BEST VALUE PROCUREMENT EVALUATION FOR FEDERAL ROAD PROJECTS' CONTRACTOR SELECTION FROM THE ETHIOPIAN ROADS AUTHORITY PERSPECTIVE

Hanan Zeinu

A Thesis Submitted to the Department of Civil Engineering

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Civil Engineering

(Specialization in Construction Engineering and Management)

Office of Graduate studies

Adama Science and Technology University

August, 2021

Adama, Ethiopia

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DECLARATION

I hereby declare that this thesis entitled "Best Value Procurement Evaluation for Federal Road Projects' Contractor Selection from the Ethiopian Roads Authority Perspective" was composed by myself, with the guidance of my advisor and co-advisor, and that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted, in whole or in part, for any other degree or professional qualification.

Name: Hanan Zeinu Signature: _____ Date: _____, 2021

RECOMMENDATION

We, the advisors of this thesis, hereby certify that we have read the revised version of the thesis entitled "Best Value Procurement Evaluation for Federal Road Projects' Contractor Selection from the Ethiopian Roads Authority perspective" prepared under our guidance by Hanan Zeinu submitted in partial fulfillment of the requirements for the degree of Master of Science in Construction Engineering and Management. Therefore, we recommend the submission of revised version of the thesis to the department following the applicable procedures.

_____	_____	_____
Major Advisor	Signature	Date
_____	_____	_____
Co Advisor	Signature	Date

APPROVAL SHEET

We, the advisors of the thesis entitled "Best Value Procurement Evaluation for Federal Road Projects' Contractor Selection from the Ethiopian Roads Authority Perspective" by Hanan Zeinu, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Major Advisor	Signature	Date
Co-advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the final open defense by Miss Hanan Zeinu, have read and evaluated her thesis entitled "Best Value Procurement Evaluation for Federal Road Projects' Contractor Selection from the Ethiopian Road Authority Perspective" and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement of the Degree of Master of Science in Construction Engineering and Management.

Chairperson	Signature	Date
Internal Examiner	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).

Department Head	Signature	Date
School Dean	Signature	Date
Office of Postgraduate Studies, Dean	Signature	Date

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AHP	Analytic hierarchical process
BVA	Best value approach
BVP	Best value procurement
CR	Consistency ratio
CSP	Competitive sealed proposal
DB	Design bidding
DBB	Design bid build
ERA	Ethiopian road authority
ETB	Ethiopian birr
FCE	Fuzzy comprehensive evaluation
GDP	Growth domestic product
ICB	International competitive bidding
ITB	Invitation to bid
KMO	Kaiser Meyer Olkin
KPI	Key Performance Indicator
LB	Lowest bid
MCDM	Multi-criteria decision making
MEAT	Most economically advantageous tender
MUDC	Ministry of Urban Development and Construction
NCB	National competitive bidding
PIPS	Performance information procurement system
PPA	Procurement and Property Administration Agency
PS	Parameter scale
QBS	Qualifications-based selection
RFP	Request for proposal
RFQ	Request for quotation
SBD	Standard bidding document
WAM	Weighted average method

ABSTRACT

The most important decision-making process to ensure the successful completion of construction road projects due to the enormous importance to the country is selecting the best contractor to deliver a project on time, within budget, and with superior quality. As it's seen frequently, many contractors fail to meet project objectives for a variety of reasons. Due to these, one of the reason has been attributed to the current criteria for awarding contracts ineffectiveness in identifying contractors capable of meeting today's demands and challenges, thus there is a need for identifying criteria in terms of adding value to projects using a best value procurement principle. Best value procurement is a fit in procurement process in which price and other criteria are considered during evaluation of a contractor. Therefore, this study aims to develop a best value procurement evaluation using fuzzy comprehensive evaluation to consider both the multi criteria nature of best value procurement and the fuzzy nature of human perceptions during evaluation and rating of tender. About 33 selection criteria were identified from different literature and the current procurement practice of Ethiopian road authority, and rated based on their importance to add value to projects through a first round survey by experts. After extracting six parameters namely past project performance, current and future workload, compliance with specification, plant and equipment capacity, proposed project completion date and warranty of works provided, from the survey result through factor analysis, the criteria were modeled using fuzzy comprehensive evaluation by the value assigned on a second round survey through a pairwise comparison. Then based on the original best value model, a best value evaluation was developed and the developed evaluation was reviewed by using expert opinions in a semi structured face to face interview. The result of the study serves as a benchmark for the application of best value procurement in Ethiopia and as a basis for future researches.

Keywords *- Best value procurement, Fuzzy comprehensive evaluation, Contractor selection, Best value parameters, Ethiopian road authority.*

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

In many countries, the construction industry is a vital part of the economy, accounting for between 7% and 10% of a country's Gross Domestic Product. Ethiopia also has been investing heavily in infrastructure development in recent years, which accounts for up to 15% of the country's GDP. From this substantial amount, the Ethiopian Roads Authority executes a significant number of contracts each year, devoting around more than 29 billion ETB annually for the construction of federal roads (Ambaw and Telgen, 2017).

Recently due to growing complexity and time constraint in construction projects, the demand for coordination across various project activities has increased (Eriksson and Westerberg, 2009). Among these activities, in this era of globalization and increasing competitive environment, is the need for evaluating contractors' performance which is becoming more crucial. This is because the technological complexity of construction projects creates tremendous risks, and choosing a qualified contractor is one of the most critical roles of construction client or his representative must perform for a successful project completion (Wube, 2019).

According to Fekadu, (2013), procurement is a set of activities and procedures that must be followed in order to obtain critical products or services from the finest contractors at the best price (Fekadu, 2013). Accordingly, procurement entails the selection of contractors, the creation of payment terms, strategic vetting, contract selection and negotiation, and actual execution. As a result, the construction industry has undergone significant changes, resulting in a variety of project delivery systems such as lowest-bid, design-bid-build, construction management at risk, and others, which has been a prominent characteristic of the sector for the past three decades. (Goodridge and Kashiwagi, 2006).

The traditional procurement method is the most widely used procurement method in Ethiopia (Fekadu, 2013). The researcher went on to say that the traditional procurement technique has generated bad working conditions, poor wages, and a deteriorated environment in the construction industry, lowering the sustainability and quality of both products and services. Furthermore, numerous studies on the method have documented poor performance and poor

quality of contractors obtained through the traditional procurement method. These issues were primarily caused by contractors' focus on cost reduction during project execution, which resulted in poor quality and contractor claims (Mechegiaw, 2012). Consequently, professionals, scholars, and society in general have called for a change in emphasis, behavior, and procedures to improve the chances of construction projects succeeding and resulting in better end products (Belay, 2018).

In the study of Dubale, (2014) it is stated that the role contractors play in the construction industry is critical in addition to the procurement process, as the services provided are critical to the quality of the end product as well as meeting cost and time targets. As a result, hiring a qualified contractor increases the likelihood of a successful construction project completion that meets the client's objectives of balancing schedule, cost, and quality (Dubale, 2014). According to Laychluh, (2012), a good contractor, is expected to complete a project on time, within budget, and to the desired level of quality because the quality of a product is largely determined by the skills, experience, and competence of the producing agents (Mechegiaw, 2012).

In today's construction environment, public authorities are under growing pressure to enhance project performance, expedite project completion, and lower the cost of operating in the construction programs (Letarge and Macarubbo, 2016). Because of the limitations of the award technique of the "lowest price" in the recent literature, there has been a shift away from this method and toward awarding using multi-criteria decision methods (MCDM). As a result, a creative procurement strategy, such as best value procurement, is necessary to reduce the risk of non-performance and create a win-win situation for both the client and the contractors, while boosting transparency and adding value to the project.

Best value procurement is a performance information-based procurement approach (PIPS) that forecasts contractor performance based on historical data and proposals. Contractors are ranked and then chosen based on past performance, present capability, pricing, risk management, key personnel quality, and other evaluation factors that vary according on the organization's goal and definition of value. In the selection process, best value procurement is described as a strategy that focuses on getting the highest value by evaluating both cost and qualifications-based criteria (Savicky et al., 2014). In the public sector, best value is

sometimes referred to as a sort of competitive sealed proposal procedure (Nguyen et al., 2018). This study aims to develop a best value procurement evaluation using fuzzy comprehensive evaluation to consider both the multi criteria nature of best value procurement and the fuzzy nature of human perceptions during evaluation and rating of tender. The results of this study is believed to help create the understanding of the concepts of best value procurement approach and make use of it as a valuable contractor selection option for federal road projects contractor selection.

1.2 Statement of the Problem

The Ethiopian main road network comprises a very large national asset that requires careful development planning, project implementation and maintenance to provide the high level of service that is demanded by the road users and communities. For many decades, the time delays and cost overruns on road construction projects have been a key issue for the government, contractors and ERA in Ethiopia. This is because of the industry's significant role on the development of the economic and social sector of the country and the government allocates great deal of money every year in the road sector development (Ambaw, 2017).

According to Elsayah, (2016) the success of any construction project is considered a complementary procedure. When any participating body is wrongly chosen, it influences the achievement of the completion project. The selected contractor selection method influences the project success in many ways like stakeholder integration, cost of the project, quality and time of project completion. Without a proper and accurate method for selecting the most appropriate contractor, the performance of the project is affected (Abdelrahman, 2008); therefore, the selection of the most appropriate contractor in procurement is mandatory by the client to achieve project goal and objective.

Both Mechegiaw, (2012) and Belay, (2018) argued that most of the construction projects in Ethiopia suffer in terms of time and cost due to the clients' contractor selection mechanisms and procurement which doesn't ensure the best contractor is selected in terms of adding value to the project (Belay, 2018; Mechegiaw, 2012).

Therefore, there's a gap in the procurement process of the current low bid method and the set criteria to ensure the best value has been procured. To ensure successful completion of road

projects and to avoid project failure due to contractor inability to undertake or complete the project work successfully, contractor selection methods and criteria set forward need to be tailor-made to enhance the different project and organization objectives and add value to projects while considering the uncertainty or fuzziness inherent in human perception during evaluation. As a result, it is vital to choose contractor selection criteria for road projects depending upon preset requirement and organization objectives in terms of adding value to projects in a fuzzy based system.

1.3 Objectives of the Research

1.3.1 General Objective

The main objective of the research is to develop best value procurement decision support evaluation model for contractor selection in Ethiopian Road Authority under fuzzy environment.

1.3.2 Specific Objectives

- ✓ To investigate best value procurement related practices in the current procurement practice of Ethiopian Road Authority.
- ✓ To identify best value parameters that impact contractor selection in terms of adding value to projects.
- ✓ To develop a fuzzy based best value procurement evaluation model to select appropriate contractor in Ethiopian Road Authority.

1.4 Research Questions

The research is focused on the questions to find an answer to the knowledge gap, based on these, the following research questions were formulated;

- ✓ What is the current state of best value procurement related practices in road projects procurement in ERA?
- ✓ What are the best value contractor selection parameters for Ethiopian federal road projects' contractor selection in terms of adding value to projects?

1.5 Scope and Limitation of the Study

1.5.1 Scope of the study

This study investigated the current best value procurement related practices in Ethiopian road authority and concentrates on the development of best value procurement model based on primary parameters that impact contractor selection in terms of adding value to projects as stated in the objectives. Due to best value procurement's success on highly budgeted and valued projects, the research scope is delimited to the development of best value procurement model for federal road project's contractor selection under ERA considering their high value and economical advantage.

1.5.2 Limitation of the Study

The primary limitation of this research was the use of questionnaire survey as source of primary data. In addition, further counteractive recommendations and model was proposed based on response to the outcome of the survey, literature review and interview for the most critical factors and validated by a few experts due to the lack of best value procured projects to use as a case study which would have been a more reliable source. Additionally, lack of available local literature about best value procurement was the basic limitation that precludes the researcher from further in-depth researching on the topic.

1.6 Significance of the Study

The outcome of this study is believed to have a wide range significance including for contractors, consultants, owners in this case and for future researchers. The research will help in its result of best value procurement model, to improve the short comings of the low responsive bid awarding systems by concentrating on both cost and value adding contributions of the contractor. The significant of the study also stretches to decreasing the claim raised between the parties both client and contractor, in terms of cost overruns, time, quality of works, health and safety and environmental and other issues since the outcome of the study which is best value procurement evaluation facilitates the selection of contractors tailored to the project specification. The research is believed, as an initial study on best value procurement method for Ethiopian road projects, to lay a foundation for more detailed analysis of the subject for future researchers in the road construction sector as well as the whole of construction industry.

1.7 Structure of the Study

The structure of the thesis is divided into the following five sections as follows:

Chapter one - Introduction: This part consists of the introduction of the research and is devoted to giving a general review and introduction to the study. This chapter includes the background of the study and statement of the problem by which the research is based on. The significance, the objective of the research as well as the research question intended to be answered by the end of the research are discussed. Following that, the scope and limitations of the research and structure of the research are illustrated.

Chapter two - Literature Review: The literature review section of the research containing previous researches and information by different researchers, authors and guidelines and official documents. This chapter starts by giving general information in regards to the general procurement overview, the general process of bid, contractor selection process, approaches. In addition, this chapter is aimed at establishing a better understanding of subjects related to the best value procurement in road projects for evaluation and selection of contractors for road projects.

Chapter three - Research Methodology: This chapter focuses on the research methodology, presents and discusses the research design, study population, source of data, research instrument, method of data collection and data analysis. The chapter also briefly presents the model specification, the proposed methods to be used and helps to establish a framework for the fuzzy based contractor selection model.

Chapter four - Result and Discussion: This chapter named results and discussion section of the research and is considered as the main chapter in the research. It is devoted to providing the findings of the analysis of the research followed by the proposed model for best value contractor selection procedure in road projects in Ethiopia.

Chapter five - Conclusions and Recommendations: The last section is the conclusion and recommendation section of the research and it is the final chapter of the research. It explains the conclusions and the findings from the research work. Then the chapter identifies the areas of weakness where future research is recommended.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

A literature review is the collection of background information of a research study, which aims to consolidate all previous studies related to the research topic and to form understanding of the current practice and a comprehensive literature review helps researchers to identify research problems or gaps through critical thinking, while reading existing works (Kothari, 2004). This chapter provides a comprehensive literature review to identify research gaps in Ethiopian federal road project contractor selection regarding best value procurement and to gain clear understanding of the current best value procurement contractor selection procedures.

2.2 General Procurement Overview

The process through which governments and other publicly funded institutions acquire commodities, works, and services required to carry out public initiatives is known as public procurement. The subject has received attention because of the fact that it accounts for at least 15% of the world's GDP, and even more in African countries. Public procurement is an essential role of governments in both rich and developing countries, as large financial outflows have a significant impact on their economies, necessitating realistic control (Fekadu, 2013).

Over the last three decades, the change of procurement has accelerated as governments at all levels have been under growing pressure to achieve more project goals with fewer resources. Certainly, public procurement experts have worked in a continually changing environment characterized by quickly emerging technologies, expanding product options, environmental concerns, and the intricacies of international and regional trading agreements. Furthermore, policymakers are increasingly utilizing public procurement as a tool to attain socioeconomic objectives (Wolde, 2019).

The procurement process is one of the most critical aspects of project delivery in construction. It is critical to understand that the procurement phase entails much more than simply selecting a contractor for the project. It is a critical phase in the overall development of the project that implements a collaborative approach between the owner and the contractor to develop the

project's construction in a way that both maximizes the project goals and provides the most cost-efficient technique to achieve those goals (Tewodros, 2019). Thus prudent handling of public procurement functions is fundamental to achieving economic, socio-political and other government objectives.

In Ethiopia the major purchaser of public works is the federal government and the most common procurement method is the competitive low-bid procedure in which contracts are awarded to a responsive contractor who offers the least price. The procurement process on public sectors is regulated by Ethiopian Federal Government Procurement and Property Administration Proclamation by the power vested in proclamation no. 649/2009. The two principal legal instruments to deal with the Federal Governments public procurement are the Public Procurement Proclamation (2009) and Public Procurement directives (2010).

2.3 Contractor Selection Approaches

Contractor selection is one of the critical tasks for project owners or representatives of clients dealing with the early stages of a project. Given the importance, this topic has been broadly discussed in different literatures. Procurement strategy and contractor selection approaches consists of policies and procedures which govern the selection of a satisfactory contractor to support a preferred project delivery method (Lombasso, 2017). Conventional procurement strategies are mostly based around the concept of time, cost and quality. Such criteria are inevitable and are the basic attributes for selecting a contractor. Other factors have been considered with the complexity associated with client needs and priorities, the contradictory nature of the performance and lack of agreement to measure these criteria when assessing contractor performance (Tewodros, 2019).

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, when the bidder is found to be responsive. In pure negotiated method the price is negotiated with a selected contractor. To minimize the shortcomings of these two extreme types, modifications have been proposed and tried in many countries (Wolde, 2019).

Bedford, (2009) argues that the recent trend is shifting away from the lowest price policy. Undoubtedly, the bid price is still an important factor in contractor selection, however there are other important factors that are merit in consideration (Ayettey and Danso, 2018; Bedford, 2009). Government agencies also believe that the lowest bid, even under competitive bidding, may not result in the best value for money or the best performance during construction (Abdelrahman et al., 2008).

Bruno, (2018) further explained that the majority of contractor selection methods exhibit constraints and rely overly on acceptance of lowest bid. For some public sector clients, the lowest bid selection is a legislative requirement. Otherwise, public sector clients are facing more difficulties while selecting a bidder other than the lowest. In general, it is considered to be a low-bid selection if the cost criteria represent more than 90% of the evaluation criteria (Skitmore, 2002).

Khisa, (2015) identified three main procurement strategies that govern contractor selection from different literatures as price based procurement (Low-Bid), qualification-based procurement (Best Qualifications), and value-based procurement (Best-Value). Whereas Molenaar et al., (2010) identified 'sole-source procurement' as the fourth procurement strategy; however, this has been categorized in many literatures along with 'Best Qualifications' procurement strategy because selection is based on qualification only.

2.3.1 Sole Source Contractor Selection

This type of procurement method involves the direct selection of the contractor without proposals. The lack of price competitiveness factor discourages public owners from selecting contractors using this procurement method (Damte, 2018). However, the sole source selection potentially allows a shorter procurement time and thus, may be used during emergency conditions to ensure a faster project delivery.

Lombasso, (2017) further defines single source procurement as a method that involves procurement from a supplier without any competition. It is used for procurement of sole or single sourced requirements. This method is only used when the work, good or service to be procured is deemed very urgent or can only be provided by a single source (Lombasso, 2017). Sole-source selection can be a direct selection of the contractor based on established

relationships through previous projects. Private sector clients especially, who have established long-term relationships with contractors, use sole-source or direct selection. Public sector clients may also employ sole-source selection when there are no other potential bidders or in an emergency, which allows the waiver of strict procurement rules (Carboni et al., 2017).

2.3.2 Qualifications Based Contractor Selection

In best qualification-based selection, the owner selects the contractor through a request for qualification for the project and negotiates directly with the contractor who has the most qualifications at a reasonable price. Selection of the contractor is primarily based on qualitative criteria, which include past performance, reputation, technical competence, and financial stability. The owner ranks the contractors and begins negotiations with the number one ranked contractor to reach a 'fair and reasonable' price for the services required (Alleman et al., 2017).

