ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Identification of Factors Affecting Bid No Bid Decision for Construction Projects in Addis Ababa and Developing Decision Model Using Fuzzy Rule -Based System

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DECLARATION

Hereunder, I have attached my research work and taken into consideration acknowledgments of other scholars' work through referencing. This has been written by me and not submitted for any pervious degree.

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Date: July 2021

Place: Addis Ababa, Ethiopia

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ABSTRACT

The main way of acquiring a job for a construction company is through competitive bid. Most of the time, bid invitations float for a short period of time and are seasonal. This activity is critical as it is done frequently, quickly, and intuitively. For a construction company, the decision to participate in a bid has to be done wisely. This decision is influenced by different factors and it varies with different background.

In related to this, current research has been done to study the factors affecting bid decision as well as develop model. The purpose of this research paper was to identify factors and examine which of these factors had a relationship with the decision to bid or not to bid. The research results show that prequalification requirements have a significant relation with the decision to not bid or bid and the other factors include turn over requirements, ability to do the job, project tie with company future , future projects, overall economy (availability of work), past experience in managing similar projects and market conditions (stability of material prices).

The decision support model was developed using multi-variable regression and the Fuzzy Rule-Based (FRB) System. For the FRB model, the C-means clustering technique is applied for generating membership function and rule base.

The Data driven fuzzy rule base system model has been selected as the Mamdani or Linear Sugeno type having 38 rules, 14 inputs and 1 output structure and showed an R^2 value of 85. Multiple linear regressions resulted in having a 3 variable model using a stepwise approach with an R^2 value of 69and was a good fit.

It has been established that for contractors it is better to use such predictive models to support their decision to bid.

Key words: Bid no bid decision; Multiple linear regression; Data driven fuzzy rule-based systems

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List of abbreviations

ANOVA	Analysis of variance
B	Unstandardized coefficient
DDFRBM	Data driven fuzzy rule base model
EPC	Engineering procurement and construction
F	F - ratio
FDRE	Federal Democratic Republic of Ethiopia
FIDIC	International federation of consulting engineers
FRB	Fuzzy Rule Base
GDP	Gross domestic product
PPA	Public Procurement Agency
R	Correlation coefficient
R^2	Coefficient of determination
R^2	Mean Square error
Sig	Significance
SPSS	Statistical package for the social sciences
t	t-statistic
RMSE	Root mean square error
MAPE	Mean average percentage error
MLRM	Multiple linear regression model
VIF	Variation inflation factor
β	Under standard coefficient beta
D_f	Degrees of freedom

1. Introduction

This chapter provides a brief background discussion on the importance of bid decision at the beginning of construction projects and introduces the research problem and the need, along with the research purpose, questions, and the contribution to the construction industry.

1.1. Background

The construction industry here in Ethiopia is the backbone of the development of the nation's economy. This industry's objective/outcome is to acquire assets and deliver attainable, time-bound goals. This includes accomplished construction projects to satisfy the demands of other sectors and the national economy. Because of this, and for other reasons, the government has invested a lot of budget in the sector. The sector also contributed about 8.5% of the GDP in 2014/2015G.C.(Zerihun et al., 2016).

Moreover, the number of private construction companies engaged in the sector is increasing and the contribution of stakeholders too. This has a correlation impact on entrepreneurship, small-scale enterprise business and occupation opportunities. Supporting contractors to participate in joining the construction sector is also supported by proclamation for public projects. This favorable action reduces the needed evaluation criteria by one step. But research indicates that completion of projects on time, quality and within the budget has been an issue. Construction companies face significant cost overruns, time overruns, and performance problems by reducing the overall value of projects.

The cause of the above mentioned problem might be arbitrated in different directions; it has been the area of investigation by research and recommends their way out measures. Related to the construction project contractor getting through bid, research shows, (Ayalew, 2009); lack of proper evaluation of tender documents at the tendering stage is identified as one of the causes. (Fekadu, 2013)study results claim incapable contractors, as compared to the project scope, might not have the capacity to study the projects in detail before submitting their bids, come up with an unnecessarily low offer, and the other one is that tender documents lack quality, consistency, and are not prepared based on specific project nature.

Furthermore, contractors' Response for Delay, Cash-flow problems during construction, Mismanagement by the contractor (financial, supplier support, sub-contractor), Payment for completed work, Design errors, increase in quantities, Economic conditions Changed orders and mistakes and discrepancies in contract documents,

experience of the project team, Conflicts between the drawing and specification. (Tebeje, 2016)

Besides, acquiring a construction job is based on low price bidding. In relation to this the cost estimating system used by the local building contractors seems to have some drawbacks (Andom, 2015). This may happen due to not being well informed about the project and alternatives. Contractors are exposed to challenges during the contract period that could lead them to failure in the decision they made at the start of obtaining the job. On the other hand, the above causes and consequences are also the responsibility of the contractor; as a business organization, they have the principal role in performance and understanding of jobs.

Construction bidding proposal prepared based on the possibility that the contractor will fulfill the obligation according to the contract agreed upon. This includes providing the necessary project finance in case the client is unable to pay or supplying the necessary resources within the time frame. In general, proposals are expected to be prepared based on the reduction of the problems mentioned above by Ayalew et al., (2016), Fekadu, (2013) and Tebeje, (2016).

Giving necessary attention to selection of construction projects, understanding the project and evaluating the capacity, capability and limitations of the company in making the decision to participate or not in construction projects bidding by the construction company is an important task that leads them to their main objective. This is an activity defined as a bid or no bid decision. (Oyeyipo et al., 2016)Stated wrong bidding decisions and practice have their own contribution to the construction sector's inefficiency. This indicates that improvement in the way construction companies practice decision making has the potential to upgrade industry performance. As a result, this gives a better opportunity for construction companies to achieve their strategic contractual obligations.

This part of activity in a company is done by experts most of the time based upon experience and awareness. This research aims to develop a model that assists construction companies in undertaking careful selection of construction projects using significant subjective factors. Meanwhile, it is essential to identify factors and examine their relationship with decision making.

1.2. Research Problem and significant

Bidding decisions are highly complex and unsystematic, requiring numerous factors to be considered simultaneously. This decision has to be passed through knowing the information included in the standard bidding document, assess own capability and actual working conditions within a limited period of time. This situation makes

construction contractors sustain most of the suffering, losses and hold back projects from completion. This has an impact on the final performance of a specific project, as the result can cause losses of a company. In general, reduce the contribution of the construction sector.

