which level the assessment of contractor selection process take place in LBBAS (List Bid Bidder Awarding System). (tick one or more)

   [ ] Technical department and engineering

   [ ] financial department

   [ ] Project manager [ ] High managerial level (director)

   [ ] Independent consultant [ ] by a committee member If other reasons, please specify_____

3. In your experience, how do you rate in percentage, the quality of the project completed using lowest bidder bid system?

   [ ] 0%-25% [ ] 25%-50% [ ] 50%-75% [ ] 75%-100%

4. In your experience how do you rate in percentage of the project cost in lowest bid system projects are exposed to change order.

   [ ] 0%-25% [ ] 25%-50% [ ] 50%-75% [ ] 75%-100%

5. How much percent defects are observed the built facilities within the warranty period?

   [ ] 0%-25% [ ] 25%-50% [ ] 50%-75% [ ] 75%-100%

Part 3: Effect of LBBAS (Lowest Bidder Bid Awarding System)

Lists of Negative effect of LBBAS for the study are mentioned below. From your experience, please tick the appropriate cell by indicating how much you agree to listed negative effect of LBBAS on project which is awarded using competitive low bidding

(1) Very low (2) Low (3) No Idea (4) High (5) Very High

NO	Effect (Negative) of LBBAS	Scale of Impact				
		1	2	3	4	5
1	Cost Overrun					
2	Delay on project completion					
3	Increase disputes and claims between contracting parties					
4	Select of inefficient contractors					
5	Increased No. of Change Requests/ Orders					
6	Change in project scope					
7	Shortages in resources (labors, equipment, and materials.)					
8	Underachievement in project performance					
9	Serious question on public safety					
10	Unsatisfactory quality of work					
11	Financial loss for owner					
12	Financial loss for contractor					
13	Increase in maintenance, replacement and operational costs					
14	Stress on the public services such as office, home and others					
15	Failed Projects/ Work Suspensions					
16	Failure to achieve the project objectives					
17	Terminate and Re-tendering for projects several times					

Appendix B.2. Questionnaire: Pairwise Comparison (For Fuzzy AHP)

This survey is designed to facilitate pairwise comparison of Cost (C1) variables/factors

Fill out this comparison matrix? The evaluation/comparison process of the relative importance of variables is shown in the table below. If a factor on the left "A" is absolute important for identifying the factors affecting the performance of building construction projects than the one matching on the right "B", you may mark "√".

Cc	AI	VSAI	VSI	SVSI	SI	MSI	MI	EMI	EI	EMI	MI	MSI	SI	SVSI	VSI	VSAI	AI	Cc
(A)	√																	(B)

If a factor on the left "B" is absolutely important factor for factors affecting the performance of building construction projects than the one matching on the right "A", you may mark "√".

Cc	AI	VSAI	VSI	SVSI	SI	MSI	MI	EMI	EI	EMI	MI	MSI	SI	SVSI	VSI	VSAI	AI	Cc
(A)																	√	(B)

Abbreviations:

Absolute important (AI), Very strong to absolute important (VSAI), Very strong important (VSI), Strong to very strong important (SVSI), Strong important (SI), Moderate to strong important (MSI), Moderate important (MI), Equal to moderate important (EMI), and Equally important (EI).

Please compare in pairs the relative importance among Cost (C1), Performance (C2), Quality control (C3), Health and safety (C4), and Project control (C5),

Questions

1. How important is Cost when it is compared with Performance?
2. How important is Cost when it is compared with Quality control?
3. How important is Cost when it is compared with Health and safety?
4. How important is Cost when it is compared with Project control?
5. How important is Performance when it is compared with Quality control?
6. How important is Performance when it is compared with Health and safety?
7. How important is Performance when it is compared with Project control?
8. How important is Quality control when it is compared with Health and safety?

9. How important is Quality control when it is compared with Project control?
10. How important is Health and safety when it is compared with Project control?

Pairwise comparison of the Criteria with respect to the overall objective

W.R.T C		Importance of one factor over another																	
Qs	Cij	AI	VSA	VSI	SVSI	SI	MSI	MI	EMI	EI	EMI	MI	MSI	SI	SVSI	VSI	VSA	AI	Cij
Q_1	C_1																		C_2
Q_2	C_1																		C_3
Q_3	C_1																		C_4
Q 4	C_1																		C_5
Q 5	C_2																		C_3
Q 6	C_2																		C_4
Q 7	C_2																		C_5
Q 8	C_3																		C_4
Q_9	C_3																		C_5
Q_{10}	C_4																		C_5

Please compare in pairs the relative importance among Cost criteria groups (C) and sub-criteria and satisfy the following questions (Q) according to the examples shown above. Pairwise comparison with respect to the criteria C1: weight determination for sub- Criteria in the C1.

Questions

1. How important is proposed tender price (C_{11}) when it is compared with Low project life cycle cost (C_{12})?
2. How important is proposed tender price (C_{11}) when it is compared with financial capability (C_{13})?
3. How important is proposed tender price (C_{11}) when it is compared with Additional financial resources for priority projects (C_{14})?
4. How important is Low project life cycle cost (C_{12}) when it is compared with financial capability (C_{13})?
5. How important is Low project life cycle cost (C_{12}) when it is compared with additional financial resources for priority projects (C_{12})?
6. How important is financial capability (C_{13}) when it is compared with additional financial resources for priority projects (C_{14})?