Gransberg and Senadheera, (2005) indicated that the administrative burden can be considerably eased when owners select the contractor based on qualification. A procurement strategy is to be considered as the qualification based selection when the non-price criteria represent more than 50% or more of the evaluation. Drawbacks in qualification-based selection processes include high subjectivity on selection, reduced competition, and favorability towards non-minorities. This is less socially sustainable, because contractors who are new to the market would find it difficult to be sustained in the market merely because they have no experience or lack of relationships with clients (Eriksson and Westerberg, 2009).

2.3.3 Best Value Contractor Selection

In a best value approach, the contractors respond to the owner by submitting proposals that are primarily evaluated based on the technical aspects together with the associated cost of the project. Negotiations may take place after the proposal submittal phase. The owner selects the proposal that offers the best value (Nguyen et al., 2018).

According to Hilger, (2009), best value procurement is not a delivery method, because it has proven to be effective with both design-bid-build and design-build projects. Rather, best value procurement is a means of sourcing a supplier of a project. Though the use of the practice varies among different organizations, the reason for using best value is fairly consistent to

match the best qualified contractor to the project, thereby reducing the owner's risk and increasing the value received (Hilger, 2009).

A common definition can be suggested as follows for a best value as a method of procurement that matches project requirements, as defined by the construction documents, with a contractor that is best able to complete the project, factoring in contractor qualifications, experience, technical competency, construction planning, and cost, using a formulaic scoring methodology, or more simply: the best qualified contractor for the price considered most fair (Goodridge et al., 2012; Kashiwagi, 2010). A weighting criteria evaluation method is usually used to identify the right contractor and the weights assigned to each of the factors are specific of the owners' organization, in addition to the type and size of the project. The best value selection is advantageous because it also allows owners to prequalify the contractors based on technical criteria before the final selection phase, which is based on the price competitiveness (Kashiwagi and Adeyemi, 2014).

2.3.4 Fixed Budget/Best Design Contractor Selection

The owner specifies the project budget during the RFP process. The contractor competes by placing as much scope as they can in the submitted proposals. Using this approach, the contractors are selected based on qualitative and technical aspects, taking into consideration that the project cost is fixed for all competing teams. This procurement method is considered to be competitive regarding scope and quality rather than project cost. It allows the owner to have the optimum for the specified budget value. The fixed price approach, takes into consideration only the price as the sole criterion for selection (Mechegiaw, 2012). Accordingly, the lowest bidder is awarded the contract in an approach very similar to the traditional general contractor selection procedure.

2.3.5 Competitive Low-Bid Contractor Selection

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. Competitive bidding believes to give everyone an equal chance to bid, eliminates collusion, and saves tax-payer's 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 (Letarge, 2016).

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 bidder who submits the lowest bid that meets the specifications must be awarded the contract. As stated earlier, this method of competitive bidding is the standard method for awarding federal owned construction contracts in Ethiopia (Mechegiaw, 2012).

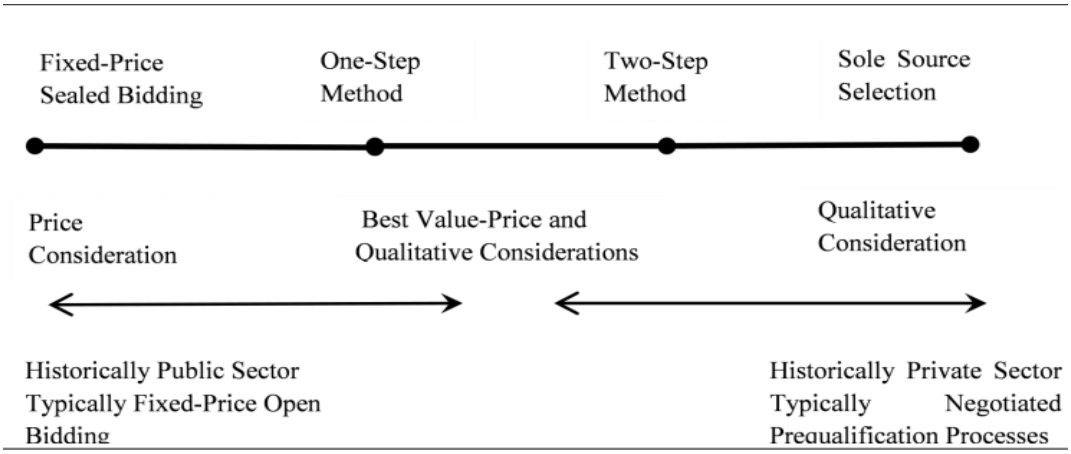

Figure 2-1 Comparison of contractor selection approaches (Khisa, 2015)

2.4Best Value Procurement

2.4.1 The Concept of Best-Value Procurement

The value of procured goods or services may be simply described as a comparison of costs and benefits. Comparing all the benefits from what you get and how to use it, against the costs to purchase, use, and perhaps dispose of it. The foundation of best value is based on the concept of using multiple criteria, contractor competition increases and transparency increases thereby making it more difficult for contractors to mislead clients in their proposals. In the assessment of costs and benefits, it is important to identify comparative costs of different alternatives for meeting the same need, function or program purpose, as well as the costs of doing nothing at all (Boateng, 2014).

Best value is a dynamic approach that optimizes wasteful communication. Expert vendors are recognized not only by their profession, education, trade or length of experience, but also by their ability to identify and cater to the client's requirements. To enrich the long term performance and value of construction, there are various factors like past experience, physical

and human resources, that need to be considered in procurement process including price, performance and quality (Gaaff, 2015).

This innovative concept originated form the idea of multiple criteria; competition among contractors increases because one contractor offers to deliver good quality product than the others. Undeniably, quality grounds are not the same for each contractor. Therefore, it is preferable for the procurement party to have a better quality project at mutually agreed price. Since all quality standards cannot be implemented on a project at the lowest cost, it is thoughtful to use a cost–time tradeoff approach (Storteboom et al., 2017). Further, satisfaction is also an important qualitative project deliverable which, when it is not met, reduces the quantitative success to a mere paperwork.

Best value selection is more of a formal discussion which takes place on both qualitative and quantitative factors in combination. A two-step selection approach consists of an evaluation of technical aspects and then price. This represents the best value approach and the weights given to each of the technical and financial criteria differs from one organization to the other. It is worth that management aspects, an organization's financial standing, in addition to previous contractor experience are also considered in a best value procurement approach (Adeyemi and Kashiwagi, 2014).

Santema and Rijit, (2012), further defines best value procurement as a procurement method which focuses on gaining the best value for the lowest costs (Rijt and Santema, 2012). It is a successful approach that minimizes the detailed wasteful communication and information, and creates a "win-win" scenario for both the client and contractor, the highest possible value at a lowest cost, high vendor profit, and minimal project cost and time deviations (Hasnain and Thaheem, 2016). It examines various factors that need to be considered in procurement processes to enrich the long-term performance and significance of the construction (Elyamany and Abdelrahman, 2010).

More importantly, best value procurements force the early development of detailed project and procurement plans and create solicitations containing accurate source selection criteria. This combination of early planning and quality-based contracting yields significant benefits in construction timeliness, cost containment, and customer satisfaction (Bruno et al., 2018). In

the multi criteria method, the contractor who can maximize the client's investments wins the tender. There is greater recognition and an increasing acceptance of factors other than price as key determinants of the contractor selection process in obtaining best-value (Hillen and Santema, 2013). Best value procurement consists of four primary concepts evaluation criteria in which contractors' attributed are evaluated against, rating systems in which the contracting authority uses to rate the bids submitted, and award algorithms for which the contractor attributes are weighted and computed to identify the highest scoring as stated in the Fig 2-2 (Molenaar and Gransberg, 2016).

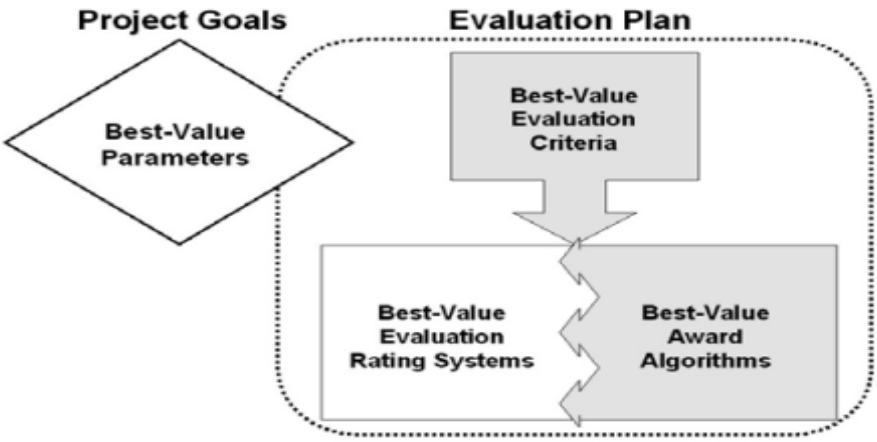

Figure 2-2 Best value procurement general parameters (Molenaar & Gransberg, 2016)

Hillen and Santema (2013) revealed that the best value selection is the most flexible procurement strategy that allows evaluation of project specific factors such as project size, complexity, design and technical requirements. As such, best value procurement emphasizes quality, efficiency/effectiveness, value for money, and performance standard (Hillen and Santema, 2013). As described extensively, the best-value procurement is more advantageous to the client than traditional price-dominated low-bid procurement (Nguyen et al., 2018).

Abdelrahman et al., (2008) indicated in the study of different cases in which best value has been applied, that the low-bid selection fails to offer the lowest overall cost; however best-value offers a reduction in cost growth from 5.7 to 2.5% and in claims and litigation by 86%, which are important to project owners. The findings emphasized that the best value selection achieves overall best performance for projects with high complexity with the least cost growth

and schedule growth. Moreover, best-value selection contributes many values such as innovative designs, additional facilities, better aesthetic value, cost and time savings, better quality control, lower life-cycle costs and reduced risks. This is further evidenced in the report of Molenaar and Gransberg (2016), that the largest proportion of public projects were acquired through best-value procurement to achieve value for money which incorporating the best value parameters which are the primary parameter of evaluation criteria, award algorithms and bid rating system (Molenaar and Gransberg, 2016).

2.4.2 Best Value Contracting Strategy

First of all, it should be mentioned that best value approach is not a procurement procedure in itself rather is fit within the standard procurement procedures (Santema et al., 2011). Therefore, it is generally used in combination with the open procedure. However, in line with the proportionality principle, in order to prevent that too many contractors participate in the tender, it may be wise to use a prequalification procedure (Veenen, 2018). Shortlisting the amount of candidates is possible, but the suitability requirements and selection criteria should be proportional to prevent that the expert is excluded too early (Thaheem and Dawood, 2019).

The BV contract strategy is implemented in various phases. It consists of a pre-qualification or preparation phase, competitive selection phase, a clarification phase and finally the execution phase (Hasnain et al., 2018). The selection phase is where the client identifies an expert contractor with the highest level of expertise for the lowest cost (Smithwick et al., 2013). The criteria to determine expertise differ from organization to organization based on the goal and objectives. Comprehensive comparison of values and prices is done in competitive selection phase and since this process caters most of the factors mutually, BV is always the 'best value proposed for the lowest price' and it is relative (Alleman et al., 2017).

The clarification phase consists of three parts, a kick-off meeting, a clarification part and a contract award meeting. The clarification phase is as described by Hillen and Santema (2013) the most important phase of BVP, and the purpose is to clarify what the contractor deliver and how to deliver it. An essential part is therefore to clarify what is in and outside the scope, as well as outlying technical solutions (Perrenoud et al., 2017). The general goal is to clarify whether the offer is acceptable for the client, clarify expectations, identify key performance indicators (KPIs), and finally sign an agreed contract for the project (Rijt and Santema, 2012).

Important elements in this phase are the risk management plan, scope document, elaboration of potential critical sub-contractors, KPIs, letter of intent, contract award meeting, involving the contractor in framing of contract, distribution of risk responsibility and risk contingency fund (Storteboom et al., 2017).

The Execution phase is where the project is realized. The overall goal for this phase is to deliver the service or the deliverable, but also to enhance transparency, communicate information quickly, assign accountability and create a supply chain approach in the project organization (Scott, 2006). This is done by implementing weekly risk reports and performance measurements using KPIs throughout the execution phase. During this phase, the contractor is also responsible for performing quality control and risk management (Wondimu and Lædre, 2018). The general phases of best value procurement is summarized in the following Fig 2-3;

Figure 2-3 Phases in best value contracting strategy (Hasnain et al., 2018)

In short after identifying BV contractor, it is ascertained that the action plan in clarification phase to justify their capability, performance and expertise. The detailed proposal is then put into contract along with the contractor's quoted price. The contract is finally signed binding the contractor to deliver the project in the execution phase (Elyamany, 2014).

Best value contracting ties all these initiatives together through quality-based contracting which requires early commitment of time, personnel, and resources to succeed. By determining priorities and identifying key features, this up-front strategy results in significant savings in total project cost, minimizes delays, and increases customer satisfaction. Clients help select contractors most responsive to their needs, construction managers participate in the selection of quality contractors, and the government gets the best value for every expended resources (Collin et al., 2006). The best value procurement starts with the need of the contracting authority, but in this system is called the "deliverable". The deliverable is

described in terms of project goals and requirements. In short, the requirements determine the minimum that should be achieved, and the project goals express the additional ambition that the contracting authority wants to reach. The aim is that the contracting authority specifies what the deliverable is, and that it is up to the contractor how the deliverable is achieved (Thaheem and Dawood, 2019).

The project goals function as the foundation of the assessment framework in the tender phase. The project goals should be formulated in a specific, measurable, achievable, realistic, and time-related way and on a high abstraction level and, preferably, match with the organizational ambitions of the contracting authority (Shane et al., 2006). The philosophy of the BVA is that the project goals should be on an abstract level, because this leaves room for contractors to make an offer that distinguishes themselves from others. When the project goals are formulated more precisely, it becomes a requirement and no room for distinction is left, because everyone needs to fulfill that requirement. However, only formulating abstract project goals is not allowed. The description of the deliverable should still relate to the object of the contract. So, at least some requirements or functions of the object should be prescribed by the contracting authority (Gaaff, 2015).

Another part of the deliverable is the project requirements and specifications. The contracting authority defines contract specifications in order to create a minimum level to which the work has to be performed and to stimulate contractors to design something that performs above this minimum (Veenen, 2018). According to the BVP philosophy, it is recommended to specify as little as possible, as it gives the contractor more freedom to make use of its expertise, knowledge and inventiveness. However, just like the project goals, the specifications should still be sufficiently determinable and relate to the object of the contract (Lines and Kakarapalli, 2018). The contractors draft their plan related to the aforementioned sub-award criteria. The important difference in the best value procurement is that contractors can only submit 2 A4's per sub-award criterion, which is very limited. Therefore, it is not possible to submit a fully detailed design, only the most important aspects, underpinned with dominant information and metrics have to be presented. Contractors should be able to explain clearly and briefly that about being the expert (Veenen, 2018).

Best value procurement process involves assigning a score for each contractor with consideration to price and quality. Usually such evaluations are performed separately and the best value algorithms combine each score to find the best value to the owner (Savicky et al., 2014). Molenaar et al., (2010) indicated that the project owners rate contractor ability to meet project objectives that are defined by the best-value parameters. The final score for each document will be determined after a discussion of all members of the assessment team and in consensus one final score is given for each document. After the assessment of the documents, the candidates are invited for the interview round (Ahmed, 2011).

The next step in BVP includes interview of key personnel about the offer. However, in contradiction to previous documents, the assessment is rather subjective. In order to honor the procurement principles, it should be stated clearly in advance how the assessment is done to make it as objectively as possible. Lastly, after the interviews, the envelopes with the submitted price are opened and weighted against the scores of the quality document. Then, the contractor with the best price quality ratio becomes the preliminary winner (Wondimu and Lædre, 2018).

In the process the preliminary winner is asked to enter in another phase before the contract is officially awarded which is as discussed before a clarification phase. The clarification phase is essentially different compared to the standard procurement process, but it can be fit in an open or restricted procedure. In the clarification phase the preliminary winner is asked to further develop his offer in detail. The contractor needs to prove that the submitted dominant information is correct (verification) and also how he will monitor and measure the performance of the intended solution during execution. The performance can be captured in measurable key performance indicators (KPI's) that relate to the project goals (Elyamany, 2014).

The contractor drafts these KPI's because, according to the BVA philosophy, the contractor is the expert and knows best how to measure the performances. In the clarification phase the contractor establishes a detailed planning for the project and the risks, including mitigation measures are further developed. The contracting authority decides which of the added value options are honored for the project. When value added options are chosen, the contractor

includes the options in the solution. It is not allowed for the contracting authority to make use of value added options of a contractor that did not win the tender (Elyamany, 2014).

Selecting value added options is only allowed when there is a possibility to change included in the tender documents and the contracting authority has to mention the size and type of the option, the conditions under which the option can be used, and that the object of the contract does not change. The clarification phase is still part of the tender procedure and therefore the procurement principles of equality, non-discrimination, transparency and proportionality still apply. Also the expert contractor can be eliminated from the process when it becomes evident that it does not fulfill all the requirements, even though in best value procurement, the contractor gets room to make use of its expertise, it is still needed to comply with the requirements of the contracting authority in the first place and the next is when one exceeds the price ceiling since the clarification phase is not about negotiating new contract terms and therefore the proposed solution should not become more expensive than the price ceiling (Ahmed, 2011).

Within the clarification phase the process of the project is monitored through a weekly risk reports until the realization of the object of the contract. This helps in keeping the relation between contracting authority and the contractor transparent and helps in solving contractual disputes related to risks. During execution the progress related to the project goals is measured with respect to the drafted KPIs. The impact of the events during each weekly period have to be determined in terms of money, time and performance (Veenen, 2018).

2.4.3 Best Value Procurement Parameters

Contractor selection criteria should be capable of identifying optimum choice in respect of the objectives and suitable for the multi-criteria/multi-alternative nature of contractor selection. Abdelrahman et al., (2008) highlighted that the right choice of the evaluation factors and their relevant weights is the core of successful best value procurement. A set of criteria and procedures breaks down BV into logical and easily quantifiable constituent variables that must be tackled before choosing the best contractor (Hasnain and Thaheem, 2016).

Selection strategy, selection criteria, model type, parameter weights, and other technical factors differed significantly depending on the organization's requirements, ability, expertise,

and importance, according to the literature. Most literatures emphasize that the selection of criteria should be done without any bias. Therefore, owners must consider what is 'valuable', not just 'important' or 'required', in the selection process (Abdelrahman et al., 2008). Cost, time, qualifications, quality, technical, environmental aspects, maintenance and operability, and managerial safety are potential parameters of best-value procurement (Hillen and Santema, 2013).

Abdelrahman et al., (2008) indicated that cost, time, qualification performance, quality, and design alternatives are the primary criteria. Abdelrahman et al., (2008) and Smithwick et al., (2013) both highlighted that the factors other than price can be typically placed under key groups of technical and managerial merit, financial health, and past performance. Abdelrahman et al., (2008) specifically indicated that by inclusion of key factors that can address the specific needs of a project, increases the possibility of selecting the best contractor.

Adeyemi and Kashiwagi, (2014) identified in their study that the best value criteria for tender evaluation of prequalified contractors as bid price, and other criteria that include quality assurance, existing workload, experience on projects, experience of working with the owner, financial stability, organizational reference, and responsible attitude towards the work. These criteria contribute in different degrees to the project success factors which include cost, time, and quality (Kashiwagi and Adeyemi, 2014).