The significance of the study is to help contractors gain an increased understanding of the major factors in relation to their bidding decisions. Contractors in ownership of this information will be better positioned to make more informed bidding decision, taking into account the most critical factors. The model may assist bid experts in evaluation of the standard bid document, using their capability, and the end result. In the meantime, reducing experts' stress arises through limitations on making decisions considering all criteria in uncertainty with limited time. Hence, decisions are both knowledge and experience-driven; developing a system model by integrating both knowledge and experience quantitative approaches will be applicable. Regression Analysis and fuzzy rule base approach are used for the development of the model. The application of different approaches to decision making may pave the way to more efficient and effective decision making in the bidding process. Furthermore, it will contribute to the accomplishment of the project with better performance.

1.3. Research Objectives

1.3.1. General Objective

The main objective of the study is to identify the key factors affecting bid no bid decision making and develop a model which supports decision making.

1.3.2. Specific Objectives

- To identify top 10 factors that affect bid and no bid decision making.
- To assess the relationship between the decision and the factors.
- To develop a model that will support managers or bid experts in decision making using Regression Analysis and Fuzzy Rule-Based System.

1.4. Research Questions

- What are the key factors that will influence the bid or no bid decision?
- Is there any significant relation between the decision and the factors?
- How to apply Regression Analysis and Fuzzy Rule-Based System to deal with the uncertainty involved in bid no bid decision.

1.5. Scope and Limitation of the research

The study will focus on identifying the factors which affect contractor decision making and developing a model that can support decision making. The study taking population size general contractor category one, assumption contains that, they are found in a well-organized manner and due to many obligations and an interest in working continually in the sector. The number expert participates and previous data scenarios taken for model development from contractor are limited to this chosen category.

1.6. Research Methodology

The methodology of this study mainly consists of the following; it will start with the identification of factors from secondary source literature. Categorization of identified factors. Designing a questionnaire survey based on the information gathered from the literature review. Applying this questionnaire to the practitioners, who are in charge of the bidding process, examines important factors. Select the most relevant one. Using the recognized factors, request previous data considering what their assessment was regarded to a specific project and the evaluation score. Using this dataset, develop a model that will predict the evaluation score or result. Verification will be conduct using actual test dataset and validation using statically performance measures such as R^2, RMSE and MAPE. Comparison of models will be taken. Finally, Conclusions will be drawn and recommendations will be forwarded based on the findings of the survey.

1.7. Organization of the Research

This research paper has six chapters.

Chapter one: Introduction

The first chapter addresses the background, research problems and significance, specific research questions to be answered related objectives, scope and limitations encountered during study.

Chapter two: Literature Review

This chapter discusses some procurement methodology of construction project, the bidding process for construction projects by construction companies, contractor evaluation criteria according to(The FDRE PPA Proclamation No. 649/2009), review previous studies done in different countries to identify factors affecting bid no bid

decision, and a review on prediction model which uses regression analysis and Fuzzy – Rule Based System as a technique.

Chapter 3: Research Methods

This chapter presents the research design and data collection techniques. The decided on population the size, sampling technique, choose the relevant data, and choosing which modeling techniques to be applicable are mentioned in this chapter.

Chapter four: Data presentation, Analysis and Model Development for Decision

This chapter presents the analysis of data and interpretation. Define input/independent and output/dependent variables, data categorization; develop a regression model and fuzzy rule base model; interpretation of result and measure performance of models.

Chapter five: Conclusions and Recommendations

This chapter also draws the conclusion. Finally, recommendations are made. Recommendations for future research are made.

Chapter six: Reference.

This chapter presents the references and appendixes.

2. Literature Review

The chapter starts with the definition of variables, brief of some procurement methodologies for construction projects, the bidding process for construction projects by construction companies, and contractor evaluation criteria according to (The FDRE PPA Proclamation No. 649/2009), a review of previous studies done in different countries to identify factors affecting bid decisions, and a review of the prediction model which uses regression analysis and Fuzzy – Rule Based System as a technique.

2.1. Operational Definition of Variables

- "Procurement" means, in this case, acquiring a construction job through bidding (The FDRE PPA Proclamation No. 649/2009).
- "Bid" means a stage in the procurement process extending from advertisement or invitation to bid up to the signing of the contract (The FDRE PPA Proclamation No. 649/2009).
- "Bidders" mean a natural or juridical person submitting a bid (The FDRE PPA Proclamation No. 649/2009).
- "Bidding document" means a document prepared by the public body as the basis for preparation of bids which contains specifications of the desired objective of procurement (The FDRE PPA Proclamation No. 649/2009).
- A Bidding proposal means a document submitted by bidders to participate in a bid on the basis of the bid document prepared by a public body in respect of that procurement (The FDRE PPA Proclamation No. 649/2009).
- According to Agung et al., (2015)Bidding is the simplest plan for success and this approach to construction compromises a number of decisions to be made, including whether to bid or not bid, the winning strategy, and the degree of effort and competitiveness to be applied. The producer starts by identifying and reviewing the source invitations that are publicized to sing the contract document. Bidding and tendering are used in this paper interchangeably.
- Decision making defined by (Harris, 1998)as the study of identifying and choosing alternatives based on the values and preferences of the decision maker. Making a decision implies that there are alternative choices to be considered. In such a case, not only to identify as many of these alternatives as possible, but to choose the one that best fits with our goals, objectives, desired values, and so on.

- Giving necessary attention to selection of construction projects, understanding the project and evaluating the capacity, capability and limitations of the company in making the decision to participate or not in construction projects bidding by the construction company, this is an activity defined as a bid or no bid decision.
- Input/independent variable and output/dependent variable are used in this paper interchangeably.
- Prequalification bid is defined in the procurement method and it differs from the prequalification requirements factor is used to indication that mandatory request (letter of attorney, manufacturer authorization and returning standard bidding document), legality document and bid security requests, which is used to prequalify the bidder in the date of opening. These are most of the time critical. May result automatic rejection from the bid.