Pairwise comparison of the sub- Criteria with respect to Cost

W.R.T C1		Importance of one factor over another																	
Qs	Vcij	AI	VSAI	VSI	SVSI	SI	MSI	MI	EMI	EI	EMI	MI	MSI	SI	SVAI	VSI	VSAI	AI	VCij
Q_1	C_{11}																		C_{12}
Q_2	C_{11}																		C_{13}
Q_3	C_{11}																		C_{14}
Q_4	C_{12}																		C_{13}
Q_5	C_{12}																		C_{14}
Q_6	C_{13}																		C_{14}

Pairwise comparison of the sub - Criteria with respect to Performance: weight determination for sub- Criteria in the C2.

Questions

1. How important is past performance and expertise of the company (C_{21}) when it is compared with Number of key personnel (C_{22})?
2. How important is past performance and expertise of the company (C_{21}) when it is compared with Optimized resource utilization (C_{23})?
3. How important is past performance and expertise of the company (C_{21}) when it is compared with training and skill level of project team (C_{24})?
4. How important is number of key personnel (C_{22}) when it is compared with optimized resource utilization (C_{23})?
5. How important is number of key personnel (C_{22}) when it is compared with training and skill level of project team (C_{24})?
6. How important is optimized resource utilization (C_{23}) when it is compared with training and skill level of project team (C_{24})?

Pairwise comparison of the sub- Criteria with respect to Performance

W.R.T C2		Importance of one factor over another																	
Qs	Vcij	AI	VSAI	VSI	SVSI	SI	MSI	MI	EMI	EI	EMI	MI	MSI	SI	SVAI	VSI	VSAI	AI	VCij
Q_1	C_{21}																		C_{22}
Q_2	C_{21}																		C_{23}
Q_3	C_{21}																		C_{24}
Q_4	C_{22}																		C_{23}
Q_5	C_{22}																		C_{24}
Q_6	C_{23}																		C_{24}

Pairwise comparison with respect to the C_3: weight determination for the sub - Criteria in the C_3.

Questions

1. How important is Quality control measures (C_{31}) when it is compared with Meeting design requirement (C_{32})?
2. How important is Quality control measures (C_{31}) when it is compared with User expectations and satisfaction (C_{33})?
3. How important is Meeting design requirement (C_{32}) when it is compared with User expectations and satisfaction (C_{33})?

Pairwise comparison of the sub- criteria with respect to Quality Control

W.R.T C3		Importance of one factor over another																	
Qs	Vij	AI	VSAI	VSI	SVSI	SI	MSI	MI	EMI	EI	EMI	MI	MSI	SI	SVSI	VSI	VSAI	AI	Vij
Q1	C_{31}																		C_{32}
Q2	C_{31}																		C_{33}
Q3	C_{32}																		C_{33}

Pairwise comparison with respect to the C4: weight determination for the sub - Criteria in the C4.

1. How important is Health and safety performance (V_{41}) when it is compared with Environmental impact (V_{42})?

Pairwise comparison of the sub- Criteria with respect to Health and safety

W.R.T C4		Importance of one factor over another																	
Qs	Vij	AI	VSAI	VSI	SVSI	SI	MSI	MI	EMI	EI	EMI	MI	MSI	SI	SVSI	VSI	VSAI	AI	Vij
Q1	C_{41}																		C_{42}

Pairwise comparison with respect to the C5: weight determination for the sub - Criteria in the C5.

Questions

1. How important is type of project control and monitoring process (C_{51}) when it is compared with actual schedule achieved for similar works (C_{52})?

Pairwise comparison of the sub- Criteria with respect to Project control

W.R.T C5		Importance of one factor over another																	
Qs	Vij	AI	VSAI	VSI	SVSI	SI	MSI	MI	EMI	EI	EMI	MI	MSI	SI	SVSI	VSI	VSAI	AI	Vij
Q 1	C_{51}																		C_{52}

Appendix B.3. Questionnaire (Fuzzy TOPSIS): Case Study

Performance of Alternatives (Contractors)

The following tables is intended to be utilized to perform TOPSIS analysis. As part of this case study, seven contractors (alternatives) are supposed to be considered for analysis. The performance of all alternatives is supposed to be filled based on the criteria listed. Then after, the numbers shall be converted to triangular fuzzy numbers (a,b,c).

Designation:

1…Very High Performance

2…High Performance

3…Average

4…Low

5…Very Low

Performance of Alternatives (A1 – A7)

No	Criteria	Level of Performance A1 – A7				
		1	2	3	4	5
Legal Qualification of the Bidder						
1	Nationality					
2	Conflict of Interest					
3	Debarred by decision of the FPPA					
4	Government Owned Entity					
5	Registration in the FPPA's Suppliers List					
6	Valid business license indicating the stream of busi-					
7	VAT registration certificate					
8	Valid tax clearance certificate					
9	Business organization registration certificate					
Technical qualification of the Bidder						
1	Professional qualification					
2	General experience					
3	Specific experience					
4	Essential equipment					
5	Schedule requirement					
Financial qualification of the Bidder						
1	History of financial performance					
2	Average annual turn over					
3	Financial resources					
4	Financial offer					
Others requirement for qualification of the Bidder						
1	History of Non performing Contract					
2	Pending Litigation					
3	Health and Safety					
4	Past failures					
5	Number of projects in the hands of contractor					
6	Participating Micro and Small Enterprise (MSE) as a					