Watt et al., (2010) explained that no individual criteria or group of criteria are constantly being considered as more important than others and are often varied according to the purchasing situations. As discussed above various criteria in various literatures have been proposed. Nevertheless, to facilitate the contractor selection process, the number of criteria should be kept as low as consistent with making a well-founded decision; the more typical arrangement is from six to twenty (Alleman et al., 2017). Given the large number of criteria that exist in literatures, it is helpful to identify them into a series of themes that relate to separate and distinguishable components of the overall objectives for the decision as follows.

2.4.3.1 Cost parameters

Cost is one of the most significant criteria for measuring project success. It is defined as the basis at which general conditions of contract stimulate the project completion (Buba et al., 2020). It cannot be suggested that cost comprises only the tender sum but it also covers the expenses utilized in various stages of project leading from inception, designing, and execution to maintenance. In acquisition, price plays a vital role where the requirements are well defined and risks are negligible (Skitmore, 2002).

Historically, cost is the most important factor considered by clients. On the contrary, where requirements are not well defined, non-price criteria may dominate. Therefore, best value source selection motivates financial creativity and improvement from contractors who intend to fulfill project requirements, and augments the flexibility in selecting best proposal (Lines & Kakarapalli, 2018). This enables the client to make comparison between different tenders and cost plans, and assess where the value lies. It is used to identify the areas of savings that might be negotiated with bidders while still in competition. It offers an insight into the value proposition of different proposals (Scott, 2006). Cost parameter on most literatures consists proposed tender price and low project life cycle cost (Abdelrahman et al., 2008; Hatush & Skitmore, 1997).

2.4.3.2 Financial parameters

The financial analysis of a contractor's accounts involves assessing past, present and expected future financial position so that any risks which they may bring to the project can be highlighted early on. In the pre-qualification and bid evaluation stages the main objective of using financial parameters is to determine the applicants with the financial capability of developing and delivering the project to the client's requirements (Price, 2007). It involves scrutiny of their accounts to determine profitability, solvency, liquidity, asset strength, and payment history. The financial stability of a contractor refers to their financial position and ability to effectively manage their finances and continue to meet contractual obligations without the need for assistance. Construction companies are severely affected by outer influences such as inflation and interest during a boom time and a reduction in construction activity during a recession (Ahmed, 2011).

2.4.3.3 Time parameters

There are two prime factors for owners to consider regarding this time parameter in most literatures. First, when using time as a filter to qualify contractors, one needs to determine whether the schedule is to be stipulated or negotiated. Including time in the best-value model allows the contractor to establish a schedule that compliments the construction plan. In this case, both lane rental and traffic control systems permit the owner to communicate the need to minimize a project's impact on the traveling public during construction. These parameters create an incentive toward innovative management of congestion in work zones reducing detour time by rewarding proposals that minimize construction impacts on traffic (Nguyen et al., 2018).

The second factor for owners to consider is the overall project duration, which includes the time commitment from the owner to get the project to the point of issuing a request for qualification. When contractors have the necessary experience, it can often keep the schedule reasonably well under control. However, it is frequently the owner that has not adequately planned for the impacts of construction in the form of disruption to its work (Hasnain et al., 2018).

2.4.3.4 Performance & Qualifications parameters

Qualification parameters allow the owner to obtain some of the benefits from the historically accepted practice of qualifications-based selection (QBS) which consists of the following parameters namely prequalification, past project performance, personnel experience, sub-contractor's information and project management plans and so on. Past performance of contractor is evaluated prior to its selection. In this process, various attributes such as human resource, machinery and equipment, skill level of project team, optimized resource utilization, and number of key personnel are evaluated. In order to improve the overall performance of contractors, they must focus to complete the project in stipulated time, reduce delays, and establish good relationships with sub-contractors (Storteboom et al., 2017).

Contractor enactment plays a dynamic role in project success since contractor is duty-bound for successful project delivery. Better contractor performance definitely enhances user satisfaction, contractor repute, and its effectiveness in market. Therefore, during selection,

those contractors who have excellent past performance record should be given preference in contract award (Adeyemi and Kashiwagi, 2014). The contractors who are able to finish the project by deadline are more viable to bring out future projects. Therefore, during selection, contractors who have excellent past performance record should be given preference (Veenen, 2018).

2.4.3.5 Quality parameters

The assessment of quality in the construction industry is subjective. In the construction industry, quality is defined as the totality of features required by the products or services to satisfy a given need; fitness for purpose. This need, which is provided by the client, is achieved with the help of specifications defined as workmanship guidelines. Specification is defined as workmanship guidelines provided to contractors by client at commencement of project execution (Kolli, 2015). Clients expect the contractors to deliver highest quality in every dimension. Therefore, they must prefer contractors who follow standards. The value proposition due to quality is very strong and must be considered in decision making. Contractors achieve client satisfaction by establishing strong quality culture and delivering higher quality services and facilities (Kakarapalli, 2018). Therefore, it is of importance to owners to encourage the contractors who follow high quality standards (Smithwick et al., 2013).

The ability to review a contractor's quality management plan before the contract is awarded is a primary advantage of quality parameters. Doing so has the potential to change the whole dynamic of quality management from an adversarial, compliance-based system to a competitive, award-to-the-best-plan system. Coupled with some form of warranty or performance-based acceptance indicator, these parameters create a system aimed toward delivering quality (Buba et al., 2020).

2.4.3.6 Design Alternate parameters

Design criteria are components of many best-value procurements, particularly when highway agencies are soliciting bid alternates under design-bid-build or design-build delivery methods. Design alternative in the road construction projects experiments with alternate bids for

specific materials, construction items, or pavement types with some success, and evaluated the value received in terms of lifecycle cost (Alleman et al., 2017; Khisa, 2015).

2.4.3.7 Health and Safety parameters

Health and safety is defined as the extent to which general conditions are implemented on project without injuries and accidents. Since most of the accidents happen during the execution phase, safety is primarily focused during this time. In rapid environment, general reminders to implement safety are very important to avoid fatalities (Salama et al., 2006). It is usually mentioned in contract document that contractor is responsible for providing personal protective equipment.

Additionally, warning signs must be displayed to develop a safe and healthy environment at workplace. These warning signs keep the workers attentive to follow safety rules, enable them to communicate the hazards, provide them the necessary instructions about using personal protective equipment (Lombasso, 2017). BV procurement advocates that contractor is authorized to develop strategies to control environmental hazards on site and surroundings. The possible value addition due to better health and safety management is expected to go a long way with safety boards, regulatory authorities, and environmental protection agencies (Kashiwagi, 2011).

2.4.3.8 Project Control parameters

Project monitoring and controlling process should be initiated from planning phase which involves appropriate breakdown into smaller components, using performance metrics and analytical tools, earned value management and performance forecasting. The procedure of evaluating project cost and performance has been significantly analyzed. In order to quantify the progress based on work breakdown structure and cost accounts, several models have been developed (Wondimu and Lædre, 2018).

However, researchers still need catching up for achieving lowest possible level of scope breakdown to evaluate the progress without messing with data handling. The contractor is obligatory to ensure proper monitoring and controlling procedures on site so that cost and schedule variances could be identified from the management plan. This ensures tracking of

such variations and as a result enables timely measures to attain project objectives (Alleman et al., 2017).

2.4.3.9 Productivity parameters

In the construction process, delay claims are considered to be an area of uncertainty and severance. The cost of disruptions is production related and often problematic to justify. Several issues may arise such as how to alleviate the risks relating estimation, resource utilization, poor workmanship, plant breakdown, deprived quality or impaired material (Goodridge and Kashiwagi, 2006). In case of potentially problematic aspects of delay claims in a construction project, a study reveals that various aspects like pre-contract negotiation, clarity in project scope, and agreement between contractor, owner and project team are likely to lessen the conflict among parties and increase the certainty in achieving project success (Wondimu, 2019).

The other productivity parameter, current workload refers to the number and size of projects that a company is carrying out at the moment. It gives the information that whether the resources will be available for a particular project depending upon the workload during construction (Destaye, 2019). A company having undertaken few projects at one point in time, then they would have ample capacity of resources to incorporate on multiple projects. In case the company has undertaken many projects then the resources will be distributed, hence a limited capacity will be available for the projects (Fekadu, 2013; Scott, 2006)

2.4.4 Best Value Evaluation

The best-value system requires the selected criteria to be evaluated during an evaluation. It is recommended that the owner assemble an evaluation committee to select the contractor that offers the best value to a specific project in a fair and transparent manner. In an effort to lower the probability of a protested bid, the owner should incorporate a committee comprised of various viewpoints, expertise, and background. A chairperson, preferably with best value experience, should run the committee. Prior to reviewing any submissions, the evaluation committee should be educated on the project, the owner's requirements and the established selection criteria with weight of items (Fekadu, 2013).

The most used evaluation techniques used to identify the best value proposal in different literatures are the evaluation of financial proposal, technical proposal, and evaluation of past performance indicating documents, schedule proposal and in some cases interviewing key personnel of the contractor entity as briefly described below.

2.4.4.1 Financial Proposal

The financial proposal is the lump sum amount within which the contractor promises to finish the project and is the total amount the contractor proposed for the project at the time of bidding. It is the most common evaluation criterion used in evaluation matrices for contractor selection (Lombasso, 2017). This variable was one of the most frequently considered selection criteria in the construction industry. When responding to owners' invitation to tender, contractors includes the amount that must be paid when the project is awarded. A contractor calculates this amount by estimating direct project costs and including other compensations and fees that are necessary to finish the project (Storteboom et al., 2017).

2.4.4.2 Technical Proposal

Contractors are required to submit technical proposals explaining their project management plans based on the scope indicated in the project's construction drawings and specifications. Contractors are also asked to provide initial risk assessments, identifying factors that might cause deviations in the budget, schedule, or quality during the construction phase. After identifying potential risks, the contractors recommended how to mitigate each risk. Finally, the contractors provided value engineering feedback that might benefit the project. The owner's evaluation committee assigned each contractor's technical proposal an evaluation score of 0%–100% (Bruno et al., 2018).

2.4.4.3 Past Performance

The past performance of a contractor is a key indicator of future performance (Destaye, 2019). As part of the invitation to bid, each contractor is asked to provide information about the contractor team's previous project performance. The contractor team usually includes the prime/general contractor and any subcontractors. At the end of each project, the owner rates the performance of the prime contractor and any subcontractors, usually on a scale of 0–100%, with 100% meaning "excellent". Contractors may use these ratings as a past-performance index when bidding on new projects (Perrenoud, 2017).

2.4.4.4 Interviews

As no proposal is perfectly clear in its written form, an interview is typically used to clarify aspects of the proposal. This is a critical stage in the process where issues of transparency and neutrality can easily break down. In most literatures the majority of projects included interviews as an evaluation method. The interview evaluation was designed to evaluate each contractor's project team members. The team members interviewed most commonly included the project manager, site superintendent, and lead members of critical subcontract teams such as lead mechanical contractor or lead electrical contractor (Scott, 2006).

2.4.4.5 Schedule Proposal

Developing schedule evaluation criteria for the best-value selection is more than just setting a contract completion date. All foreseen material impacts on the scheduled completion date must be disclosed in the solicitation. Some owners asked for contractors' proposed schedules. Specifically, the contractors were asked to identify the number of days required to finish the project. These days were assigned scores for ease of comparing the contractors. For each project, the contractor that proposed the fewest number of days was given a score of 100%, and all competitors received a linearly prorated score based on the percent differential from the shortest proposed schedule duration (Kashiwagi, 2011).

2.4.5 Best Value Evaluation Rating System

Calculating Best-Values requires assigning rating systems to the evaluation criteria. Satisficing, modified satisficing, adjectival, and direct scoring systems are used in best value procurement. Common rating methods used to grade the technical or non-price factors in proposals from different literatures can be grouped into the following two groups; Qualitative Scoring also known as merit or adjectival is a system in which qualification or proposal criteria are rated on a conceptual scale from positive to negative, which may be expressed in such terms as excellent, very good, good, satisfactory, or unsatisfactory (Price, 2007).

In direct Point Scoring, qualification or proposal criteria are scored on a numerical basis within the varying ranges assigned to each evaluation criterion. These scores are totaled for an overall score. Cost or pricing is not rated or scored unless there are risk factors to be applied or some adjustment or weighted algorithm is needed for a cost-versus-technical tradeoff

analysis. The evaluation team should determine how to handle pricing before issuing the solicitation (Kashiwagi, 2011).

The complexity of the methods of bid rating increases as we go from satisficing to direct point scoring system as shown below in Fig 2-4 (Kashiwagi, 2011). Where satisficing is the simplest and easiest to understand for both evaluators and proposers, satisficing requires establishing standards for each criterion. Doing so creates a baseline for comparing proposals. Modified Satisficing considers the degrees of responsiveness to any given criteria. As a result, the range of possible ratings is expanded to allow an evaluator to rate a given category across a variety of degrees and an extension of modified satisficing; adjectival rating systems utilize a specific set of adjectives to describe the conformance of a criterion to the project's requirements. Evaluators assign points to each criterion based upon some predetermined scale or the evaluator's preference in direct point scoring. The greatest strength of this system is the scale's flexibility (Goodridge and Kashiwagi, 2006).

Figure 2-4 Continuum of criteria rating methods (Kashiwagi, 2011)

The method of bid rating or scoring permissible in the Ethiopian public procurement as stated in the standard bidding document for procurement of works (SBD) section 3(B)/2b evaluation of bids states that for a set of evaluation criteria stated on the bidding document the procuring entity shall use the following adjectival direct scoring and the rates shown below in Fig 2-5;

SCORING		DESCRIPTION
10	Excellent	Exceeds the requirements of the criteria significantly and in beneficial ways/very desirable
9	Very Good	Exceeds the requirements of the criteria in ways which are beneficial to our needs
7-8	Good	Fully meets the requirement of the criteria
5-6	Average	Adequately meets most of the requirements of the criteria. May be lacking in some areas that are not critical.
3-4	Poor	Addresses all of the requirements of the criterion to the minimum acceptable level.
1-2	Very Poor	Minimally addresses some, but not all, of the requirements of the criteria or lacking in critical areas.
0	Unsatisfactory	Does not satisfy the requirements of the criteria in any manner.

Figure 2-5 Bid scoring as described in SBD for the procurement of works

2.4.6 Best Value Award Algorithm

Best-Value award algorithms define the steps owners take to combine the parameters of evaluation criteria, and evaluation rating systems into a final award recommendation. Seven best-value award algorithms identified in the literature review documents

Meets Technical Criteria - Low-Bid - In the meets technical criteria or the low-bid algorithm, the final award decision is based on price. Technical proposals are evaluated before any cost proposals are reviewed. The price proposal is opened only if the technical proposal is found to have met the minimum requirements. The technical proposal review can be done on a pass/fail basis or using numerical ratings with a predetermined minimum score required for the proposal to be considered responsive. If the proposal does not meet the minimum standards, it is deemed non-responsive and the associated price proposal will not be opened. The price proposals associated with responsive technical proposals are then opened, often publicly, and the contract is awarded to the contractor offering the lowest price (Fekadu, 2013).

Adjusted Bid - The adjusted bid algorithm requires use of numerical scoring (or adjectival ratings converted to numbers). Price proposals are opened after the technical proposals are scored. When the price proposal is opened, the project price is adjusted in some manner by the technical score, typically through the division of price by a technical score from 0–1 or 0–100. The adjusted bid is used only for project award. The contract price will be based on the

amount stated in the price proposal. The offeror with the lowest adjusted bid will be awarded the project (Goodridge et al., 2006).

Adjusted Score - The adjusted score algorithm also requires use of numerical scoring (or adjectival ratings converted to numbers). The price proposals are opened after the technical proposals are scored. The adjusted score is calculated by multiplying the technical score by the total estimated project price and then dividing by the price proposal. Award is made to the offeror with the highest adjusted score (Smithwick et al., 2013).

Weighted Criteria - The weighted criteria algorithm also requires use of numerical scoring (or adjectival ratings converted to numbers). The technical proposal and the price proposal are evaluated individually. A weight is assigned to the price and each of the technical evaluation factors. The sum of these values becomes the total score. The offeror with the highest total score is selected (Adeyemi and Kashiwagi, 2014).

Quantitative Cost-Technical Tradeoff - The quantitative cost-technical tradeoff algorithm also requires use of numerical scoring (or adjectival ratings converted to numbers). It involves calculating the technical score and the price score increment and then examining the difference between the incremental advantages of each. The increment in the technical score is calculated by dividing the highest technical score by the next highest technical score minus one multiplied by 100%. The increment in price score is calculated by dividing the highest price score by the next highest price score minus one multiplied by 100%. The award is made to the offeror with the lowest price, unless the higher priced offers can be justified through a higher technical value. This justification is made by determining whether the added increment of price is offset by an added increment in technical score (Adeyemi and Kashiwagi, 2014; Smithwick et al., 2013).

Qualitative Cost Technical Tradeoff - This method relies primarily on the judgment of the selection official to determine the relative advantages offered by the proposals following a review of the evaluation ratings and prices. The final decision consists of an evaluation, comparative analysis, and tradeoff process that often require a subjective judgment on the part of the selecting official (Goodridge et al., 2006; Savicky et al.,2014).

Fixed Price-Best Proposal - The fixed price-best proposal algorithm is based on the premise that the project owner will establish either a maximum price or a fixed price for the project. Each offeror must submit a technical proposal accompanied by an agreement to perform the work within the specified pricing constraints. The award is based only on the technical proposal evaluation. The offeror that provides the best technical proposal will be selected (Bruno et al., 2018).

2.5 Current Procurement Process in ERA

Road construction project is a vital component of Government of Ethiopia (GoE) strategy considering its effect on every sector of the economy. ERA on behalf of the Government of Ethiopia (GoE) plays a major role on identification and prioritization of road projects, procurement of service and works contracts, contract administration and the maintenance of completed projects. ERA is an organization in Ethiopia that operates under the Ministry of Works and Urban Development and is responsible for road construction and monitoring the maintenance of trunk and major link roads as well as infrastructure project management. In addition to administer the federal government's road construction projects, ERA assists and supports the regional self-government road construction project offices helping them improve their capacity on road construction and administration activities (Abayneh, 2019).

The mission of ERA is to provide safe, comfortable and adequate road infrastructure to support the socio-economic development of the nation and satisfy road users by improving the condition of roads and expanding the network ERA strives to achieve its mission by working closely with other authorities under the Ministry of Works and Urban Development. To ensure the success of this mission an undeniable part of ERA operation is procurement (ERA, 2019).

2.5.1 Procurement Planning

The contract type used by ERA for all design projects is a lump sum where the payment is made based on delivery of design documents. The selected design consultant prepares, as per the required scope of the project, the complete design of the project including defining the project scope and preparation of the required tender document. The consultant is also responsible to select the appropriate project delivery method in consultation with ERA. From the projects where the design is completed and the required tender document is prepared,

based on the priority of projects and availability of budget the Planning and programming directorate forward the lists of projects to the Engineering Procurement Directorate to start their procurement process (Destaye, 2019).

The Engineering Procurement Directorate then prepares a procurement plan which indicates a schedule of main activities to be carried out in the procurement process. Since the project is handed over to procurement directorate after identification and completion the project design, the procurement plan has nothing more than the schedule of main activities to be carried out in the procurement process. Consequently, the procurement plan does not consider historical information, assumptions to be made on a specific project and limitation of projects. However, considering historical information and assumptions help to prepare a realistic procurement plan from lesson learnt in previous projects. The procurement plan is not incorporating as part of the scope definition. These have an impact in selecting the best delivery strategy, bidding method, managing risks and selection of the suitable contractor for the project (ERA, 2019).