2.2. Importance of Studying bid decision making

The history of Ethiopian construction industry reviewed by Ayalew et al. , (2016); has shown

- Start from 1968 to 1982 E.C emergence of small scale micro enterprise domestic construction
- In 1982-1987 E.C, all private companies were taken over by the government and state-owned construction companies took over all construction activities.
- 1987-1991E.C has shown the design service and construction phase were introduced as a separate phase.
- Between 1991-2001E.C again showed a reemergence of sector development. As a result, private construction companies were established.
- Since 2001, E.C realized local contractors' performance and capacity were limited and to increase their involvement, the government has introduced the concept of integration and capacity building.

The benefit of Encourage local contractors' involvement in the construction industry (Kassaye, 2016) creates competent contractors in the construction industry, builds capable companies, helps employers get a reasonable offer, reduces construction costs, saves hard currency, and increases gross domestic product (GDP). Generally, in situations where demand for infrastructure, building, roads, and other is not met, local construction companies' good practices play a vital role in the construction industry. Yet again, the government plan strives to insure the impact of projects; investments are undertaken to add value to GDP and focus on the quality of projects. In addition the

owners manly focus on performance. Consequentially contractor accountability for their due obligations stated in a contract is to be high.

Furthermore, the procurement directive and regulation by itself awards better opportunities for local contractors to participate in the bid. It gives a good prospect for contractors participating in bidding and a chance of winning the bid. On the other hand, project purpose is critical. The budget for this project is massive, and some of the projects are new exposure based on complexity and scope for the majority of local contractors.

Regardless of the fact, the industry has increased the participation of private contractors that are engaged in the construction business and has shown progress. But still, contractors have limitations on performing the contract at the given quality, cost and time. The construction industry is a competitive business environment. Involve competitive due to optimization of cost, effective use of time, and motivation for innovation. Bidding is one practical tool to accomplish this all.

As a business organization, companies have to check their capacity, all requirements and analyses information use for successful completion of the project pre-decision to bid. Bidding for inappropriate projects or not performing a contract may affect the company's future. As a result, the investment ends up with a loss rather than the owners can invest their capital and time in other areas of business which are profitable. For the contractor, it is not only about performing according to the contract, but also continue start from delivery date extends to ten years of accountability for proper execution and solidity of the work, according to civil code article 3039.

Researchers Van et al., (2018) and Alsaedi et al., (2019) confirm that bid decision has an effect on the final project performance. This shows that construction companies have to rationalize before they decide to participate in a bid. In related to this, construction companies also have to be sure about their choice. Their decision making has to follow a binding way.

Agung et al., (2015) indicate that decision made by managers have a direct impact on the subsequent performance of a specific project and as a whole for a company. Experts have their own limitations and difficulty in making decision. In relation to this, thinking about alternatives, preferences, and uncertainty comes naturally. This makes Bidding decision complex.

To generalize this, because of its significance to both project performance and company performance, bid no bid decisions have been the subject of inquiry by many researchers in other countries. Some research Ayalew, (2009), Fekadu, (2013) and Tebeje, (2016) indicate that some of the causes for not performing according to contract the fault of the contractor making first bid decision. They recommend for improvement.

But to improve this or help local companies, couldn't find a research match with the topic. In other words, increasing knowledge and introducing a system which facilitates decision making. To come up with a solution or to achieve effective decision making, it is desirable to contribute systematic mechanisms together with high quality, organized information through this research.

2.3. Procurement methods, contractor evaluation criteria, and review of the bidding process

2.3.1. Procurement Method

The public body recommends using regulation (The FDRE PPA Proclamation No. 649/2009)for all governmental organizations with exceptional cases where procurement with an international organization or institute has relation to financing of the project and/or security of the nation. In the case of conflict, agreements prevail. In addition to our directives/regulations for procurement of works, FIDIC methods of procurement are summarized and discussed in this section.

The Federal Democratic Republic of Ethiopia, Ministry of Finance and Economic procurement directive

According to (The FDRE PPA Proclamation No. 649/2009), invites bidders to two approaches, which are national competitive bidding and international competitive bidding. National competitive bidding ascertains that the required objects can only be procured by the local company. The value of the procurement is below the threshold for international competitive bidding, below one hundred fifty million, and is also available only at the national level, notwithstanding the cost. International competitive bidding procurement is made when the value of the contract is above one hundred fifty million. Following this, the following methodology of procurement is indicated.

Open Bidding: the public body recommended using open bidding in general for procurement of works. Both national and international competitive bidding can be used. Two-stage bidding: the first stage shall state the general requirements of the public body and the bidder is not expected to submit bid security. May also conduct discussion to have a better understanding of the work and develop the proposal by the bidder. In the second stage, bidding shall be taken according to national or international competitive bidding.

Pre-qualification bid: it is necessary to prequalify bidders first. It may be national or international Bidding. In the invitation clearly indicated as bid for

prequalification. No restriction is applicable in number if the bidder is prequalified for the requirement. Restricted bidding: can be national competitive bidding or national competitive bidding. For this bidding, the value of the contract shall not exceed six million. To use this bidding first, the project has to try with an open bid for the procurement must have been published twice, with no attraction in the second invitation and other reasons mentioned in the directive. Single source or direct procurement: applicable if the procurement is small or has a value of up to five hundred thousand and to extend the contract by not exceeding 25%, any adjustment in the price is not allowed. If allowed, according to the price adjustment mentioned in the directive.

International federation of consulting engineers (FIDIC) Procurement procedures guide 2011

According to (FIDIC Procurement procedures guide, 2011), tendering methods are classified as open, selective, Negotiation and competitive dialogue methods. The use is influenced by the size, cost, and anticipated cost of the contract. Open: invitation announced through appropriate media. The number is unlimited. This method is not recommended by the FIDIC but is used if it's recommended by regulation of the country as it may be obligatory. Frequently used for small jobs. Selective, which is called restricted. The first stage will be to prequalify bidders and the second stage will come up with a limited number of contractors which satisfy the prequalification requirements.
Negotiation: this is used in a situation where urgent work is not expected from repeated tender enquiry. Normally, one construction company from the list meets the qualification criteria. If more than one contractor is invited, confidentiality will be retained.

Competitive dialogue for large and complex infrastructure project; adopted because employer is not always capable to finalize the technical specification of project. Discussing all aspects of the project with bidders before submission is needed. It consists of technical, environmental aspects and specifications, legal, financial, and commercial issues, including payment terms. Discussions take place with selected bidders to identify and define solutions to meet the requirements of the employer. This is done in successive stages with the aim of reducing the number of bidders. The main difference between Competitive dialogue and negotiation is the technical specification discussion and clarification held after the bidder's submission of the proposal.

2.3.2. Contractor evaluation criteria

Construction contractors have a big influence on projects and their accomplishments too. As it is quite critical to select a qualified contractor, the contractor

should also give consideration to how it will be evaluated in the process of acquiring a job through bidding. It has to be relevant to assess the evaluation criteria and process. Contractor pre-qualification and bid evaluation procedures are currently used for the assignment of contractors with consideration of a wide range of necessary and sufficient evaluation criteria to examine the overall suitability of contractors (Puri et al., 2014).

The process of selecting the most competitive tender offer and appointing the most suitable contractor for the construction works is a risk-related task (Fekadu, 2013). The author also suggests that selecting the most appropriate contractor requires: preparation of an appropriate procurement plan; selection of a suitable project delivery strategy; method of bidding and form of contract; preparation of quality tender documents and properly managing the tender process; setting suitable qualification requirements; and appropriate bid evaluation and contract awarding procedures. In short, this procurement plan considers the idea of a project having to be completed on time, cost and quality. To make this close up with the achievement of all, contractors' contributions is unquestionable. Through being well informed about the evaluation process and getting appropriate information. Claim for his right option using clarification request related to the specific project.

A construction company has to be well informed about the rights and obligations under which they operate. If it is a public project, the amendment directive gives guidance and in the bid document instruction to bidders too. The expert shall review the Federal Public Procurement Directive Ministry of Finance & Economic Development June/2010 and/or the Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia Proclamation Number 649/2009 published on September 9th, 2009. Accordingly, here under attached a summary of the requirements both local and foreign contractors must fulfill to participate in a bid.

Table 1: Requirements that have to be fulfilled by local and foreign contractors to participate in a bid according to PPA

Criteria	Local contractors	Foreign contractors
General construction experience	2 years' work experience in the sector.	Years of work experience in the sector.
Specific construction experience	One project has 70% and above substantially performed in the last ten years.	Two projects have 80% and above substantially performed in the last ten years.
For local contractors in projects estimated at greater than one billion, bid	can submit 2 or 3 projects having a value of not less than 1/2and 1/3 as an experience	"
For low rise buildings (G+0 up to G+5)	Can submit G+0 as an experience	"
Mid-rise building (G+5 up to G+15)	Can submit low-rise building as an experience	"
High rise building (G+15 up to G+45)	Can submit mid-rise building as an experience	"
Mega high rise building (G+45 up to above)	Can submit height rise building as an experience	"
Short Span bridge (less than 25 meter span)	Can submit building projects as an experience	"
Medium span bridge (25 up to 50 meter span)	Can submit a short-span bridge as an experience	"
Large span bridge (50 and above meter span)	can submit a medium span bridge as an experience ″	
For estimation of the project, less than 400 million two steps from the type of road project to be constructed	two steps reduced from the type of road project to be constructed	,,
Personnel requirements	as per required.	As per required.
Equipment requirements	rented or owned	rented or owned
Turn over the requirements set using a formula.	.=estimation cost of the project *12*0.8/ estimates completion period in month	two times requirements for local contractors

The above table includes the minimum requirements used to participate in a bid. In relation to this, the regulation gives clearly reduced evaluation criteria for local bidders on all basic requirements. In computation, foreign companies require two times the requirements than local contractors in turnover requirements and have to work in the construction industry at list five years. Also favorable action by reducing specific

experience requirements in a way that local contractor submit as an experience lower than required. Accordingly a contractor who has experience in low rise building can participate in mid-rise building bid. Using the above requirement's, contractors are evaluated in two way first one technical eligibility and lowest price award system and second one sum up of both technical and financial result the highest will be awarded .

2.3.3. Bidding process in Construction Company

An invitation to bid is an opportunity for contractors to bid on a project. Invitation letters, newspapers, websites and social media are the main sources for Construction Bid. This format includes fewer details about the project are usually strict, source of fund, aspects about the employees' deadlines, floatation period, forms, and procedures, technicalities and delivery method and commitment from the owner to hire a contractor. The contractor gets manuscript details about the project. This source also includes information used for purchasing bid document.

In general, bidding process by contractor's is described in detail through three steps.