2.5.2 Tender Document Preparation

Poor preparation of documents is one of the main sources of disputes and claims under a contract. It must be remembered that a substantial proportion of the tender documentation subsequently are incorporated into the contract documentation. The task of preparing them warrants close attention to detail and uniformity of approach. The bidding documents furnish all information necessary for a prospective bidder to prepare a bid for works to be provided. Which include invitation to bid, instructions to bidders, form of bid, contract, specifications and drawings, list of goods or bill of quantities (Dubale, 2014).

The Invitation for Bids/Tenders usually includes brief information on the funding agency for the contract for which bids are sought. The eligibility requirement is not indicated in all of the invitation to bid except for projects financed by the World Bank. Not indicating the required qualification criteria in the invitation to bid will have an impact on the decision making of bidders to participate in the bid as bidders do not have the information whether they are capable or not for the project. When preparing and submitting tenders, bidders must adhere to particular guidelines and all relevant procurement requirements may be included in instructions to bidders/tenderers. These may include the distribution of tender files, the receiving of bidder questions, and the distribution of notices and addenda (Abayneh, 2019).

The general specification would typically be a standard document that has been prepared by the relevant authority and would be included in the tender and contract documents for all contracts. They generally contain many references to, and should be read in conjunction with, the specification. Preparation of the drawings is the responsibility of the designer but, as with the specification and bills of quantities, a contractual overview is required. A particular feature of this overview would be checking cross-references to the specification and nomenclatures, such as materials descriptions, included on the drawings to remove any anomalies or inconsistencies (Destaye, 2019).

The other parts of bidding document includes bid data sheet which states the provisions that are specific to each contract and supplement the information requirements included in Instructions to Bidders (ITB), bidding forms which contains the forms which are to be completed by the bidder and submitted as part of the tender, eligible countries which gives information on the list of countries allowed to participate in the bid and schedules of supplementary information which indicates the information from bidders on their proposals for carrying out the works.

2.5.3 Bidding Methods

The Proclamation of public procurement of Ethiopia restrict public sector clients to use open invitations in which all contractors are welcome to submit bids unless a stated special reasons is there. The Federal Public Procurement Directive states the total contract value of a procurement of works made by restricted bidding shall not exceed ETB 2 million. Hence, alternative procurement procedures other than the open bidding cannot be applicable for most public bodies' construction contracts. As a public body, ERA for most projects uses open tendering as most of contracts are more than the maximum limit provided in the directive and not usually fulfill the conditions set forth for the use of other alternatives except in rare cases consequently ERA is unable to use other type of procurement as most of the projects handled by ERA are larger than ETB 100 million.

As per the proclamation by federal procurement and property administration 649/2009 cited herein after, the selection mechanism for all government financed projects in ERA is a two envelopes system where the envelope containing the qualification of the bidder first opened

and the envelopes containing the financial bid of all bidders put unopened. The financial bid will remain sealed and kept carefully under the custody of the Deputy Director General until the second bid opening preceding. However, for other international financed projects, either pre-qualification or one envelop post qualification is being used. In the procurement directive there is no clear rule when and for which types of projects to use a two envelop system. However, there is a specific procedure to open bid documents in two envelopes (Art 16.18.3).

Moreover, under the procedure for evaluating bids and selecting the successful bidder it is stated that bids submitted in two envelopes, the selected bidder shall be the one who scores the highest point in the total sum of results of the technical and financial evaluation conducted on the basis of criteria applied to determine the functional value of the procurement (Art 16.19.2.1 (b)). This implies the two envelop is suitable for a service/works contract where the lowest evaluated bid and found responsive to the qualification criteria offering the best economic advantage. In all cases, the lowest responsive bidder who meets the required specifications is awarded. This practice, however, ignores the competitive bidding process and frequently results in poor performance (Wolde, 2019).

2.5.4 Bid Process

Bidding or tendering is defined as the process of preparing and submitting an offer to complete the projects for a price, thereby converting an estimate to a bid. Tendering to select a contractor for a construction project has two goals: to test the current market, especially where existing contracts are long-term, and to comply with regulations governing free and open competition (Abayneh, 2019). The bid process has several steps that are typically standard no matter what delivery method is used for projects these are according to Borson (2019), the bidding question and answer period, reception of bids, evaluation and selection, and finally contract negotiations and starting of construction.

Bid evaluation refers to the process of strategically evaluating bids submitted by pre-qualified contractors. The bid evaluation strategy should reflect the client's objectives as well as additional project-specific criteria such as safety, durability, security, and maintenance (Ayettey & Danso, 2018). Bid evaluation is the responsibility of a body known as the bid evaluation committee. How this committee is called, depends on the organization and

synonymous terms are quotation review committee, bid review board or bid review committee, to name a few. Most procurement legal and regulatory frameworks require it to be an ad-hoc body with at least three members knowledgeable in procurement, with technical expertise in the specific item being procured and a representative of the user entity. According to the Federal Government of Ethiopia Public Procurement Directive (2010), there is an establishment of a procurement endorsing committee by public bodies to approve procurements of high value in the public body, consisting of members no less than three persons which serves for a maximum period of three years and where appropriate, there is chance to extend the service of members of the procurement endorsing committee for one additional term.

However, when the evaluation of the bid requires complex technicalities there may be establishment of other temporary bid evaluation process committees during pre-bid evaluation, technical evaluation or financial evaluation. For any report the bid evaluation committee generate there must be prerequisite to meet to form quorum. That is, more than 50% of the committee members need to attend in any decision made as a team or register personal views during group meetings. The evaluation of tenders received is normally carried out in three stages. These are pre-qualification evaluation, detailed examination and post-qualification evaluation (Wolde, 2019; Abayneh, 2019).

Preliminary examinations for responsiveness to formal qualification requirements are carried out to identify and reject tenders that are incomplete, invalid or substantially non-responsive to the bid document. During preliminary examination, bids are examined to ensure they are from eligible companies or countries, that the bid is submitted with all requirements that bid securities (when required) are valid, and that tax and other legal and commercial requirements are met. All bids determined non-responsive at this stage are therefore would not be considered further evaluations (Lombasso, 2017).

Pre-bid conference is then held after the bid documents are issued to shortlisted contractors and sufficiently ahead of the date of submission of tenders, a pre-bid conference is held by the employer to which all the intending bidders are invited. Before this conference, the intending bidders are also encouraged to visit the site and see for themselves the site conditions, the facilities available at the site and its vicinity and examine all data on investigations. In the

conference, the job requirements will be clarified and contract conditions explained wherever an explanation is needed in documents resulting from this conference (Eriksson and Westerberg, 2009).

Evaluation for compliance with technical requirements then takes place for only the tenders that survive the preliminary examination for further evaluation. At this stage, the committee evaluates for compliance with specified quality (specifications). They also look at issues such as the bidder's experience, delivery schedule, compliance with quantity specified, works schedule, warranty and other requirements specified in the bidding documents. These are, however, not fixed but predetermined based on the particular case. Bids that do not comply with the technical requirements are not considered for price/financial evaluation. Before price evaluation, all bids that are not responsive would be listed and clear reasons recorded for their not being eligible for further evaluation (Wolde, 2019).

Price/Financial Evaluation - At this stage, the committee examines the offered price for computational errors and, depending on the procurement type (goods, services or work), takes into consideration factors such as provisional sums and discounts, here if bids are priced in more than one currency, all currencies are converted to a single currency for evaluation based on exchange rate from a specified source, as stated in the bidding documents. The corrected evaluated prices are then compared and bids ranked in order beginning with the lowest responsive evaluated bid. A price reasonableness analysis is also done to ascertain that the price of the recommended bidder is fair given the prevailing market conditions (Abayneh, 2019).

Post-Qualification of the lowest evaluated responsive tenderer should be conducted to determine the tenderer's capability to perform the contract. Using the criteria specified in the bid document, this review should include an assessment of the tenderer's financial and physical resources available to undertake the contract, including his current workload. This activity applies to the lowest responsive evaluated bid. For some organizations, where prequalification of bidders was done, verification is done on the lowest responsive evaluated bidder to ascertain that such bidder still complies with the prequalification requirements. Where prequalification was not done, post qualification is done based on criteria specified in the bidding documents (Lombasso, 2017; Bruno et al., 2018).

Contractor Selection - A successful bidder must meet all the minimum qualifying criteria stated in the bid document. The lowest evaluated bidder is then selected and recommended for the award of the contract. In other words, the responsive tenderer who satisfied the post-qualification evaluation requirements is selected (Abayneh, 2019).

2.5.5 Evaluation and Qualification Criteria

Evaluation criteria are the standards against which bids are evaluated. The Ethiopian Roads Authority as a public entity also has set a number of qualification criteria to evaluate contractors' tender documents. For qualification criteria described in measurable ways, some formula is used whereas others expressed as range to determine specific requirements to be fulfilled in accordance to World Bank, ERA or PPA. Generally, evaluation criteria can be categorized into three categories including mandatory criteria, weighted criteria and Weighted criteria with mandatory elements (Alleman et al., 2017).

Mandatory criteria are used in straightforward bid evaluation methods where they are rated as pass/fail, responsive/non-responsive or comply/non-comply. They are usually used in evaluation for goods procurement, but may also be used for the procurement of services and infrastructure works. The mandatory criteria are the first criteria against which bids are evaluated in order to eliminate bids that do not conform to these requirements. Whereas weighted criteria are criteria which can be measured in terms of degree of responsiveness. The scale used to measure the degree of responsiveness depends on the procurement method and category of procurement. Usually this applies to the evaluation of services (Fekadu, 2013).

Weighted criteria with mandatory elements are criteria that have mandatory minimum requirements defined and are measured above that minimum requirement for example, a requirement may be set for a consultant to be fluent in at least two international languages and a rated score may be assigned for persons with additional international language capabilities, if the additional language adds value to the requirement (Abayneh, 2019).

Qualification of contractors in ERA generally measure the technical ability and capacity of the bidder to perform the intended projects by means of established minimal capacities below which contractors will not be considered. The major criteria include financial capacity (turnover, cash flow and historical financial performance like current soundness and long term

profitability), experience (general and specific to the project), and performance of the contractor in ongoing projects and technical capacity of contractor (availability of equipment and key personnel required for the execution of the works). In addition, the work schedule and construction methodology presented for the execution of the works is also assessed. Currently ERA takes the following qualification criteria while selecting contractors for road projects (Abayneh, 2019; Fekadu, 2013; Lombasso, 2017; Destaye, 2019).

2.5.5.1 Legal Status of Contractors

Legal requirements are main eligible criteria that enable the bidder to participate. Different countries have different set of legal status requirements. FDRE Proclamation 649/2009 article 28 in qualification of candidate states that the bidder has to present renewed trade license and fulfilled their obligations to pay taxes according to Ethiopian tax laws.

2.5.5.2 Contractors grade and Project size

Contractors grade and project size indicative of awarded amount of construction sized pre-determined with its grade and in invitation to bidder grade of contractors to call shall carefully examined. Contractors needed to present required manpower and equipment to award requested category and grade. Grade one General Contractor must present stated manpower and equipment in MUDC Amended Directive 19/2013 and for any particular project again the contractor must present his available manpower and equipment. On the other hand the contractor may be requested to present historical contract non-performance and pending litigation to evaluate further legal capability to be awarded (Fekadu, 2013).

2.5.5.3 Annual Construction Turnover

Annual construction Turnover of the company is total amount of money the company collects in the budget year without considering advance payment (Dinku, 2000). On the other hand, Historical Financial Performance of the contractor requests to the assurance of the financial capability to the contractor in future. Historical financial performance presents the last five years' financial situation of the bidder indicating the parameters from balance sheet about current asset, total asset, current liability, short-term debts and working capital.

2.5.5.4 Construction Experience

There are different ways to measure organizations long term effectiveness, one and best way is general construction experience of the contractor with unit of years and type of works executed in those years. Specific construction experiences are experiences which indicate contractor's capability only for proposed area of work similar to work experience. In addition to general and specific construction experience the contracture is evaluated in current contract commitments. Current contract commitments are project on hand and not completed in six months or completion less than seventy present in financial progress. Current contract commitments indicate the current organization and performance of the bidder.

2.5.5.5 Proposed Equipment

In the tender document "Evaluation and Qualification Criteria" there are number of equipment the bidder expected to proposed as owned, hire or lease (in some case to be purchased also acceptable) for particular project in subject. Where tender documents prepared fairly and precisely there will be points for provisions of equipment; sometimes it is good to provide more than required to assure the employer/evaluator the company have enough of equipment and not to worry in missing of required attached data.

2.5.5.6 Proposed Personnel

Where the tender document request to present personnel requirements the contractor should demonstrate the qualification and competence of the personnel proposed for the subject project; the bidder should show for every required position education level, general experience, experience in similar works and position.

2.5.5.7 Proposed Work Program and Methodology

The bidder shall demonstrate technique capability, full knowledge how each activity shall be executed, time required for each activity, how crew formed and managed, site condition and safety measure to be taken in contract execution period. These ideas can be demonstrated in two forms; First work program which indicated time line to project execution, start and finish date of project, relation between each activity, project closer, items delivery time and critical activates. Secondly; construction methodology, includes crew formation, camp and site organization, activates detail description, required manpower and equipment for every

activity. Both demonstrates bidder technical knowledge towards the project, assures understanding of the site and scope work (Destaye, 2019).

As part of assessing the financial situation of contractors, ERA checks bidder's current soundness and long term profitability from the financial audited reports submitted by the bidders. However, this will not be a basis for rejection as the evaluators are civil engineers who cannot justify the soundness and profitability of the bidder by checking the historical financial performance. Moreover, the assessment made for major construction equipment, key personnel, work schedule and construction methodologies is not considered as an evaluation criteria except noting the defects to be requested for clarification and confirmation by the contractor and then if the contractor pass the minimum criteria for passing on to the next price proposal evaluation (Fango, 2019).

A contractor who fulfilled the above requirements is legally qualified to be considered in the next selection process (Fekadu, 2013). After a comprehensive review of different literatures related to this work, different contract documents, many factors or selection criteria bring in to being that could affect the selection process of participating contractor, criteria were listed and then combined with best value selection criteria. The final criteria list that is believed to affect the contractor selection is determined. These criteria are shown in Appendix A. The preliminary screening, legal qualification, is not included in the criteria list and criteria weight calculation as it is a must to meet requirement.

2.6 Research Gap

From the analysis of the literature, it become apparent that although various researchers and organizations have proposed contractor selection frameworks (Fekadu, 2013b; Tadesse, 2018; Wolde, 2019) and models for project contractor selection methods (Abate, 2019; Bishaw, 2019), to date there was no focus on the best value procurement method in Ethiopia road construction industry, despite the best value method having gained popularity with increased use in the resource sector and infrastructure projects in recent years in the world as seen in many literatures (Adeyemi & Kashiwagi, 2014; Goodridge & Kashiwagi, 2006; Kashiwagi, 2011; Smithwick et al., 2013).

Similarly, some of the unexplored areas in the general literature of best value procurement model appear to be important and worthy of investigation in the context of selecting criteria based on adding value and considering the uncertainty in the decision making during evaluation of bids. Furthermore, previous empirical research (Abdelrahman et al., 2008; Elyamany, 2014; Magdy Abdelrahman, 2008; Scott, 2006; Wondimu & Lædre, 2018) has focused primarily on the multi criteria nature of best value model only and very little research been done considering uncertainty of the decision makers in best value model. Consequently, comprehensive best value procurement method for Ethiopia road construction contractor selection and model development of the procedure considering both the multi-criteria nature and uncertainty in decision is yet to be explored.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This section describes all the procedures that were undertaken to achieve the objectives set for in this study. The procedures that were adopted including all the information relevant to the collection of data, where and how those data were obtained from are discussed. In addition, data and information sources, research instruments, sample size and method of analysis are presented. The succeeding sub section provides a general description of the research strategy adopted for this thesis, as well as justification of the methodology.

3.2 Research Design

For this study both qualitative and quantitative research method were adopted in order to investigate the current best value procurement practices, identify the parameters of best value procurement as well as their weights for the model. Its central premise is that the use of quantitative and qualitative approach in combination provides a better understanding of research problems than either approach alone (Creswell J, 2011). It involves the use of qualitative, quantitative approaches, and the mixing of both approaches in a study. A strong mixed methods study should start with a mixed method research question to shape the methods and the overall design of a study, because a mixed method study relies on neither quantitative nor qualitative method alone (Damte, 2018). The overall approach followed are; having established the basis of the research, necessary data was collected, analyzed, and an evaluation is then developed and evaluated, and conclusions and recommendations was made based on the findings.

3.3 Sampling Technique

The sampling approach used in this research was judgment sampling because the choice of the respondents was selected purposively rather than randomly, based on their expertise on the subject matter and procurement area. Consequently, the selection was mainly focused on procurement experts in ERA who was assumed to have wider experience in the procurement process.

3.3.1 Study Population

Since this study is limited to the development of best value procurement model based on primary parameters that impact contractor selection in terms of adding value to projects in Ethiopian

federal road projects, the population of the study was focused on best value related procurement process and contractor selection on federal road projects procurement of the country. In which the organization responsible for such operations is Ethiopian Road Authority.

3.3.2 Target Population

There are two core directorates in ERA which involve in the construction execution, contractor selection and procurement process respectively, the regional construction project management directorate and engineering procurement directorate. The regional construction project management directorate has five sub directorates: south region, north region, central region, east and west region project management directorate. So the study designated these directorates as a target population of the total population due to very close experience on the procurement methods and execution of road projects.

3.4 Method of Data Collection

In this research in order to answer the research-questions a mixed method (both quantitative and qualitative) approach was selected for data collection. The research methods that are used to collect the data which is necessary to answer the research questions are desk study, questionnaire and in-depth interviews. Research data is compiled from both primary and secondary sources.

3.4.1 Questionnaire Survey

First, a literature study was done to provide insight to best value procurement related practices in ERA. This is to provide theoretical insights and elements for the, to be developed, best value procurement model. Based on the information acquired from literature reviews and desk study inputs, questionnaires are developed for survey exercise to investigate the current best value related practices and determine primary parameters of contractor selection criteria and their weight in terms of adding value to projects. Due to its appropriateness for acquiring the level of the required information in a larger number, questionnaire was selected as the major research instrument.

The structured questionnaire in round one survey was accompanied by a cover letter and consisted of three parts. The first part sought demographic information about the respondent's profile following that the second part assesses the contractor selection criteria currently being used for bid evaluation process and about the general best value related practice and further

investigates the most common contract awarding method and award algorithms practiced among the respondents. In the third part, participants were asked to rank identified best value procurement contractor selection criteria being used for bid evaluation process from literatures based on their significance to adding value to projects. The questionnaire, for the purpose of identifying the best value contractor selection criteria and the employed a five-point type 1-5 Likert ordinal scale to measure the level of ranking by responding professionals.

The round two questionnaire was distributed specifically to subject matter experts in the fields of road construction work procurement who have been involved in tender preparation and evaluation process in ERA with the purpose of weighting the best value procurements previously identified from literature review and further short listed through round one survey. The scale utilized to derive the relative importance from matrices of pairwise comparisons is 1–9.

3.4.2 Interview

During the survey and validation process, the interview research method was used to collect validation data in this research based on semi structured style where a list of questions and topics that need to be covered during the interview are used. The type of interviews includes face-to-face interviews with the construction professionals who are experienced in contractor selection process, to validate the model. The interviews were conducted in a semi-structured manner that allowed interviewees to extend their opinions and to express their views in their own terms.

3.4.3 Desk Study

After comprehensive literature review, background information associated with the research topic was collected, the research gaps were identified, the research questions were formulated, the research methods to obtain data were selected, and ways of analyzing data were identified. Best value procurement related practices are then studied for the investigation of best value related procurement practices through a desk study. For this purpose, various data sources such as academic journals, conference proceedings, government publications, and books, were extensively examined. Additionally, data was obtained from government documents such as directives and proclamations, standard bidding documents and PPA, to enable the researcher obtain the necessary data and qualitative information concerning the current best value related criteria setting in ERA.

Another purpose of the desk study in this research is reviewing existing knowledge of best value procurement contractor selection and identifying contractor selection criteria for road projects. For the purpose of identifying a list of criteria, after a keyword searching for literatures based on similarity to the topic, a list of 32 journals, articles and books were identified as relevant and similar to the research questions and focus on road projects. Through another content review, the list was narrowed down to 12 literatures. The reason for eliminating the other papers was based on similarity on findings, project specific studies and inconclusive findings. The final list of best value procurement contractor selection criteria is listed on Appendix A.

3.5 Study Participants

Because of the specificity nature of the study that needs knowledgeable persons in the procurement methods and related area of practices, a judgmental sampling, which is a non-probability sampling method, is deployed to select the respondent directorate for this research purpose. A judgment sampling technique is used to select representative experts for questionnaire distribution purpose and for the interview data collection method, to select respondents who have good knowledge about the subject in question.

Therefore, it was believed that the data collected from the above stated staff members of the Engineering Procurement directorates all the staffs are selected as sample to have sufficient information about the best value procurement related practice. On the other hand, regional construction project management directorate staff members which includes (three regions have 37 members and two regions have 41 members) in which the total number of target population from these directorates is found to be 193. To select respondents from the following formula was used taken from similar researches (Arain & Pheng, 2005; Abayneh, 2019). For a 95% confidence level;

$$n_0 = \frac{p*q}{V^2} \quad \text{Equation 3-1}$$

$$n = n_0 / \left[1 + \left(\frac{n_0}{N}\right)\right] \quad \text{Equation 3-2}$$

Where: n_0: first estimate of sample size p: the proportion of the characteristic being measured in the target population, q: Complement of p or 1-p, V: the maximum standard error allowed, N: The population size and n: the sample size.

In order to maximize the sample size of respondents (n), using equation 3.1 for a 95% of confidence the value of p was set at 0.5. The compliment of p will resultq = 0.5, V=0.05, therefore;

$$n_0 = 0.5 * 0.5/(0.05)^2$$

=100

Similarly, by using equation 3.2, the sample size (n) is calculated as follows;

$$n = \frac{100}{1 + (\frac{100}{234})} \cong 70$$

To calculate the number of people needed to be invited to take the survey, was used (Cochran, 1977) based on the expected response rate,:

$$number\ of\ respondents\ to\ invite = \frac{\text{Number of respondents needed}}{\text{expected \% response rate}} * 100 \quad \ldots\ldots\ldots \text{ Equation 3-3}$$

For an 85% of response rate and 70 respondent needed for this study, the number of respondent to invite for this study is calculated using Equation 3.3;

$$number\ of\ respondents\ to\ invite = \frac{70}{85} * 100 \cong 85$$

Therefore, a relatively large unbiased sample of 85 questionnaires was distributed to participants which consists of 35 questionnaires for the whole available stuff members from Engineering Procurement directorates and 50 questionnaires for staff members from Regional construction project management directorate (10 questionnaires per stuff members from each region) for round one questionnaire survey.

For the purpose of the second round survey, the questionnaire was distributed specifically to subject matter experts in the fields of road construction work procurement only who have been involved in tender preparation and evaluation process in ERA which exclusively includes 20 engineering procurement stuff members only who are willing to participate in the second round survey and identified during a round one survey due to their work experience and willingness to participate again.

Potential interview participants were identified using a referral sampling method from both directorates. The survey participants who had the most experience working on procurement and execution of road construction projects were asked to nominate potential interview participants who have extensive experience in selection process of contractors. Seven interview participants therefore were selected based on the referral and their availability and willingness to participate. But five participants only were interviewed due to schedule and their willingness by the time of the interview.

3.6 Data Analysis Methods

The out puts of the interviewees and answers from questionnaires resulted in several factors being listed that are beneficial for effective procurement of value from contractors. These factors are then analyzed and are combined with the theory of the best value procurement and desk study outputs in order to formulate a model for best value procurement.

Data collected from the questionnaires were analyzed using the methods descriptive and statistical analysis conducted for the questionnaires and results were generated using statistical packages for social sciences (SPSS) version 22 and Excel to analyze the data. Therefore, the techniques that are used in this research study, in respect of data analysis include the following.

- ✓ Frequency and descriptive analysis

Descriptive and inferential statistics are mathematical approaches that describe the characteristics of a sample. In descriptive statistics, it's often needed to find the central tendency or the middle of distribution. A measure of central tendency is a summary measure that attempts to describe a whole set of data with a single value that represents the middle or center of its distribution (Creswell J, 2011). For this particular research, frequency values of the respondent response were used to analyze the descriptive data which was gathered from questionnaire.

- ✓ Factor analysis

Owing to the large number of variables (33 criteria: see Appendix A) involved in this research, there was the need to reduce the items to form a smaller representative number of factors, hence, this promotes the use of factor analysis. Factor analysis according to various researchers identifies small number of factor groupings that is used in representing sets of many inter-related

variables as a data reduction technique (Sentosa, 2016). The present study applied factors analysis to reduce the collected criteria of best value procurement collected from different literatures through a questionnaire survey. The type of factor analysis computed in this research is principal component analysis and to apply the factor analysis based on principal component analysis using SPSS software, the following main steps are followed;

Step 1: before starting a factor analysis, the starting point for all factor analysis techniques is to check the correlation matrix to test for the appropriateness of using factor analysis. In order to check for the correlation between the criteria we can either eyeball the correlation matrix for identification of the existence of correlation or use the KMO and Bartlett test of sphericity to compare the correlation matrix. Bartlett's measure is a test of null hypothesis, which states that the correlation matrix is an identity matrix. This illustrates that the variables are not related, thus unsuitable for factor analysis. Values of range < 0.05 indicates that the data is suitable for factor analysis (Braeken, 2016; Dogbegah and Owusu-Manu, 2011). Otherwise, the data is not suitable for structure detection. Based on the Kaiser rule, Braeken (2016) suggests accepting values greater than 0.5 and characterized measures as stated in Table 3-1;

Table 3-1 Kaiser Mayer Olkin values interpretation (Braeken, 2016)

Kaiser Mayer Olkin	Sample adequacy
Below 0.5	Not acceptable
Between 0.5 and 0.7	Mediocre
Between 0.7 and 0.8	Good
Between 0.8 and 0.9	Great
Above 0.9	Superb

Step 2: setting a criterion for determining the number of factors is the second step in factor analysis. For this research purpose the criteria set for determining the number of criteria is based on eigenvalue. According to the Kaiser Criterion, for the extraction of principal components or factors, eigenvalue is a good criterion for determining a factor. One of the most frequently used methods is known as the Eigenvalue rules or the Kaiser's criteria. Under this criterion, components with an eigenvalue larger than 1 are retained, or factors which explain a total of 70-80% of the variance is retained. When eigenvalue is greater than one, it is considered a factor

and eigenvalues less than one, then it's not considered a factor hence drop those factors. A scree plot is also used to decide whether or not an eigenvalue is large enough to represent a meaningful factor. This plot is a graph of each eigenvalue (Y-axis) against the factor with which it is associated (X-axis). The point of inflexion of this curve represents the cut-off point for selecting factors to be retained in the analysis (Boateng and Kumi, 2016; Braeken, 2016; Dogbegah and Owusu-Manu, 2011).

3.7 Data Reliability and Validity

Due attention was given to minimize the chance of getting higher errors in this research. Hence, reliability and validity tests, which help to detect the presence or absence of those errors, have been carried out. To that end, the researcher has conducted pilot tests and reliability test by SPSS to meet all the reliability and validity standards.

3.7.1 Validity

Validity test can be seen as measure to the extent to which a test accurately measures what it is supposed to measure. Validity refers to the degree in which a survey or other measuring device is truly measuring what it is intended it to measure. A research has high validity, when it produces results that correspond to real properties, characteristics, and variations in the physical or social world. In order to increase validity of its findings, the research methodology uses for validity pilot testing.

Using a small population sample, a pilot study was conducted which covers 4 engineering procurement directorate team leaders at the initial stage of the research. Based on the pilot study the researcher was advised to minimize open ended questions in questionnaires to avoid respondents from becoming fatigued and compromising data quality. Additionally, some parameters were removed from the initial list of best value procurement parameter list such as "optional features offered" for it is difficulty to evaluate in the tender evaluation stage, "legal status of a contractor" for it is a must meet criteria rather than an evaluation criteria and "pending litigation" for its qualification character rather than a contractors' attribute.

Further some parameter wording was also changed based on the pilot study such as "current workload" to "current and future work load" to clearly describe the work load of contractors and "estimated project completion" was changed to "proposed project completion date" to show the

attribute of the contractor. The major change in the questionnaire due to the pilot study is on the removal of "cost parameter" for the idea of best value can only be applicable under the current legal framework as a technical evaluation under the evaluation of the most economical tender.

In order to ensure the validity of the research, after the conduction of the pilot test with four team leaders in ERA from the engineering procurement directorate, contents of the final questioner were evaluated and checked by the advisor and work colleges with similar and greater experiences in the construction field as the researcher. The final questioner was evaluated and verified for appropriateness of content and the scales of measurement so that the developed instruments measure what it was meant to measure and also to check the clarity, length, structure and wording of the questions by discussion with the advisor.

3.7.2 Reliability

Reliability refers to how consistently a method measures what it is supposed to measure. The main idea behind reliability is consistency and repeatability of results and findings under the same conditions. A reliability measure is used to ensure that the Likert scale used as the survey instrument is consistently reflecting the construct it is measuring. Cronbach's Alpha (α) is the most commonly used measure of scale reliability (Alleman et al., 2017). Cronbach's Alpha aims to find the reliability coefficient based on the average correlation among all of the items that make up the scale. Cronbach's Alpha values range from 0 to 1. The higher the score, the more reliable the generated scale is. The Cronbach's alpha can be calculated with equation 3.4 (Gliem and Gliem, 2003):

$$r = \frac{k\overline{r}}{(1+(k-1)\overline{r})} \quad \text{.....Equation 3-4}$$

Where, K= the number of items, and $\overline{r}$ = the average inter-item correlation. Reliability coefficient denoted by the letter "r," indicates the reliability of a test and is expressed as a number ranging between 0 and 1.00, with r = 0 indicating no reliability, and r = 1 indicating perfect reliability where a result below 0.5 is unacceptable (Gliem and Gliem, 2003).

Table 3-2 Cronbach's Alpha interpretation (Gliem and Gliem, 2003)

Cronbach's alpha	Internal consistency
Greater than 0.9	Excellent
Between 0.9 and 0.8	Good
Between 0.8 and 0.7	Acceptable
Between 0.7 and 0.6	Questionable
Between 0.6 and 0.5	Poor
Less than 0.5	Unacceptable

For the case of this research, Cronbach's coefficient alpha test was used in order to calculate the reliability coefficient and determine the reliability of the questions used.

3.8 Best Value Procurement Evaluation Specification and Validation

This research explores and lay its foundation on the best value evaluation model that was introduced by Dean Kashiwagi in 1991 as best value performance-based information procurement system (Kashiwagi, 2011). This BVP model uses two alternatives of weight identification methods, namely the weighted average methods (WAM) and analytical hierarchy process (AHP). The general equation for best-value model is shown as follows.

$$BV_j = \sum_{i=1}^{n} PS_i * W_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 3-5}$$

Where, BV_j - best value for contractor $_j$, PS_i - parameter scale, W_i - weight of parameter, and n-number of parameter.

Best value procurement relies on multi-criteria decision-making approaches since it uses numerous factors for contractor selection. However, the presence of various criteria, different decision makers, uncertainty and risk associated with inadequate information, imprecise data, and ambiguity in decision-making makes the situation more complex and challenging; this leads to fuzziness. Multi-criteria techniques based on fuzzy sets can solve decision-making fuzziness caused by human perception. Most of multi-attribute decision-making problems are determined not with exact attribute values, but with fuzzy values or with values in some intervals (Morote and Ruz-Vila, 2012). To ascertain with this and address the uncertainty and impreciseness in human perception, fuzzy comprehensive evaluation (FCE) is introduced in this evaluation.

In this research fuzzy comprehensive evaluation (FCE) model is used to obtain reliable results in evaluating alternatives in an uncertain environment. The approach has strong evaluation abilities

that lead to appropriate decision-making which generates the weight of factors and priorities factors based on expert judgment and it determines the criteria and sub-criteria of best value procurement criteria for federal roads contractor selection for Ethiopia. To get priorities in an organized way, the fuzzy comprehensive evaluation (FCE) technique requires de-composing the decision through the following steps, based on the different studies. The general steps incorporated in fuzzy comprehensive evaluation are as follows (Alhumaidi, 2015; Bishaw, 2019; Serdar Ulubeyli, 2013; Singh and Tiong, 2005).

Step 1. set criteria, sub-criteria, and attributes. This step was segmented the complex problem of best value parameters into a structured hierarchy of two levels, which are level one (criteria), level two (alternatives).

Step 2. Set up evaluation factor set and evaluation set. The first level of evaluation factor set U = (U1, U2, U3, …Un) is set up, which represents the best value parameters selected whereas, the evaluation set V = (V_1, V_2..., Vn), V_i (i = 1, 2..., n) represents all possible evaluation rating for each parameter.

Step 3. Develop a pairwise comparison matrix. Analytic hierarchy process comparing methods are used usually, which greatly reduce the uncertainty factors. According to 1 to 9 scale method, relative important degree value is assigned and comparative value can be obtained. Based on comparative value, judgment matrix can be developed (Goepel, 2013). The matrix in this research was constructed using the rate of scale that denotes how much one element dominates over another with respect to a given attribute. The scale value measures the degree of relative importance in a pairwise comparison matrix using linguistic variables for best value parameters, as described in Table 3-3;

Table 3-3 The Linguistic Variables for best value parameters.

Linguistic Terms	Fuzzy number
Equal importance	1
Moderate importance	3
Strong importance	5
Very strong importance	7
Extremely strong importance	9

Step 5. Estimate normalized weight. It computed from the pairwise matrix using the arithmetic mean. The normalized weight computed by Equation 3.6: where w_i is normalized weight from the cumulative weight w = (w_1, w_2, . . ., w_n).

$$w_i = \overline{w}_i / \sum_{i=1}^{n} \overline{w}_i \ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 3-6}$$

Step 6. Determining consistency ratio aids to identify consistency of decision. Due to the inconsistency inherent in human judgment while weights are assessed during the pairwise comparison process, the aggregation weight may be invalid. Hence, to check the validity of the weight identified, the consistency index (CI) is used to measure inconsistency (Goepel, 2013). In order to consider the resulted weights from a pairwise comparison matrix, the logical consistency of weights has to be verified based on the matrix consistency ratio. If the value of consistency ratio is more than 10%, then the results are inconsistent and it is needed to revise the subjective judgment (Saaty, 1980 as cited in Goepel, 2013). It is calculated using the following formula.

$$CI = (\lambda_{max} - n)/n - 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 3-7}$$

To calculate the consistency ratio, the consistency index is further divided by a constant value of random index for a given set of variables.

$$Consistancy\ ratio(CR) = \frac{Consistancy\ index\ (CI)}{Random\ index\ (RI)} \ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 3-8}$$

For this research for the computations of pairwise comparisons from multiple input and succeeding calculations was done using an Excel template.

Step 7. Compute multi-comprehensive evaluation. In a multi-comprehensive evaluation, after establishing an evaluation factor set (U) and evaluation set (V), is to establish a single fuzzy matrix. The single fuzzy matrix uses the respondent's rate to evaluate the contractor attributes. The single fuzzy matrix computed using Equation 3.9;

$$r_{ik} = r_i/N \text{ then } R = \begin{bmatrix} r11 & r12 \ldots & r1k \\ \vdots & \vdots & \vdots \\ rn1 & rn2 \ldots & rnk \end{bmatrix} \ldots\ldots\ldots\ldots \text{ Equation 3-9}$$

Where, n is attributes or element set, evaluation factor k = (1, 2…. k), the rate of respondents for evaluation factor r_i, the total population of respondent N and single fuzzy matrix R. Lastly,

computing the multi-comprehensive evaluation used to priorities the influence of criteria on alternatives. It can be computed based on Equation 3.10;

$$B_i = wi * Ri = \begin{bmatrix} w1 \\ \vdots \\ wn \end{bmatrix} * \begin{bmatrix} r11 & r12 \dots & r1k \\ \vdots & \vdots & \vdots \\ rn1 & rn2 \dots & rnk \end{bmatrix} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \textit{Equation 3-10}$$

Where, B_i is prioritized result of criteria, R_i is a single fuzzy matrix result from Equation 3.9 and Wi is a normalized weight of criteria from the pairwise matrix.

The evaluation is then reviewed by senior procurement professionals' feedback from face-to-face-semi-structured interviews for appropriateness to use in the Ethiopian road projects contractor selection. A single round of interviews with each participant was conducted, considering the time constraints and this was believed to be adequate to elicit insight from the participants.

3.9 Ethical Considerations

During the conduction of this research, high attention was given to ethical considerations. Due attention and consideration was given to ethical considerations during the conduction of questioner by the researcher.

Inconsideration of this fact, up on receiving an official permission request letter from School of civil engineering and architecture of Adama Science and Technology University, the questioner began with an introductory opening letter containing consent of cooperation from respondents. The respondents were given assurance that the information they provide would be kept confidential and only used for the sole purpose of the research. The researcher kept a positive relationship and made sure the objectives and significance of the study was made clear to the respondents beforehand.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

The main aim of this study was to develop a best value procurement model based on the primary parameters that impact contractor selection in terms of adding value to projects. Therefore, different types of research methodologies were employed to get the necessary data for the research. From those methods, review of standard biding and contract documents were broadly used and extensive review of different literatures published on best value procurement methods and best value based selection criteria of contractors were used in addition to questionnaire survey and interview to develop the best value procurement evaluation for Ethiopian federal road projects. This chapter presents the results of the analysis undertaken on the data that were collected. The overall results of the analysis and survey and interview responses are presented and discussed in this chapter.