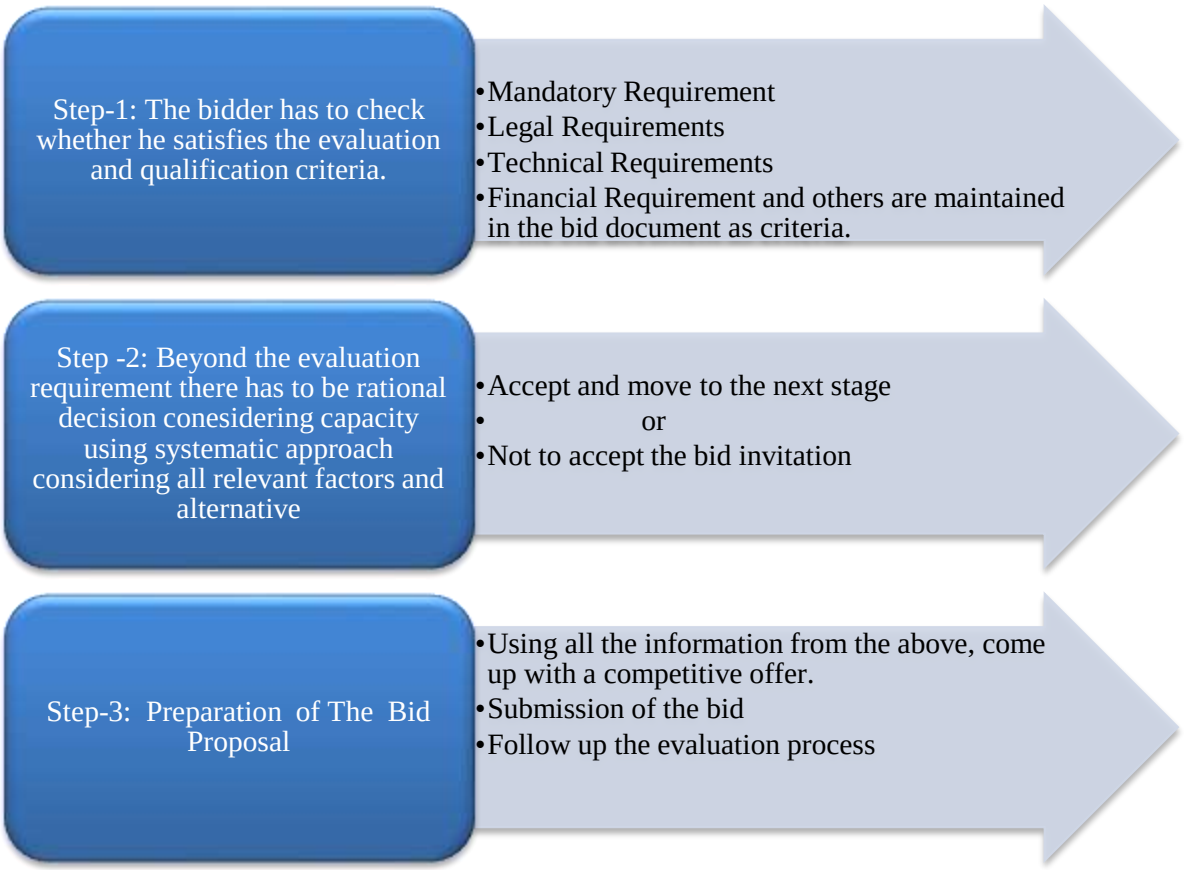

Figure 1: bidding process

Step-1: The bidder has to check whether he satisfies the evaluation and qualification criteria.

This standard bidding document most of the time consists of: Instruction to Bidders, Bid Data Sheet, Evaluation and Methodology Criteria, Bidding Forms, Eligible Countries, General Condition of Contract, Special Condition of Contract, and Contract Forms. At this step, an instruction to tender, bid data sheet, evaluation methodology, and bidding form document section that set out what is expected to be returned by the contractor and by what date it should be returned. It also includes the proposed scoring mechanism, any applicable questionnaires, details for arranging site visits and details for submitting tender queries. This section of the document has to be examined in detail.

The instruction to tender section is distinct from the other documents in the standard bid document. The other parts of the tender document eventually form the basis for the contract document, whereas the instruction to tender does not.

Contractor perception and preparation to participate in a bid all start with reference and depend on the review of procurement criteria needed and evaluation criteria weightages found in the bid document. This can be a source of information for proposal preparation.

Besides, ensure that the bid document comprises all the mandatory documentary evidence establishing the bidder's qualification. Review in detail the evaluation and qualification criteria set in the standard bidding document. Technically basic criteria such as Legal Qualification of the Bidder, Professional Qualifications and Capability of the Bidder, Technical Qualifications, Competence, and Experience of the Bidder, and Financial Standing of the Bidder.

From the document, the contractor checks if the company meets the minimum threshold/requirements set by the employer. Qualification and evaluation requirements that the bidder needs to meet to participate in the bid. These are the ones mentioned in the invitation to bid, and in the contract document in particular (bid data sheet and qualification and evaluation requirements). This can be done using a check list for minimum requirements, here under attached.

- Have a valid trade license/business organization registration certificate; Yes ☐No ☐
- Have a VAT registration certificate issued by the tax authorities; Yes ☐No ☐
- Have a valid tax clearance certificate issued by the tax authority; Yes ☐No ☐
- Have a business organization registration certificate or trade license issued by the country of establishment; Yes ☐No ☐
- Have relevant professional practice certificates, as appropriate; Yes ☐No ☐

- Having been registered with the Public Procurement and Property Administration Agency's Suppliers; yes ☐No ☐
- Have a written statement by a power of attorney; Yes ☐No ☐
- Can satisfy the bid validity period and bid security request ; yes ☐No ☐
- Can satisfy the general experience in the construction industry; Yes ☐No ☐
- Can satisfy the bidder have specific experience request; yes ☐No ☐
- Can satisfy pending litigation treated as resolved by the bidder request; Yes ☐No ☐
- Can satisfy non-performance of a contract request; Yes ☐No ☐
- submit audited balance sheets and other financial statements as required in the bid document; yes ☐No ☐
- can satisfy access to, or availability of, financial resources such as liquid assets, unencumbered real assets, lines of credit, and other financial means to meet the following cash-flow requirement; Yes ☐No ☐
- Can satisfy health and safety requirements request; Yes ☐No ☐

After checking the minimum criteria, satisfied, move to the next step.

Step -2: Identifying Project information or employer requirements

At this step beyond the minimum evaluation requirement, there has to be a balanced assessment and understanding of the actual requirements of the bid document and all dependencies. Whereas, it's has to be ready to clarify project information or employer requirements. This includes contractual obligations that the contractor is being asked to undertake with whom and other detailed information.

- Understand clarity of the plans and specifications.
- Make sure it does consist, all the details drawing.
- Make sure the estimate quantity is fair. A measure of the tasks and items of work in a project
- Make site visits and be sure about the site conditions.
- Gather information about labor and local materials
- Gather information about industrial materials that are easily accessible from the local market and imported sanitary, electromechanical, and electrical items if there is any.
- Requirements under the contract liquidated damages, method of payment, performance guarantees, dispute resolution approach and alternatives, health and safety requirements and approach etc...

If there is a needed explanation about the bid, then clarification request days are most of the time restricted by the range of days before bid submission or after bid invitation. Therefore, be sure that your request has been delivered at the right time.

At this point, based on the above information related with company strength, it should decide whether to bid or not.

Step-3: Preparation of the Bid Proposal

- Using all the information from the above, come up with a technical proposal and competitive offer or other requirements.
- Submission of the clarification request
- Bid proposal preparation
- Submission of the bid
- Follow up the evaluation process

2.4. Review of studies on Factors affecting bid decision making

Making a decision to participate or not in a specific project includes many parameters which vary contextually related to that project. Researchers have identified and categorized some of them, summarized below.

Oyeyipo et al., (2016) study examines factors affecting contractors' tender decisions for construction projects in Nigeria's construction industry, which is economically important for Nigerians. In the study review, construction companies get jobs through competitive bidding on the lowest tendering basis, but in some cases, companies get jobs without winning the actual tender, but most of them will not survive without winning the tender. The authors agree that bidding is a fair way to have the lowest commercially viable tender price on the market and also know the significant factors infusing the decision making process to address them review and discuss them regularly. 48 factors were identified. The research technique used for the study is a quantitative approach structured questionnaire survey to get actual data. The population size includes small, medium and large contractors. To measure the level of importance, a 5 point scale is used; mean and rank are used for data analysis.