4.2 Respondent Information

This section mainly designed to provide general information about the respondents in terms of profession, education level, directorate, position and years of experience. A total of 85 questionnaires for the round one survey were distributed to both directorates of Ethiopian road authority namely the regional construction management directorate and engineering procurement directorate. The respondent directorate and distribution as well as the return rates are described in Table 4-1 as follows;

Table 4-1 Response rate and distribution

Directorate	Questionnaire distributed	Questionnaire returned	% returned
Engineering procurement directorate	35	32	91.4%
Regional construction management	50	40	80%
Total	85	72	85.7%

From those 85 respondents the researcher distributed questionnaires to; the researcher was able to collect a complete data from 72 respondents out of the total sample group. Which indicates an average of 85.7% response rate as reported in response rate and distribution table above which is above the pre-set response rate of 85%. Regarding the question of the experience of the

respondents, the responses given in the survey show that most respondents in the survey indicated that, they had been involved in the road projects construction procurement for a variety of time, as indicated in Fig. 4-1;

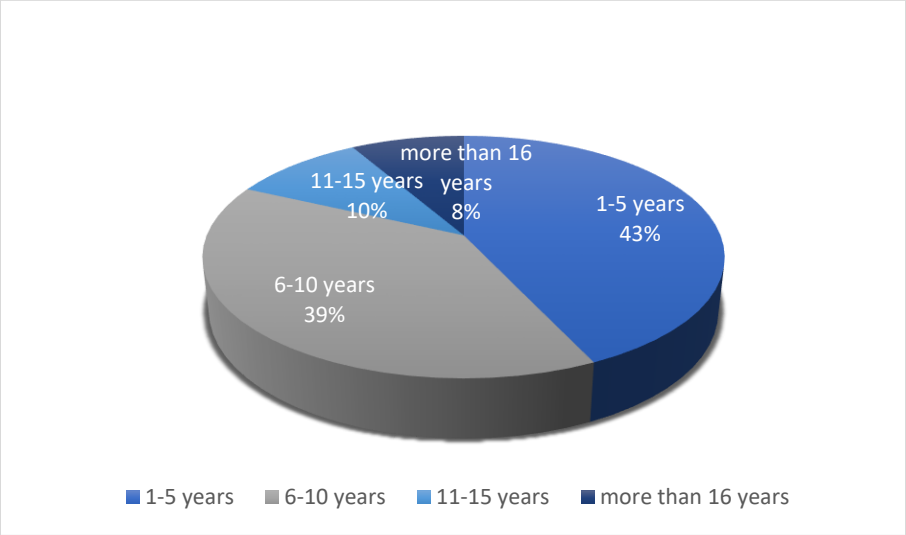

Figure 4-1 Respondents experience in years

The majority of respondents, nearly 43%, confirmed that they had between one to five years of work experience. In addition, 39% of respondents reported at least six but less than ten years of work experience. Another percentage of respondents at 10 % reported eleven year of work experience or greater but less than fifteen years of work experience. And a relatively small amount of respondents at 8% were found to have more than 16 years of work experience.

It can be concluded that the information gathered was reasonably reliable, as the majority of respondents, 57%, almost more than a half of respondents, had been involved in the industry for more than six years and had a good understanding of the industry. This can be taken as a good indicator that respondents had a good experience on the procurement method. Moreover, the variety of experiences between each group will enrich the research with different knowledge and information. For these respondents their educational qualification is shown in the following Table 4-2;

Table 4-2 Respondent educational qualification information

	Frequency	Percent	Cumulative Percent
First degree	53	73.6	73.6
Master's degree	19	26.4	100.0
Total	72	100.0	

From those respondents 73.6% were first degree holders and 26.4% of respondents were master's degree holders. This result supports the quality of the retrieved information from respondents who are qualified and experienced. Regarding their work position of each respondent was inquired and the results are shown in Fig. 4-2 as follows;

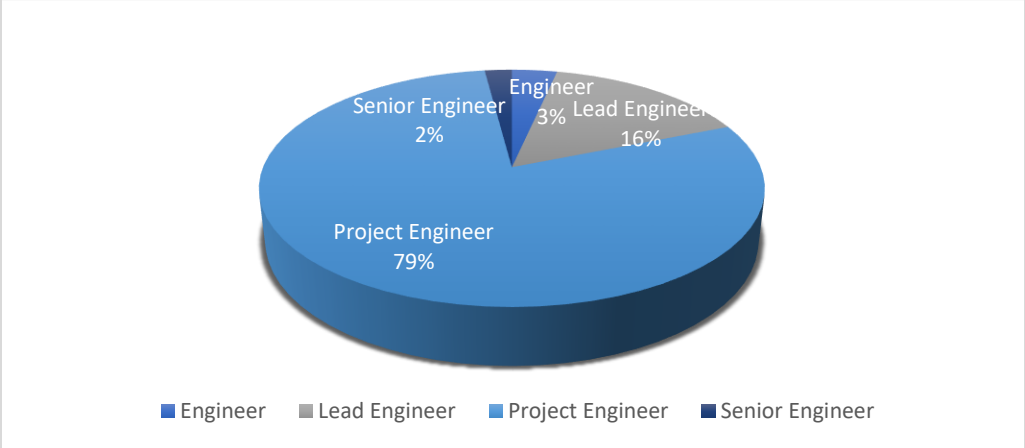

Figure 4-2 Respondents' work position in ERA

According to the respondents' reply most of the respondents were project engineers, and they account 79% of the respondents, 16 % were team leaders, 2% senior engineers and another 3% staffs of ERA were engineers. It can be seen that most of the respondents have a good procurement experience which support the quality of gained information due to direct involvement on the procurement method implementation. Experience as a general concept encompasses skill and knowledge on observation of something or some event gained through involvement and exposure to that thing or event.

4.3 Current Best Value Related Practice in Ethiopian Road Authority

In a two-envelope tender evaluation model for road projects has use a traditional method in which a non-price proposal is firstly evaluated, and secondly, the price proposal. Then the technical evaluation score and cost evaluation score are combined according to the predetermined proportions of technical to cost to calculate the final score. Tenders that provide the highest score will be regarded as the most competitive bidder.

But in the case of ERA, according to interview participants in this study the set criteria in the bid documents are used as a qualification criterion rather than evaluation criteria to only identify a responsive bidder from a list of bidders based on a pre-set percentage of score above which every bidder is eligible for the review of price proposal and then the lowest bidder is chosen. This is clearly seen in the survey participant's response to what contractor selection criteria ERA uses from the different kinds of contractor selection approaches as stated in the following Table 4-3;

Table 4-3 Frequently used contractor selection approach in ERA

Type of contractor selection approach	Frequency	Percent	Cumulative Percent
Competitive lowest bid	58	80.6	80.6
Qualification based selection	14	19.4	100.0
Total	72	100.0	

As stated above 80.6% of respondents respond that the current frequently used contractor selection is competitive lowest bid contractor selection approach which considers price as a main evaluation criterion for selecting contractors. The other part of respondents which constitutes 19.4% of the whole respondents select qualification based selection approach in which it's further clarified during the interview that it is used when a special structures construction expertise is needed and for consultancy services only.

This result can further be seen in the question where respondents were asked to select the bid awarding algorithm the authority has been using to procure construction services, as all the respondents selected the 'meet technical criteria-low bid' as the primarily used awarding algorithm for ERA which is characteristically the low bid system's award algorithm. In this type

of algorithm, the bid which meets the minimum set criteria set is labeled responsive and passes to price evaluation stage in which the lowest bid price submitting contractor gets chosen.

Other contractor selection approaches such as best value selection, sole source selection and fixed budget/best design selection are not used in the authority for a contractor selection procedure. As it can be seen clearly from the above discussion the contractor selection process in ERA is not best value based, rather it relays solely on price comparison of bids. The reason behind the slow adoption or not implementing best value procurement was justified by the respondents answer as stated in the following Fig 4-3;

Figure 4-3 the reason why ERA is not implementing BVP currently

Based on the responses of 42% of respondent, the reason behind the slow adoption of best value procurement in ERA was attributed to the lack of legal or regulatory provision in the general procurement of public sector. But interview respondents argued that while best value procurement it's not clearly defined and described in none of the directives, proclamation and standard bidding documents, it can be applied to the current construction industry under the rule stated in standard bidding document section 3(b) as well as in as an evaluation of technical proposal for the determination of the lowest bid offering the most economical advantage. Whereas 33% of respondent response shows that the reason behind the slow adoption is rather organizational guideline and expertise unavailability citing the above mentioned standard bidding document as a legal provision and the use of two types of evaluation methods that are

well adopted in the procurement system of federal public projects which are lowest evaluated bid and weighted average method.

As shown in the above diagram 25% of the respondents attribute the cause to other reasons which were not stated in the questionnaire such as lack of local contractor experience in fulfilling the stated qualification and criteria, the subjectivity of criteria evaluation in best value procurement leading to time, cost and lengthy procedures and additionally interview respondents mention that the newness of the system to the country's industry and since social, nepotism and tribal relationships are very strong aspects of the Ethiopian public services, it is feared that it will have a strong influence in the operations of best value contractor selection. Furthermore, it is indicated that the system is gradually adopted such as its now through setting a minimum criteria and developing the industry after which a criteria specified for the specific project will be set.

4.4 Best Value Procurement Primary Parameters Selection

This part consists of results and discussion of main parameters that affect the selection of contractor in terms of adding value to projects in ERA. Round 1 respondents were asked to rate the listed criteria importance using 1-5 scale. As there are hardly any studies on best value contractor selection criteria in Ethiopia road projects, it is essential to identify general best value contractor selection criteria initially from the literature review of scholarly publications and governmental documents. Accordingly, after the collection of these criteria from literatures, round one questionnaire was conducted to select the most important criteria from the collected ones.

Scale reliability: Scale reliability of round 1 questionnaire was tested using Cronbach's Alpha test for the interval scale measurement on 1-5 scale. Accordingly, the value of Cronbach's Alpha for the 33 independent variables in this research was obtained 0.896 as shown in Table 4-4;

Table 4-4 Scale reliability of round 1 questionnaire

Cronbach's Alpha	N of Items
.896	33

Cronbach's Alpha is greater than 0.7 and it indicates a good consistency of responses in this round there by making the research acceptable and suggesting that the data collected through questionnaires is reliable enough to be used for further statistical analysis.

- ✓ Factor analysis

Before conducting a factor analysis, the data set collected has to be checked weather it is appropriate to be used for factor analysis or not by identifying weather it is an identity matrix with no correlation or not. In measuring the sampling adequacy and checking for appropriateness of the said technique, the data was subjected to the Kaiser Meyer Olkin (KMO) measure and Bartlett's test of Sphericity as the result described in Table 4-6;

Table 4-5 KMO and Bartlett's test result

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.820
Bartlett's Test of Sphericity	Approx. Chi-Square	3039.034
	Df	528
	Sig.	.000

Based on the above results it can be concluded that since the result shows significance at p=0.000, the best value criteria listed is not an identity matrix and each factors are related and the observation is not taken from a population with zero correlation. Hence it makes the criteria suitable for factor analysis. Additionally, observing the above result of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.82, well above the commonly recommended value of 0.500. The communalities (proportion of item's variance explained by the extracted factors) given in Appendix D, were all above 0.300, further confirming that each item shared some common variance with other items. Given these overall indicators, factor analysis was regarded to be suitable with all the 33 criteria.

The next step after confirming that a factor analysis is suitable is computing a factor extraction through principal component analysis to define a small number of factors that can be used to best signify the whole of the relationship between variables in order to extract the significant criteria among the listed 33 criteria. The criteria with eigenvalue greater than one retained as per the Kaiser criterion is, by looking at the total variance explained table, six components which meet

the set criteria having an eigenvalue greater than one and which explain more than 80% of the variance are extracted as in Table 4-6;

Table 4-6 Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.295	37.259	37.259	12.29	37.259	37.259
2	5.756	17.441	54.700	5.756	17.441	54.700
3	4.280	12.970	67.670	4.280	12.970	67.670
4	1.975	5.984	73.654	1.975	5.984	73.654
5	1.451	4.398	78.052	1.451	4.398	78.052
6	1.111	3.366	81.417	1.111	3.366	81.417

This can be further ensured by looking at the scree plot which shows a drop at a point and the values start becoming below the set criteria of eigenvalue greater than one starting from component seven on ward which shows the analysis extracted six components that explain as much as the variance exhibited by factors as described in Fig 4-4;

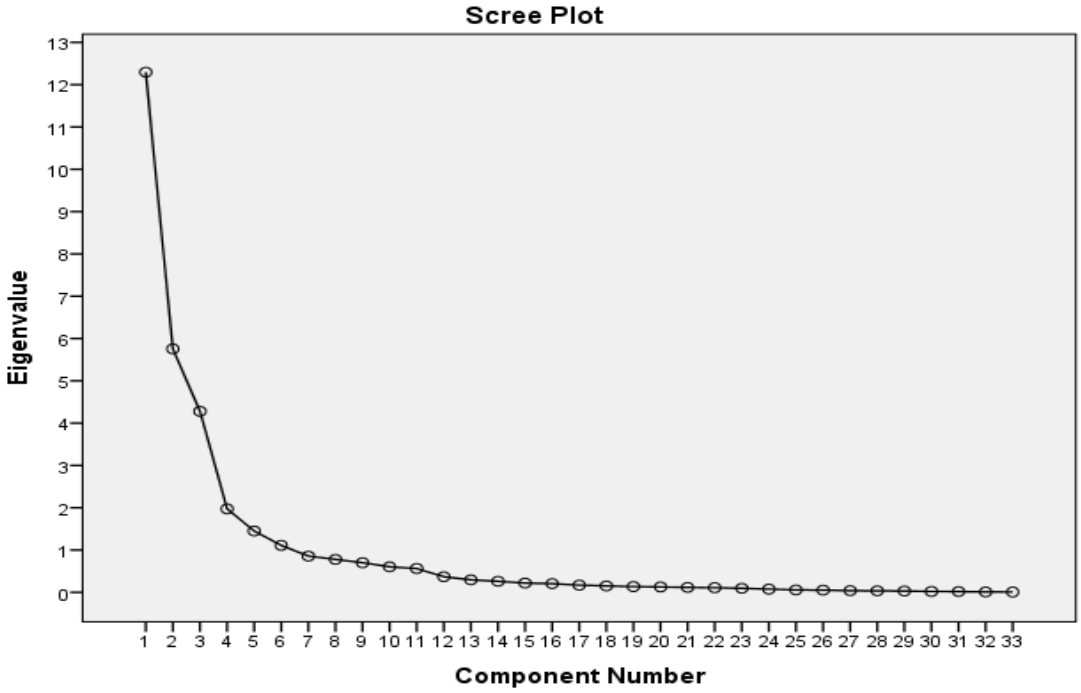

Figure 4-4 Scree plot for factor analysis of best value parameters

To identify the criteria a further look at the component matrix gives the criteria with different factor loading with respect to the retained components and those components with higher value of factor loading in each component and having more than a 0.7 factor loading in each component are the six retained criteria for this case, each criteria described namely as shown in Table 4-7;

Table 4-7 Best value criteria identified from factor analysis

	Component					
	1	2	3	4	5	6
Past project performance	.891	-.178	-.090	-.289	-.125	-.046
Warranty of works provided	.067	.793	-.408	-.211	-.080	-.060
Proposed project completion date	.594	-.231	.794	.393	.188	.205
Current workload	.012	-.228	.329	.812	-.206	-.093
Plant and equipment capacity	.135	.009	-.238	-.386	.794	-.008
Compliance with specification	.180	-.130	.290	-.096	-.227	.829

From the 33 criteria selected from different literatures, and governmental provisions, the above six representative parameters are selected for this study in order to minimize the complexity that results in including too many evaluation criteria for bids evaluation based on the suggestion from interview participants and experience seen on most literature. Additionally, each criterion is not primarily evaluated based on one merit or is not independent. For instance, while evaluating a past performance of contractor an evaluator is supposed to see from different parameters such as cost, time and quality performance of a contractor. Hence, the number of criteria is limited in this research into 6 based on the factor analysis.

The first parameter selected "past performance of a contractor", is relevant information regarding a contractor's actions under previously awarded contracts. This includes the contractor's record of conforming to specifications and to standards of good workmanship, the contractor's record of containing and forecasting costs on any previously performed contracts, the contractor's adherence to contract schedules, including the administrative aspects of performance and the contractor's history for reasonable and cooperative behavior and commitment to customer satisfaction. This information can be used to forecast the contractor's ability to undertake the

current contract effectively and are rated accordingly. A contractor with a record of unsatisfactory past performance should be screened out of the selection process as part of the responsibility determination. When a contractor's past performance record passes the responsibility determination, then the record should be compared to the other responsible offerors to determine the offeror that provides the best value.

"Compliance with specification" is in a construction context, a requirement for contractors who must satisfy the requirements of contracts, specifications, drawings, standards, best practice guidelines and legislation. When used as a historical record for contractor's performance, compliance with specification becomes a past performance parameter it-self. But in the case of best value procurement it is a separate parameter. It's not in best value procurement practice to specify every detail in the bid document in order to leave room for contractors to come up with the best proposal utilizing their expertise. Therefore, the project goals and client's minimum requirement is set and communicated in bid documents. While presenting the proposal in response to the invitation to tender and according to bid documents, a contractor who prepares a proposal that best complies with the specification scores higher on this parameter.

The third parameter "current and future workload" refers to the number and size of projects that a company is carrying out at the moment. It gives the information that whether the resources are available for a particular project depending upon the workload of a contractor during construction. When a company undertakes few projects at a time, then it would have ample capacity of resources to incorporate on multiple projects. In case the company has undertaken many projects then the resources are distributed, hence a limited capacity of equipment is available for the projects.

Furthermore, according to the responses from the interview participants, there is no mechanism in the ERA qualification criteria to limit the number of projects to be handled by a single contractor based on contractors' capacities, so the current system allows some contractors to take on more projects than they can handle. As the number of projects handled by a single bidder grows, so must the capacity to support that growth; otherwise, the contractor may suffer significant losses.

This parameter is linked to 'plant and equipment capacity' criteria in which availability of a pre-determined number of equipment and more, results in a favorable score for the contractor since it ensures that the contractor has the resources to finish the project without hindrances regarding the lack of and acquiring necessary plant and equipment. When the contractor does not manage to increase its capacity in line with the growth of its projects, the company resources are spread and its project management becomes thin, which promote the use of inexperienced employees, or be forced to hastily hire additional inexperienced project managers. When the controls are not adequate the company experience problems on its financial management, poor project management and cash flow problems.

The other parameter identified is "Warranty of works provided". Regarding this parameter, since in best value procurement the evaluation depends up on the proposal provided by the contractor in response to the invitation of the contracting authority, for attributes the contractor set forward in his proposal he must provide a warranty to create accountability and trust between the contracting entities. In best value procurement parameters such as "proposed project completion date" as extracted among the six parameters in this study which describe a different time scheme a contractor proposes to finish the project, and other parameters like alternative bids for materials, quality, need to be accompanied by a warranty so that a contractor doesn't get a maximum score for a reduction in duration of project or increment of quality on an empty promise.

Contrary to the experience from previous literatures in best value procurement model and the researcher's expectations health and safety related parameters were not among the top parameters selected here which shows that little consideration is given to health and safety as an attribute to add value to projects, whereas 'proposed design time' and 'proposal for sub-contracting' were ranked as the least important criteria respectively.

4.5 Best Value Procurement Fuzzy Comprehensive Evaluation

This step was segmented the complex problem of best value parameters into a structured hierarchy of two levels, which are level one (criteria) which includes the six selected criteria, level two (alternatives) list of contractors.

Following the first step, evaluation factor set U = (U1, U2, U3, U4, U5, U6) is set up, which represents the best value parameters selected as U1 is past project performance, U2 is warranty of works provided, U3 is proposed project completion date U4 is current workload, U5 is plant and equipment capacity and U6 is compliance with specification. For this study an evaluation set is selected from the standard bidding document which states as follows in Table 4-8;

Table 4-8 Evaluation set determined from SBD

Scoring	Description
10	Excellent
9	Very good
8-7	Good
5-6	Average
3-4	Poor
1-2	Very poor
0/ fail	Unsatisfactory

The next step after identification of best value contractor selection criteria for Ethiopian federal road authority contractor selection is to determine the relative importance (criteria weight) using pair-wise comparison based on the experts' determinations and check whether the criteria weights are consistent or not. On the second round of survey a total of 20 experts were selected from their participation in round one survey and 17 questionnaires were returned while 14 questionnaires hold a completed answer and considered for analysis. The experts' answers were computed using analytical hierarchy process used to identify the weights.

In pairwise comparison, criteria in pairs are compared to judge the best value criteria preferred among all or find similarities between them. The pairwise comparison of all the six criteria identified in the factor analysis of this study are pair wisely compared with respect to the goal of determining the priorities of the six criteria, when contractor selection is carried out. It highlights the relative importance of each criterion against study goal. Table 4-9 gives the consolidated decision matrix from respondents rating after pair-wisely comparing the criteria using Excel.

Table 4-9 Consolidated decision matrix from respondents

Matrix	P1	P2	P3	P4	P5	P6
P1	1.00	1.86	1.74	2.23	1.20	1.41
P2	0.54	1.00	4.52	1.84	1.25	2.35
P3	0.58	0.22	1.00	2.87	0.88	0.52
P4	0.45	0.54	0.35	1.00	0.33	0.84
P5	0.83	0.80	1.14	3.04	1.00	0.77
P6	0.71	0.43	1.93	1.19	1.29	1.00

The next step in AHP based weight identification is normalization of the grouped pairwise data in the above table. The goal of normalization is to change the values of numeric values in the dataset to a common scale, without distorting differences in the ranges of values. So we normalize the data to bring all the variables to the same range by dividing each data with the sum of a column.

Table 4-10 Normalized value of consolidated weight

Matrix	P1	P2	P3	P4	P5	P6
P1	0.24	0.38	0.16	0.18	0.20	0.20
P2	0.13	0.21	0.42	0.15	0.21	0.34
P3	0.14	0.05	0.09	0.24	0.15	0.08
P4	0.11	0.11	0.03	0.08	0.06	0.12
P5	0.20	0.16	0.11	0.25	0.17	0.11
P6	0.17	0.09	0.18	0.10	0.22	0.15

Criteria importance weightings in this AHP based weight identification were determined using the mean of normalized values which consists the summing of the elements of each column and then by normalization of each values in the column by dividing with the sum. Then the mean of each row corresponds to the weight value of each criterion from the second round of the survey as given in Table 4 -11;

Table 4-11 Best value Criteria importance weightings

No.	Best value Parameters	Criteria weight
1.	Past project performance	0.24
2.	Compliance with specification	0.22
3.	Warranty of works provided	0.18
4.	Plant and equipment capacity	0.15
5.	Current and future workload	0.13
6.	Proposed project completion date	0.08

For this AHP calculations done above using excel, the consistency ratio was found by dividing the consistency index with random index for six criteria which equals 1.24 and it gives the value at 7.5% which is well under the permissible 10% which assures that the values obtained are consistent. Then, the single fuzzy matrix computed using Equation 3.9 and results are illustrated in the following Table 4-12;

Table 4-12 Single fuzzy matrix of best value Criteria

Criteria	Fuzzy number				
	1	3	5	7	9
Past project performance	0.21	0.07	0.36	0.14	0.22
Compliance with specification	0.36	0.14	0.29	0.07	0.14
Warranty of works provided	0.21	0.21	0.29	0.15	0.14
Plant and equipment capacity	0.29	0.14	0.29	0.14	0.14
Current and future workload	0.29	0.15	0.21	0.14	0.21
Proposed project completion date	0.21	0.08	0.36	0.14	0.21

Lastly, computing the multi-comprehensive evaluation used to priorities the influence of criteria on best value contractor selection it is computed based on Equation 3.10 and the results are tabulated in the following Table 4-13;

Table 4-13 Multi-comprehensive evaluation of best value criteria

criteria	1	3	5	7	9	% of importance
Past project performance	0.05	0.02	0.09	0.03	0.05	24%
Compliance with specification	0.08	0.03	0.06	0.02	0.03	22%
Warranty of works provided	0.04	0.04	0.05	0.03	0.03	18%
Plant and equipment capacity	0.04	0.02	0.04	0.02	0.02	15%
Current and future workload	0.04	0.02	0.03	0.02	0.03	13%
Proposed project completion date	0.02	0.01	0.03	0.01	0.02	8%

Calculating the arithmetic mean value of each factor will result in the importance of the factor using fuzzy comprehensive evaluation which is similar to the weight identified using AHP. Recalling Equation 3.3 of the original Dean Kashiwagi model, the best value for a contractor scored based on the submitted proposal can be generally re-written based on this research finding as follows;

$$BV_{j(p1)} = PS_{past\ performance} * 0.24 \quad \text{Equation 4-1}$$

$$BV_{j(p2)} = PS_{compliance\ with\ specification} * 0.22 \quad \text{Equation 4-2}$$

$$BV_{j(p3)} = PS_{Warranty\ of\ works\ provided} * 0.18 \quad \text{Equation 4-3}$$

$$BV_{j(p4)} = PS_{Plant\ and\ equipment\ capacity} * 0.15 \quad \text{Equation 4-4}$$

$$BV_{j(p5)} = PS_{Current\ and\ future\ workload} * 0.13 \quad \text{Equation 4-5}$$

$$BV_{j(p6)} = PS_{Proposed\ project\ completion\ date} * 0.08 \quad \text{Equation 4-6}$$

Combining the above equations from equation 4.3 up to 4.8 will give the total best value score for a given contractor as follows;

$$BV_j = \sum_{p=1}^{n} BV_{(p)} \quad \text{Equation 4-7}$$

Where, BV_j- total best value score for contractor $_j$, BV_P – best value score on each parameter p, and n- number of parameters which is six in this model.

From the above equation, the only unknown value which will be determined through the evaluation process is the parameter scale and score for each contractor. This value is mainly project specific and will be determined by the decision makers at the beginning of project planning. The six criteria identified are represented as follows; "P_1" represents the parameter

"Past project performance", "P_2" represents the parameter that is "Compliance with specification" and so on until "P_6" representing parameter "Warranty of works provided". Additionally based on the research results, "W_1" is the weight of P_1 "past project performance" which equals to 0.24 and "W_2" is the weight of P_2 "Compliance with specification" as 0.22, "W_3" is the weight of P_3 "warranty of works provided" which equals to 0.18, "W_4" is the weight of P_4 "plant and equipment capacity" as 0.15, "W_5" is the weight of P_5 "Current and future workload" which equals to up to 0.13 and "W_6" representing the weight of P_6 "Proposed project completion date" as 0.08 based on the weight findings on Table 4.11. Based on the SBD for evaluation purpose the following linguistic terms 'Excellent', 'Very good', 'Good', 'Satisfactory', 'Poor', 'Very poor' and 'unsatisfactory' are used.

Table 4-14 Linguistic rating scale of bids and fuzzy number coding

Linguistic variable (F)	Fuzzy number coding
Unsatisfactory	Fa
Very poor	Fb
Poor	Fc
Average	Fd
Good	Fe
Very good	Ff
Excellent	Fg

For this research the triangular fuzzy numbers for the given 7 scale linguistic terms are described graphically in the following Fig 4-5;

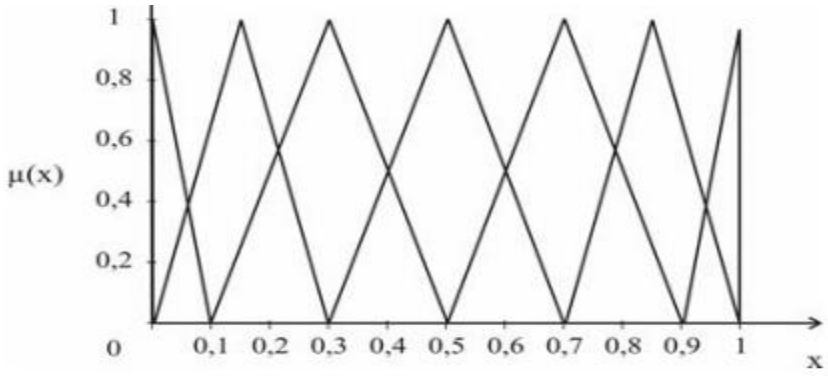

Figure 4-5 Graphical representation of fuzzy numbers

Where, 'X' represents the factors identified and μ(X) representing the degree of membership of x. The list of fuzzy numbers for the above graphical representation is given by Table 4-15;

Table 4-15 Triangular fuzzy numbers for linguistic variables

Linguistic variable (F)	Fuzzy number coding	Fuzzy membership
Unsatisfactory	Fa	(0,0,0.1)
Very poor	Fb	(0,0.15,0.3)
Poor	Fc	(0.1,0.3,0.5)
Average	Fd	(0.3,0.5,0.7)
Good	Fe	(0.5,0.7,0.9)
Very good	Ff	(0.7,0.85,1)
Excellent	Fg	(0.9,1,1)

Fuzzy score of each contractor on each criterion can then be calculated by transforming the linguistic variables to fuzzy numbers as stated in the above Table 4-15 for each parameter. Then to compute the total fuzzy score for each criterion and development of total fuzzy Score matrix, based on the general combining operation on fuzzy numbers. After identifying the total score, normalized fuzzy score of each contractor on each criterion is computed using the formula

$$NS_F = \frac{Total\ fuzzy\ score\ (Sf)\ of\ each\ criterion}{number\ of\ descision\ makers\ (m)} \ldots\ldots\ldots\ldots\ldots\ldots \textit{Equation 4-8}$$

The de-fuzzification method using the center-of-area is calculated by using the following simplified formula given for the triangle is given as;

$$Sc = \left(\frac{x1+2x2+x3}{3}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{Equation 4-9}$$

Therefore, the total crisp score will be calculated as;

$$TSc_{for\ c1} = NS_{f_{C_1P_1}} * w1 + NS_{f_{C_1P_2}} * \ w2 + \cdots + NS_{f_{C_1P_6}} * w6 \ldots\ldots\ldots\ldots \textit{Equation 4-10}$$

Then ranking of contractors by normalized total weighted crisp score (NTSc) will identify the best valued contractor as shown below.

$$NTSc_{\ for\ contractor\ 1} = \frac{TSc_{for\ contractor\ 1}}{\sum_1^r TSc_{for\ contractors}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{Equation 4-11}$$

As a summary, this section presents the development stages of fuzzy comprehensive evaluation for best value contractor selection. Particularly, by identifying best value parameters for Ethiopian road projects and computing their weight through a two round survey, best value tender evaluation model and its sequential steps were developed.

4.6Proposed Best Value Procurement Evaluation Review

The major goal of the evaluation review was to assess the proposed evaluation's suitability, relevance, clarity to the contractor selection for Ethiopian road authority and to achieve the aims of review as discussed below. As described in the methodology section, a total of seven experienced members of the engineering procurement directorate of Ethiopian road authority (ERA) were selected using a referral from the professional stuff of Ethiopian road authority (ERA) and five participants who agreed to participate in the interview were contacted and the interview was scheduled. The interview participant profile is in the following Table 4-16;

Table 4-16 Profile of interview participants

Interviewees	Position	Educational qualification	Experience In procurement
Interviewee 1	Lead Engineer	BSc	7 years
Interviewee 2	Senior Engineer	BSc	11 years
Interviewee 3	Project Engineer	MSc	6 years
Interviewee 4	Senior Engineer	MSc	12 years
Interviewee 5	Lead Engineer	MSc	8 years

The interview general description was sent a few days ahead of the interview which included a brief description of the proposed best value evaluation, explaining the best value procurement, the parameters selected, and the procedure. During the interview process including confidentiality of data, purpose of interviews and how the data was applied in the research were explained and assured. During the interview, the best value procurement evaluation was briefly explained with some background information. Each interviewee who participated in this validation process was asked a total of four questions to assess the model against as provided in

Appendix C at the end of this paper. The results of the validation are discussed under here as follows.

- ✓ To identify the appropriateness and completeness of best value evaluation criteria, and their importance weights

Regarding this objective of the validation, participants were asked if the list of contractor selection criteria identified here is comprehensive and if there are there other criteria that must be added based on their opinion and the following answers were given. Interviewee 1 said that the criteria list is comprehensive and good as an initial list and as a new foundation of knowledge since the industry lacks the experience of best value currently.

However, while interviewee 2 and 3 agreed with the list of the criteria being comprehensive, citing that some of the criteria are in use currently, indicated that selecting no more than 10 criteria is better as some of the criteria listed can be further divided into sub sections during evaluation and it can be tedious. Furthermore, interviewee 4 emphasized the need of avoiding inclusion of a criterion for which all the contractors would give same answer when best value is applied, therefore, when the industry becomes mature and experienced with best value, some of the criteria can be eliminated which all the contractors can meet. Interviewee 5 highlighted that selection of criteria should be project specific and suggested that 'performance on ongoing projects' must be included in the evaluation criteria and a minimum score for criteria must be set by decision makers. The respondents commented that considering value in selection process is what the industry currently lacks and emphasized its significance.

- ✓ To explore the opinions of experts towards practicality of the evaluation, as such appropriateness and ease of use in practice

The evaluation's relevance was acknowledged by respondents in selecting the best value contractors, and the use of fuzzy numbers to address uncertainty. The validations results indicate that overall best value tender evaluation model is easy to implement since the computations can easily be done in excel. Interviewees in general indicated that the current practice is not supported by models and software which can reduce repeated and tedious works and human errors during tender evaluation and the development of such models is appreciated. However, emphasized that the model by itself cannot ensure the selection of best value since other factors

such as corruption, industry experience and other procurement factors affect the selection process also.

Regarding the appropriateness of the model, the interviewees expressed difficulty to comment because of the lack of best value procurement practice in the current system to compare the model to. But as a proposed model for future use interviewees commented that it is in line with rules and regulations regarding procurement and it can even be applied for weighted average bid evaluation computations currently. Interviewee 5 further recommended that while making project specific criteria, the decision making members can use a fuzzy approach to rate criteria importance and the use of fuzzy AHP method for weight identification.

- ✓ To rate and discuss the ways of improving the model, if any, for use

Interviewees remarked that application of best value in tender evaluation is a new concept for our industry, so the model is significant. They highlighted that the model enhances the tender evaluation process more systematic and realistic way to achieve value for projects. Out of the five participants two of them strongly recommended the use of the model, while the other two rated the model as recommended and one interviewee rated the model as not sure by citing the criteria have to be project specific to meet the objective of each project. Which overall shows that the model received more than a half recommended ratings and hence proves that its suitability.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATION

5.1Conclusion

The research and research findings are concluded in terms of identifying the contribution of the work towards achieving the study's objectives, and the following conclusions are drawn based on the findings of the desk study and the data obtained through both the questionnaire and the interview.

- ✓ As it can be understood from the findings of the research, the mostly used contractor selection approach used in federal road projects contractor selection is competitive low bid approach in which many researchers attribute the problems related with poor cost, time and quality performance of contractors to for its focus on the lowest price as a main evaluation criterion since it can be difficult to achieve the desired project objectives relying on price.
- ✓ The lowest evaluated bid method is being given a higher application and preference in ERA contract selection and other contractor selection approaches such as best value procurement, fixed budget/best design selection and sole source selection are not practiced for a variety of reasons such as lack of legal or regulatory provision, organizational guideline and
- ✓ Additionally, the current contractor selection criteria are used to identify the responsive bidder among bidders against a pre-set score by the Authority in which the contractors who pass the minimum set score are eligible for evaluation of price proposal and the lowest bid price offering contractor is awarded the contract. Which from the best value point of view, doesn't ensure the selection of best valued contractor as the main evaluation criteria is only price.
- ✓ The main element in the best value procurement is the identification of best value parameters in terms of adding value to projects and these criteria are subjective in nature and differ from organization to organization as their core emanates from organization objective, mission and value. Based on these principles six parameters selected as a best value parameter for federal road projects' contractor selection in addition to the current selection criteria are past project performance, compliance with specification, current and future workload, proposed project completion date, plant and equipment capacity, and warranty of works provided.

5.2 Recommendations

The Findings from this research imply that pervious researches in improving contractor selection has shown a significant concern in introducing improved methodologies and models for the process of bid evaluation and contractor selection. Although such efforts are to be appreciated, there is still a need to present new methods such as best value procurement to overcome the difficulty of contractor selection and consider value. Therefore, the following recommendations are made based on the research.

5.2.1 Recommendations from this research

- ✓ To implement the proposed and additional mathematical models that will work in tandem with the country's construction and procurement law to achieve actual value for money and reduce underperformance issues, it is recommended that Public Procurement and Property Administration Agency examine the benefits and drawbacks of the country's current contractor evaluation and selection procedures and design a provision for the application of best value procurement and also its commended for ERA to prepare a revised contractor selection scheme accordingly.
- ✓ To avoid unethical work due to subjectivity of technical evaluations and to raise the success rate of the suggested model, it is recommended enhancing the efficiency of the decision makers, with constant training program and efforts to be made to build up the decision makers' ability to be free of prejudice and in line with the system's function.
- ✓ Similar to many federal public projects use of the two types of evaluation methods that are lowest evaluated bid and weighted average method, it is suggested that ERA as an entity entitled for the procurement for federal road projects' contractor selection, use weighted average method incorporating best value procurement evaluation to minimize the adverse effects of using low bid selection.

5.2.2 Recommendations for future research

- ✓ Application of different optimization model and software can have a significant advantage in making the process of contractor selection more precise, optimized and time saving as well as help in avoiding human factors. Therefore, different researches in the area of applying best

value procurement model using the diverse mathematical models, formulas and software for improving the contractor selection evaluation method is recommended.

- ✓ Additionally, studying the construction industry readiness in order to adapt best value procurement, its challenges and benefits is also another future area of research recommended.
- ✓ Additionally, this research is conducted from the perspective of Ethiopian road authority and didn't incorporate the view of other stakeholders in the construction of road projects. However, it is recommended that future researches to be made considering the perspective of other stakeholders regarding best value procurement.
- ✓ Another recommendation from this research for future research is the development of best value procurement model based on project specific characteristics so that each criterion is tailor made to a specific project and can identify these criteria along with the scale a parameter can be evaluated easily.