The result shows financial capability of the client, availability of capital, availability of materials, fulfilling tender, chance of getting the job, project size, need for the work, profitability and availability of labor/equipment, relationship and reputation with the client are the top ten significant factors. The author recommends that contractors

should increase their reputation in the construction industry based on their technical competency and capability. These characteristics are basic in assessing construction companies' competitiveness and are key indicators of successful tendering in construction projects. Furthermore, the authors mention that construction companies should not rely solely on their relationship with the project stakeholders to obtain construction contracts. This may not be sufficient to guarantee their chance of winning tenders and performing accordingly, but rather build their reputation on performance, technical competency and managerial capabilities.

Kumar, (2016) mentions that construction companies in India get jobs at the lowest price and having an obligation to satisfy contract conditions with specific timing and with the involvement of uncertain events makes it critical in their decision. Summary of review show significance of factors in decision and company performance related to the results of the study by Bagies and Fortune. (2006), which is, 95% of respondents agree that the consideration of factors at the selection phase is critical and 89% of respondents consider this factor considered in bid decision enhances the company's performance. The study used a quantitative approach questionnaire survey, including scale measurement 0 to 4, simple statically analysis (mean, rank, and standard deviation) used for data analysis.
The study results show the top potential factors are: having experience and familiarity with specific work, possibility of upcoming profitable projects out for tender in the future, total bid value, type of project, completeness of standard bidding document, current work load related to capacity of firm, qualified material supplier, market direction (declining and expanding), and possible contribution to increasing firm market share and dominancy in the market. Among the least significant factors is the desire of qualified contractors to bid and win the contract and having enough qualified technical staff to do the job.

Financially, experience and familiarity with specific work types have an advantage of successful completion of the project, helping achieve quality workmanship and increasing company strength. In small size, contractors in India have a high probability of getting the above benefits compared with working projects that have no experience and familiarity. The authors also recommend that construction companies bid on the project if only the financial status is adequate and sound. Small and medium contractors have the advantage of having a material supplier near to the site. This reduces transportation and handling costs, and related to this, having a qualified material supplier is a significant factor in decision making.

Ratekar et al, (2016) study considers the bid no bid decision making for engineering, procurement, and construction (EPC) projects by a construction company. The study review results the purpose of post project review, which is a lesson learned and will benefit future planning projects. They are five in type; evaluation review, gate review, audit, post project review and benefit realization review. This shall be conducted once the project is completed. This will have the result of pros and cons (success and failure) of projects and learn from them. In the study, important factors identified in two approaches to questioning experts and literature review, data collected, checked the validity, checked the response rate, analyzed compared with other research materials, and generalized the bid discussion process frame work. The integrated frame work includes the following bid process categorized into four stages:

Stage 1 list of factors that affect bid no bid decision, which includes bidding period, contract type, quality of bid document, milestone of payment, liquidity damage, the contract requires a dispute adjudication board for the projects, percentage of retention, and includes bonus for early completion, allowance for change cost, warranty requirements, and security requirements. Stage 2 lessons learned from past experience, taking into consideration project client, location, risk assessment, success/failure and with the help of numerical value and list of words. Then the summarized result with bad experience is more than profits earned, and the respondents come up with action to try to avoid the bid. Stage 3 SWOT analysis helps identify internal and external influences on the project and has the purpose of helping the organization to be fully aware of all circumstances involved in the decision. Stage 4 bid assessment this help self-evaluation by giving value 0 (serious competitive disadvantage) to 5 (strong benefit). The list of requirements includes, does the company have relevant experience, delivery time is realistic, can we offer the investment needed to pursue the opportunity?

Aznar et.al., (2017) In this study from literature and using structured interviews (help of experts), nine factors were identified. Having a local partner, having a competitive advantage and not computing agent's local contractors were the top three significant factors. The study focused on foreign companies working in Australia. Construction companies get jobs from the World Bank and projects are infrastructure projects. The author reviews that the World Bank has two main awarding systems: lowest price (applied in cases where there is a well-defined standard bidding document and the risk of corruption is high) and weightage multiple criteria approach (evaluation needed in many criteria and using the best value of many).

Van et al., (2018) the study taken in Vietnam using a questionnaire survey in seven cities. The country has more than 90 million people and 60 percent of the population is

under 35. Following the demand, the construction industry is expanding and has investment in building and infrastructure. Related to this contractor having an opportunity to win and have a job through bidding. Contractors use their common sense and experience to make bid no bid decisions. The author came up with the solution by identifying 40 factors and categorizing them under six categories from literature and decision tool (model) to assist experts in making decision making. The result of the survey was the most significant factor in ascending order: hazard/trouble of the overall situation, characteristics of the contractor, bidding situation, financial characteristics of the contractor, project characteristics, and bidding document.

Darbar and Pitroda, (2018) the study mention that equipment availability, number and capability of personal work for firms, project size, profitability, project duration, project cost, firm capital, labor availability, stringent observation of construction details and payment conditions are significant factors. And also, the tendering method, tax bidding price, tender duration and general overhead are less significant.

Holla et al, (2018) the study conducted in the Indian construction industry have a role in solving the suffering that exists in quality, time and cost overrun in infrastructure projects. Structured questions prepared to come up with an optimum number of factors. Recording the interview assists the author in having no missing points and converting them to text. The result of evaluating respondents show, the first significant factor is the project characteristics include type of project, work volume, geographical safety and political considerations of location, execution complexity, degree of importance, reputation, project duration, project location, from existing facility, existence of critical and expensive activity, payback period of the project and the specialty and uniqueness of the project.

The second significant factor is company characteristics. This includes the availability, mobilization, and location of resources (manpower, materials, and machinery), the current work load of the organization, and the willingness of the management to mobilize additional resources. The third significant factor is business benefits. This includes profitability, the chance of future scope work continuity with the same investment, growth needed for the organization, joint ventures, and market demand.

The author generalized the discussion on the rationality behind decision making; having an existing client or a new client, which is, if it is an exciting client, it is easy to contract management. If it’s a rigid and complex client, the respondent advice to sick other opportunity or client. In the case of a new client, the computation is high; proximity to resources, location of aggregate quarry, source of sand and bitumen plant, is also critical in decision making: in case related to financing risk limitation availability of asset may

help have solving project ; in availability of more expensive and critical activity the respondents increase price 20-30%; decision maker has to consider as possible as short payback period to minimize the block cash flow and future continuity with the same investment and future continuity.