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APPENDIX

Appendix A: list of general best value evaluation criteria

No.	Evaluation criteria	Hasnain and Thaheem (2016)	Hasnain et al. (2018)	Nguyen et al. (2018)	Ahmed (2011)	Narmo et al. (2018)	(Magdy	Storteboom (2017)	Buba et al. (2020)	Kakarapalli (2018)	Kolli (2015)	Tran et al. (2016)	Revised PPA for ERA
1.	Proposed initial bid price	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
2.	Proposed Low project life cycle cost	✓	✓	✓	✓	✓	✓		✓		✓		
3.	Financial capability of the contractor	✓	✓		✓	✓	✓		✓		✓		✓
4.	Financial stability of the contractor		✓	✓				✓		✓			✓
5.	Firm's annual turnover		✓		✓	✓			✓	✓		✓	✓
6.	Proposed design time	✓	✓	✓	✓		✓	✓		✓	✓		
7.	Additional financial resources	✓	✓	✓					✓	✓			
8.	Project schedule plan	✓			✓		✓	✓		✓	✓	✓	✓
9.	Actual schedule achieved for similar works.	✓	✓	✓			✓		✓				
10.	Estimated project completion date		✓		✓	✓	✓		✓	✓		✓	
11.	Past project performance	✓	✓	✓	✓		✓	✓		✓	✓		
12.	History of non-performing contracts		✓	✓					✓	✓			✓
13.	General engineering experience	✓			✓		✓	✓		✓	✓	✓	✓
14.	Key personnel experience	✓	✓	✓			✓	✓	✓				
15.	Number of key qualified personnel	✓	✓	✓			✓	✓					✓
16.	Specific construction experience in key activities		✓		✓	✓	✓	✓	✓		✓		✓
17.	Plant and equipment capacity	✓		✓		✓				✓		✓	✓
18.	Proposal for sub-contracting	✓		✓				✓		✓			✓
19.	Quality management plan	✓			✓	✓			✓	✓	✓		
20.	Warranty of works provided		✓				✓	✓					
21.	Amount of rework on past	✓			✓					✓		✓	

	projects												
22.	Compliance with specification	✓		✓			✓	✓	✓				
23.	Proposed construction Methods	✓			✓		✓						✓
24.	Site Utilities Plan		✓	✓				✓		✓			
25.	Organizational references				✓	✓		✓	✓		✓		
26.	Project control policy	✓		✓		✓				✓		✓	
27.	Project management plan	✓		✓				✓		✓			
28.	Project work breakdown structure					✓			✓	✓	✓		
29.	Health & safety record or plan	✓	✓				✓	✓					
30.	Alternative bids for materials	✓			✓		✓			✓		✓	
31.	Accident rate records							✓	✓				
32.	Environmental Considerations	✓		✓			✓	✓		✓			
33.	Mix Designs alternates	✓											
34.	Waste removal/reduction plan		✓			✓			✓	✓	✓		
35.	Optional features offered	✓					✓	✓					
36.	Sequencing of work plan	✓			✓		✓			✓		✓	
37.	Current workload	✓				✓	✓	✓	✓				✓

Appendix B: Questionnaires

Questionnaire 1

Adama Science And Technology University

School of Civil Engineering and Architecture

MSC program in Construction Engineering and Management

Questionnaire 1

Dear Respondent,

I am currently undertaking a Master of Science (MSc) degree in Construction Engineering and Management at Adama Science and Technology University (ASTU). By responding to this questionnaire, your will help me realize my final thesis work on the subject "Best Value Procurement Evaluation for Federal Road Projects' Contractor Selection from the Ethiopian Roads Authority Perspective".

> Best Value procurement is defined as a method that concentrates on achieving the highest value by considering both cost- and qualifications-based criteria in the contractor selection process. It examines various factors that need to be considered in procurement processes to enrich the long-term performance and significance of the construction. It is an effective technique for reducing costs, increasing productivity and improving quality.

The survey aims at investigating the current best value procurement related practices and challenges associated, and to develop a framework for best value procurement model application based on identified parameters and their assigned weight.

Please read each question or statement carefully and try to answer all questions honestly and to your best knowledge. Your answers will be treated confidentially since anonymity of the answers is guaranteed by the researcher and the answers are used only for academic purpose. I greatly appreciate your cooperation and contribution to the success of this study by genuinely participating in this questionnaire. If you have any questions about the survey, you may contact sarendemzeynu@gmail.com/+251904117113

Thank you,

Hanan Zeinu

Post Graduate Student (Construction Engineering and Management)

Adama Science and Technology University

Section 1: General Background Information

Please tick in the appropriate box and fill the blank spaces provided as appropriate.

1.1 Name of organization: _____

1.2 Educational Qualification:

Diploma ☐ First degree ☐ Master's degree ☐ others _____

1.3 What work position do you hold in your organization?

_____

1.4 How long have you been working in your organization?

1 – 5 years ☐ 11 – 15 years ☐

6 – 10 year ☐ More than 15 years ☐

1.5 How long have you been working specifically on road project procurement?

1 – 5 years ☐ 11 – 15 years ☐

6 – 10 year ☐ More than 15 years ☐

Section 2: General current best value related practice Information

2.1 What is ERA'S frequently used contractor selection approach for most projects?

Qualification based selection ☐ Sole Source selection ☐

Best Value selection ☐

Competitive Lowest Bid ☐

Fixed Budget/Best Design Selection ☐

Other (please specify) _____

2.2 If your answer to the question in 2.1 is other than best value selection, what are the reasons behind the non-implementation of best value procurement?

Traditional procurement methods are adequate ☐

Lack of legal or regulatory permissions for the method ☐

Organization expertise not available ☐

Lack of staffing to oversee best value selection ☐

Other, please specify; _____

_____

_____

2.3 When awarding projects using selection criteria, what selection algorithms do you use?

Meets Technical Criteria-Low Bid	☐	Quantitative Cost Technical Tradeoff	☐
Fixed Price--Best Proposal	☐	Qualitative Cost Technical Tradeoff	☐
Weighted Criteria	☐	Adjusted Bid or Adjusted Score	☐

Other please specify; _____

2.4 When evaluating contractors using selection criteria, what evaluation scoring or rating system do you use?

Satisficing	☐
Modified Satisficing	☐
Adjectival Rating	☐
Direct Point Scoring	☐

Section 3: Best Value Contractor Selection Parameters identification information

Below are a number of best value parameters identified from Desk study, please rate the degree of importance of the following best value contractor selection parameters for road construction projects based on their importance to adding value to projects using the following scale: Please tick in the appropriate box

1-no importance;

2-very low importance;

3-low importance;

4-high importance; and

5-very high importance

No.	Best value Contractor selection parameters	Parameter importance rate				
		1	2	3	4	5
1.	Financial capability and stability of the contractor					
2.	Firm's annual turnover					
3.	Proposed design time					
4.	Project schedule plan					
5.	Estimated project completion date					
6.	Past project performance					
7.	History of non-performing contracts					
8.	General engineering experience					
9.	Key personnel experience and qualification					
10.	Number of key qualified personnel					
11.	Specific construction experience in key activities					
12.	Plant and equipment capacity					
13.	Proposal for sub-contracting					
14.	Quality management plan					
15.	Warranty of works provided					
16.	Amount of rework on past projects					
17.	Construction Engineering Inspection plan					
18.	Compliance with specification					
19.	Proposed construction Methods					

20.	Organizational references					
21.	Project control policy					
22.	Project management plan					
23.	Project work breakdown structure					
24.	Alternative bids for materials					
25.	Mix Designs alternates					
26.	Current workload					
27.	Sequencing of work plan					
28.	History of delay claims					
29.	Health & safety record and/or plan					
30.	Site Utilities Plan					
31.	Accident rate records					
32.	Environmental Considerations					
33.	Waste removal/reduction plan					

Thank you very much for your time and cooperation

Questionnaire 2

Adama Science And Technology University

School of Civil Engineering and Architecture

MSC program in Construction Engineering and Management

Questionnaire round 2

Dear Respondent,

I am currently undertaking a Master of Science (MSc) degree in Construction Engineering and Management at Adama Science and Technology University(ASTU). By responding to this questionnaire, your will help me realize my final thesis work on the subject "Best Value Procurement Evaluation for Federal Road Projects' Contractor Selection from the Ethiopian Roads Authority Perspective".

> Best Value procurement is defined as a method that concentrates on achieving the highest value by considering both cost- and qualifications-based criteria in the contractor selection process. It examines various factors that need to be considered in procurement processes to enrich the long-term performance and significance of the construction. It is an effective technique for reducing costs, increasing productivity and improving quality.

This survey aims at identifying the weight of best value procurement parameters previously identified from round one survey in order to develop a model based on identified parameters and their assigned weight.

Please read each parameter carefully and try to give weight to your best knowledge. Your answers will be treated confidentially since anonymity of the answers is guaranteed by the researcher and the answers are used only for academic purpose. I greatly appreciate your cooperation and contribution to the success of this study by genuinely participating in this questionnaire. If you have any questions about the survey, you may contact sarendemzeynu@gmail.com/+251904117113

Thank you, *Hanan Zeinu*

Post Graduate Student (Construction Engineering and Management)

Adama Science and Technology University

Best Value Contractor Selection Parameters weight identification information

Below are a number of best value parameters identified from Round 1 questionnaire survey, Please give a pairwise relative importance weight to the following best value contractor selection parameters for road construction projects based on their importance to adding value to projects

Linguistic Term	Crisp Value
Equal importance	1
Moderate importance	3
Strong importance	5
Very strong importance	7
Extremely strong importance	9

You can use 2, 4, 6, 8 for intermediate values.

Comparison of criteria			
A	Respondents opinion		B
	A	B	
Past project performance with			compliance with specification
Past project performance with			current and future workload
Past project performance with			proposed project completion date
Past project performance with			plant and equipment capacity
Past project performance with			warranty of works provided
Compliance with specification with			current and future workload
Compliance with specification with			Proposed project completion date
Compliance with specification with			plant and equipment capacity
Compliance with specification with			warranty of works provided
Current and future workload with			proposed project completion date
Current and future workload with			plant and equipment capacity
Current and future workload with			warranty of works provided
Proposed project completion date with			plant and equipment capacity
Proposed project completion date with			warranty of works provided
plant and equipment capacity with			warranty of works provided

Appendix C: Interview Questions

1. Name:*(Optional)* _____
2. Position: _____
3. How long have you worked in ERA**?**

Current best value related practice in ERA questions

4. Which type of procurement approach does ERA use for projects?

   _____

5. What contractor selection criteria does ERA use to select contractors?
6. Based on your professional opinion what contractor selection parameters are important in-terms of adding value to projects not included in the study?

   _____

7. Based on your professional opinion, how many contractor selection criteria should there be in a best value procurement method considering organization capacity and ease of evaluation?
8. Based on your professional opinion, what is the reason behind the slow adoption of Best value procurement?
9. Is the process permitted by applicable law?

   _____

Model validation interview

1) Is the list of contractor selection criteria comprehensive? Are there other criteria that must be added criteria opinion?
2) To what extent is the proposed model practical and ease of use? Please, Specify the practical limitations for industry use.
3) Based on your professional opinion do you think the model will facilitate the selection of the most appropriate contractor in a contractor selection process?
4) How would you rate the model (strongly recommended/recommended/not sure/not recommended

Appendix D: Different analysis results

Percentage of total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.295	37.259	37.259	12.295	37.259	37.259
2	5.756	17.441	54.700	5.756	17.441	54.700
3	4.280	12.970	67.670	4.280	12.970	67.670
4	1.975	5.984	73.654	1.975	5.984	73.654
5	1.451	4.398	78.052	1.451	4.398	78.052
6	1.111	3.366	81.417	1.111	3.366	81.417
7	.858	2.600	84.017			
8	.780	2.364	86.381			
9	.701	2.125	88.507			
10	.604	1.831	90.337			
11	.563	1.707	92.044			
12	.370	1.120	93.165			
13	.296	.897	94.062			
14	.262	.793	94.855			
15	.220	.668	95.523			
16	.207	.627	96.149			
17	.172	.520	96.669			
18	.153	.463	97.133			
19	.137	.414	97.547			
20	.128	.388	97.934			
21	.116	.352	98.286			
22	.111	.335	98.621			
23	.096	.291	98.913			
24	.076	.231	99.144			
25	.058	.177	99.321			
26	.053	.162	99.483			

27	.041	.125	99.608			
28	.037	.111	99.719			
29	.033	.099	99.818			
30	.022	.066	99.883			
31	.020	.061	99.944			
32	.010	.030	99.974			
33	.009	.026	100.000			

Component matrix

	Component					
	1	2	3	4	5	6
past project performance	.891	-.178	-.090	-.289	-.125	-.046
plant and equipment capacity	.135	.009	-.238	-.386	.794	-.008
proposed design time	.246	.643	.071	-.020	-.166	.093
project schedule evaluation plan	.465	.431	.558	-.117	.173	-.229
accident rate records	.642	.029	-.369	-.113	-.175	-.266
financial capability and stability	.666	-.002	-.330	-.464	.181	.228
history of non-performing contracts	.671	-.389	.062	-.413	.029	.082
general engineering experience	.571	-.503	.366	-.078	-.117	-.078
key personnel experience	.582	.678	-.016	-.051	-.076	-.097
number of key qualified personnel	.502	.607	-.006	.095	-.037	.054
specific construction experience in key activities	.419	-.394	-.038	-.458	.101	.555
firms annual turnover	.563	.642	.125	-.112	-.169	-.153
proposal for sub-contracting	.033	.651	.410	-.121	.387	-.075
current workload	.012	-.228	.329	.812	-.206	-.093
mix design alternates	.386	-.214	-.417	.056	.446	-.487
amount of rework on previous works	.669	-.147	.422	.276	.334	-.014
inspection plan	.531	-.131	.607	.300	.013	-.030
warranty of works provided	.067	.793	-.408	-.211	-.080	-.060
compliance with specification	.180	-.130	.290	-.096	-.227	.829
organizational reference	.722	.042	-.289	.170	.438	-.113
project control policy	.379	.176	.468	.061	-.050	.109
project management plan	.327	.635	.182	.033	-.037	.217
alternative bid for materials	.620	.321	-.425	.375	-.320	.073
proposed construction methods	.743	-.164	-.013	.356	-.276	.051
proposed alternative pavement types	.495	-.654	.258	.251	-.285	-.046
quality management plan	.696	.099	-.409	-.021	-.172	-.172
sequencing of works	.646	.362	-.419	.206	.014	.075
history of delay claims	.623	-.448	.500	-.232	.060	-.118

health and safety record/plan	.330	-.385	-.187	.238	.250	.016
site utility plan	.543	-.677	.055	.280	.136	.164
proposed project completion date	.594	-.231	.794	.393	.188	.205
environmental consideration	.570	.318	-.534	.319	.195	.307
waste removal/reduction plan	.360	.614	.552	-.008	.184	.128

Extraction Method: Principal Component Analysis.

a. 6 components extracted.

Communalities

	Initial	Extraction
past project performance	1.000	.935
compliance with specification	1.000	.798
plant and equipment capacity	1.000	.851
waste removal/reduction plan	1.000	.861
quality management plan	1.000	.829
warranty of works provided	1.000	.855
health and safety record/plan	1.000	.412
history of delay claims	1.000	.910
proposed project completion date	1.000	.916
proposed alternative pavement types	1.000	.886
environmental consideration	1.000	.946
site utility plan	1.000	.879
sequencing of works	1.000	.773
proposed construction methods	1.000	.784
alternative bid for materials	1.000	.917
project management plan	1.000	.731
organizational reference	1.000	.840
current workload	1.000	.872
project control policy	1.000	.909
firms annual turnover	1.000	.810
inspection plan	1.000	.759
amount of rework on previous works	1.000	.879
proposal for sub-contracting	1.000	.763
mix design alternates	1.000	.808
proposed design time	1.000	.516
key personnel experience	1.000	.817
specific construction experience in key activities	1.000	.860
general engineering experience	1.000	.738
number of key qualified personnel	1.000	.765
project schedule evaluation plan	1.000	.809
history of non-performing contracts	1.000	.784
accident rate records	1.000	.803
financial capability and stability	1.000	.852

Extraction Method: Principal Component Analysis.

AHP individual participants pairwise comparison

1 Participant 1

	1	2	3	4	5	6
1	**1**	2	5	5	3	1
2	1/2	**1**	5	7	3	2
3	1/5	1/5	**1**	2	1	1/3
4	1/5	1/7	1/2	**1**	1/3	1
5	1/3	1/3	1	3	**1**	1
6	1	1/2	3	1	1	**1**

2 Participant 2

	1	2	3	4	5	6
1	**1**	3	3	9	3	1
2	1/3	**1**	3	9	3	2
3	1/3	1/3	**1**	3	1	1/2
4	1/9	1/9	1/3	**1**	1/4	1
5	1/3	1/3	1	4	**1**	1/2
6	1	1/2	2	1	2	**1**

3 Participant 3

	1	2	3	4	5	6
1	**1**	1	5	7	1	1
2	1	**1**	7	9	3	3
3	1/5	1/7	**1**	2	1	1/3
4	1/7	1/9	1/2	**1**	1/2	1
5	1	1/3	1	2	**1**	1
6	1	1/3	3	1	1	**1**

4 Participant 4

	1	2	3	4	5	6
1	**1**	1	5	7	1	1
2	1	**1**	7	9	1	2
3	1/5	1/7	**1**	2	1	1/3
4	1/7	1/9	1/2	**1**	1/2	1/2
5	1	1	1	2	**1**	1/3
6	1	1/2	3	2	3	**1**

10 Participant 10

	1	2	3	4	5	6
1	**1**	1	5	7	1	1
2	1	**1**	5	7	1	3
3	1/5	1/5	**1**	2	1	1/3
4	1/7	1/7	1/2	**1**	1/2	1/2
5	1	1	1	2	**1**	1/3
6	1	1/3	3	2	3	**1**

6 Participant 6

	1	2	3	4	5	6
1	**1**	1	5	9	2	1
2	1	**1**	7	9	1	3
3	1/5	1/7	**1**	3	1	1
4	1/9	1/9	1/3	**1**	1/2	1/3
5	1/2	1	1	2	**1**	1
6	1	1/3	1	3	1	**1**

7 Participant 7

	1	2	3	4	5	6
1	**1**	1	5	9	3	1
2	1	**1**	7	9	1	3
3	1/5	1/7	**1**	2	1	1
4	1/9	1/9	1/2	**1**	1/2	1/3
5	1/3	1	1	2	**1**	1/2
6	1	1/3	1	3	2	**1**

8 Participant 8

	1	2	3	4	5	6
1	**1**	1	5	9	3	3
2	1	**1**	7	9	2	3
3	1/5	1/7	**1**	3	1	1
4	1/9	1/9	1/3	**1**	1/3	1
5	1/3	1/2	1	3	**1**	1/5
6	1/3	1/3	1	1	5	**1**

11 Participant 11

	1	2	3	4	5	6
1	**1**	4	3	5	1	2
2	1/4	**1**	3	5	1	3
3	1/3	1/3	**1**	2	1	1
4	1/5	1/5	1/2	**1**	1/3	3
5	1	1	1	3	**1**	1
6	1/2	1/3	1	1/3	1	**1**

5 Participant 5

	1	2	3	4	5	6
1	**1**	3	4	7	1	5
2	1/3	**1**	2	5	1	3
3	1/4	1/2	**1**	4	1	1/2
4	1/7	1/5	1/4	**1**	1/4	1
5	1	1	1	4	**1**	1
6	1/5	1/3	2	1	1	**1**

14 Participant 14

	1	2	3	4	5	6
1	**1**	1	4	9	1	4
2	1	**1**	1/2	9	1/3	3
3	1/4	2	**1**	7	1	3
4	1/9	1/9	1/7	**1**	1/5	1/2
5	1	3	1	5	**1**	3
6	1/4	1/3	1/3	2	1/3	**1**

13 Participant 13

	1	2	3	4	5	6
1	**1**	3	5	9	2	1
2	1/3	**1**	7	9	2	3
3	1/5	1/7	**1**	3	1	1/3
4	1/9	1/9	1/3	**1**	1/3	1/2
5	1/2	1/2	1	3	**1**	1
6	1	1/3	3	2	1	**1**

12 Participant 12

	1	2	3	4	5	6
1	**1**	1	2	7	1/3	1
2	1	**1**	2	7	1/3	3
3	1/2	1/2	**1**	3	1/2	1
4	1/7	1/7	1/3	**1**	1/7	2
5	3	3	2	7	**1**	3
6	1	1/3	1	1/2	1/3	**1**

9 Participant 9

	1	2	3	4	5	6
1	**1**	1	5	9	1/2	1
2	1	**1**	7	9	2	3
3	1/5	1/7	**1**	2	1	1
4	1/9	1/9	1/2	**1**	1/4	1/2
5	2	1/2	1	4	**1**	1
6	1	1/3	1	2	1	**1**