Alsaedi et al., (2019) the author explains that the classification certificate of Saudi Arabian Construction Company depends on the size of the contractor, which is mandatory for bidding for governmental projects, and the primary objective of the classification system is to compute for a project that will fit into their capacity. The method adopted is a quantitative approach; factors identified from literature and categorized under four categories; project characteristics, market characteristics, contract characteristics, and owner/designer/labor characteristics. Applied questionnaire survey, population size includes first, second, and third grade contractors, who measure their important level using a five-point Linkert scale. The results were company strength, need for work, type of job, rate of return, size of job, risk involved in the investment, current work load, and project cash flow are the top ten significant factors for first class one contractor.

Using overall factors, size of contractor, type of job, company strength in the industry, project cash flow, rate of return, design/design quilt, computation, degree of difficulty, risk involved in investments, and confidence in the work force are the top ten significant factors and most of them belong to the project characteristic group. It is advised to bidders to examine first and evaluate the agent's capability and specialty areas of the contractor in detail before getting into a decision.

2.5. Identification of Different Factors affecting bid decision

Following the approach indicated in chapter one, the next step is to identify factors that have a relationship with bid decisions from secondary sources. The significant factors are customized by researchers, according to the situation by taking the list from different literature. For this study, 90 list of factors (Bagies and Fortune, 2006), 33 list of factors (Oyeyipo et al., 2016), and 30 list of factors (Kumar, 2016) are taken as initial. From this, selection and optimization are done by avoiding redundant factors and choosing factors described in a simple and easy way. As a result, the following list of 86 decision factors summary was produced and then subdivided into nine categories; competition, economic situation, bidding situation, company situation, project finance, business benefits, and characteristics.

Table 2: Summary of list factors

Item	Description
A	Project characteristic
1	size of contract
2	duration of the project
3	type of project
4	job start time
5	method of construction
6	location of the project
7	equipment requirement
8	degree of built ability
9	site accessibility
10	the project stakeholder
11	design quality
12	local clement
13	public exposures
14	technology difficulty
15	safety hazard
16	drawing and specification completeness
17	public objections
B	benefit of business
1	the benefit expected in reputation
2	the continues of employment key personnel work force
3	establishment long relationship with the client
C	the client characteristics
1	local custom
2	relationships with owner
3	the client repetition among other contractor
4	the client requirement
5	owner private or public
6	prompt payment habit of the client
7	the client financial capacity
8	size of client
D	the contract
1	type of contract
2	clearness of the work and specification
3	the ability of modifying contract
4	finesse of delay
5	number and type of supervisory and labor requirement
6	consultant interpretation of specification
7	use of nominated sub-contractor
8	the contract special requirement
9	contract condition
10	cost and duration of bid preparation
11	terms of payment

12	terms of warranty
13	claim solution
E	project finance
1	original price estimated by the client
2	working capital required to start the job
3	the possibility of shortage or delay on payment
4	project cash flow
5	the project markup size
6	percentage of insurance payment
7	anticipated value of liquidated damage
8	tax liability
9	financial goals of the company
10	degree of difficulty in obtain bank loan
11	market share
F	company situation
1	availability of cash required
2	ability doing the job
3	availability of equipment required
4	availability of qualified human resource
5	uncertainty in cost estimation
6	need of work
7	general overhead
8	current work load
9	Project tie with company future
10	strength in the industry
11	competitive advantages
12	availability of qualified sub-contractor
13	site condition familiarity
14	company ability in design and innovation
15	relations with stakeholder
16	profit from similar project from the past
17	past experience in construction industry
18	past experience in managing similar project
G	bidding situation
1	required bond capacity
2	time allowed for submitting bid
3	prequalification requirements
4	tendering duration
5	bidding method
H	economic situation
1	risk involve in investment
2	availability of material and equipment
3	overall economy (availability of work)
4	governmental division requirement
5	risk expected in cost fluctuation of resources

6	security
I	Competition
1	Who else is likely to bid for the job?
2	how many bidders will be their
3	are the bidder equal similar contract with similar overhead
4	future projects
5	Marketing condition

2.6. Review on the Technique

Some of the behaviors, such as problem solving, learning and understanding, are handled by computer programs. It began with the attempts to formalize human knowledge. "The science of creating intelligent machines", which is called Artificial Intelligence. The term was first used by John McCarthy in 1956. Artificial intelligence definition consists of the understanding of human intelligence and the building of computer programs that are capable of simulation or acting out one or more of these behaviors. Originally, it was applied to theorem proof and game modeling. The base artificial intelligence was mathematics, linguistics, algorithms etc.

Know a days through artificial intelligence is a remarkable achievement. Applications have been reported in different disciplines, including the fields of medical, military, chemistry, engineering, manufacturing, management, and others. (Georgieva, 2016)Expressed its understanding that accuracy and security have a high price and tolerance for imprecision and uncertainty in calculations, reasoning and decision making should be admitted (when and where possible). (Lu et al., 2012)Specify that decision making is influenced by uncertainty, which could be solved by the need for mathematics, physics, probability, and mechanics calculations, but also by the experience of the practitioner. This can be solved in combination with different methodologies for numerical calculation and reinforcing of human experience linguistically. The subject of Artificial Intelligence is mainly those problems for which there is direct mathematical expression or no direct mathematical or logical algorithms exist or can be resolved only intuitively and in combination (Bagies and Fortune, 2006).

Fuzzy logic is easy, understandable, provides most effective solution to complex issue and good at dealing with decision uncertainty and regression analysis also show the relation, significance and strength of dependent and independent variable; hence Regression Analysis and Fuzzy Logic are the chosen computing paradigms for bid no bid decision.

2.6.1. Regression analysis

Regression analysis is a tool that has the benefit of Examine the relationship between independent and dependent variables; Show the relative strength of different independent variables with dependent variables and prediction (Mooi et al. , 2016). Be informed about the effect of variables makes the contractor spend critical time on selective areas. Relative strength shows how much the effect of input on decision and forecasting help to generate different alternatives with the result.

Bivariate regression determines the prediction of an unknown variable from the value of a known value and multivariate regression involves many variables applicable to more than one independent variable to predict the outcome of the dependent variable (Jain et al, 2016).

Regression analysis equation noted by (Mooi et al. , 2016) and (Ketaren, 2017) :-

$$Y = \alpha + \beta x + e \qquad (1)$$

- Y = decision or dependent variables
- α= constant or intercept of the model show the value of dependent variable would be if other variable are zero
- β = regression coefficient, represent the slope line, positive value indicate upward slope and negative value indicate a downward slope line
- X= independent variables

The following main point guide via regression analysis review by (Mooi et al. , 2016) are summarized here under;

- ***Requirements of data for regression analysis***

Several considerations have to be taken on the data before going to analysis. This includes the need to have a sufficiently acceptable sample size, the value of variables not allowed to be constant, scale type of dependent variable, model type to be chosen and collinearity.

- ***Specify the type and estimate the regression model***

Regression analysis can be done using SPSS or other applications and through different approaches. Commonly used step wise method. The use of stepwise is very useful in prediction. Start its iteration with an empty and insert one independent variable at a time. Through iterative producers at the same time, including and excluding

independent variables that are significant or not to regression models based on statistical criteria. (Alemu, 2020)

- ***Validate the assumption of regression analysis***

Fulfillment of the assumption of regression analysis is a must-meet criteria to get valid output. This assumption changes relative to the type of regression analysis we use.

- ***Regression result interpreting***
- ***Validate the result***
- ***Use model***

Interpretation of result, validate the result or checking the model fitness also depend on model type. There are different types of regression model. The one to be discussed here is multiple linear regression model and binary logistic regression model related to the topic.

2.6.1.1. Multiple linear regression model

Multiple linear regression models share similar descriptions or benefit from the general regression analysis described above. This includes more than one independence variable. The general formula for multiple regression models;

$$Y = \alpha + \beta 1x1 + \beta 2X2 + \cdots + \beta nxn + e \qquad (2)$$

- Y = decision or independent variable
- α= constant
- β_1, β_2,β_n = regression coefficient
- X_1,X_2,…X_n= independent variables

Multiple linear regressions take the following four points as an assumption summarized by (Kaya et al., 2013);

1. The model should expresses the relation between variables in linear way
2. Multivariate normality
3. No or no extreme outlier
4. The variance of the error has to be homoscedasticity or constant

Validation of assumptions, interpretation of results, and validation will be discussed in brief in chapter four with the findings of the model.

Jain et al, (2016) Mention that the significant difference logistic regression has from above type of regression:-

- Conditional distribution y/x is not Gaussian distribution (known as normal distribution) (bell shaped and it is assumed during any measurement value will follow normal distribution) but Bernoulli distribution (random experiment that has only two outcomes, in this case, yes or no filliping coin is 0.5)

- The predicted outcomes are probabilities determined through a logistic regression function and they are restricted between 0 and 1.

The value determined by the logistic regression model can be represented by: odds =p/(1-p) which is the probability of the event occurring over the probability of the event not occurring (Jain et al, 2016).

Binary logistic regression equation written by(Ketaren, 2017) :-

$$\ln\left[\frac{p(y=1)}{1-p(y=1)}\right] = \alpha + \beta 1x1 + \beta 2x2 \ldots\ldots \beta nXn \qquad (3)$$

- Y = decision
- α= constant
- β_1, β_2,β_n = regression coefficient
- X_1,X_2,…X_n= independent variables

The assumption of binary logistic regression summarized indication by (Abdulgader, 2017), (Berger, 2017) and (Ketaren, 2017) listed as follow:-

- The dependent variable should be dichotomous (fail or pass, yes or no).
- It does not need a linear relationship between independent and dependent variables. It uses log transformation to predict the odds ratio.
- There is no influential value or outliner in the continuing data predictors.
- There is no high intercorrelation among the predictors. If multicollinearity is present, centering the variable may resolve the issue (Deduction the mean of each variable). Another option with orthogonally rotating factors should be done before the logistic regression is to be done.
- The model should fit correctly without being over fitted or under fitted. A good approach should be used to ensure this is a stepwise method for estimating the model.
- Need large sample data

A Binary logistic regression prediction model can be developed using a software package for social science (SPSS – 26) or other.(Sakinc et al, 2013)They indicate that

different statistical approaches can be used for evaluating the performance goodness of fit of the model. Among them, chi square, pseudo-R2, Hosmer-Lemeshow statistic and percent correct predictions.

Abdulgader, (2017) The Hosmer and Lemeshow test is a Goodness of fit test for binary logistic regression models, especially risk prediction models. This test describes how well the fits the model and checks whether the observed event rate matches the expected event in the population sub group. Test is taken using SPSS and returns with an output of p value and chi-square value. The result is small p value or p value is less than 0.05 means the model is not a good fit. But large p values do not necessarily mean a good fit, but rather mean there is no enough evidence to say that your model is a poor fit.

The Likelihood ratio test helps to choose the best model between two models. It also helps to evaluate the difference between the null model with constant only and the model with independent variables (Abdulgader, 2017). The Cox and Snell R2 or Nagelkerke R2 test explains the relationship between dependent and independent variables (Ketaren and Sianturi, 2017). These two tests explain the variation in dependent variables that can be explained by the independent variables. Percent correct predictions also describe the model's predictability.

2.6.1.2. Decision model used regression analysis

A Multiple regression model for predicting bidding prices was developed by Petroviski et al., (2015)to facilitate the decision making process. Taking into account 26 bidding construction projects as input, targeting that variable received price. The model has a value of R^2 =0.88167. This is explained as the 88% of the variation in response variables expressed by the predictor variables and MAPE (mean absolute percentage error) =3.073. The model error is three percent.

Lowe et al., (2004) studied the relationship between factors and the decision to bid and developed two models using the Binary logistic regression model. Generally, 21 factors are used to apply to accept and reject scenarios with 115 actual construction projects data in UK Construction Companies. The Spearman correlation coefficient is used to know about the relationship between factors and decisions. As a result, 8 have non-Monterey contribution, competitive environment, project type, competitive advantage, and resources to tender, alternative design to reduce cost, external resources, and tender procedures have relationship with the decision to bid. Result of a model that has a predictive accuracy rate of 94%.

2.6.2. Fuzzy Model

In decision modeling, uncertainty arises from unavailability of full information and/or naturally. In the case of the uncertainty modeling approach, (Zadeh, 1975)introduced a concept he called "Approximate Reasoning." He assumed his approach would be beneficial above all in the study of complex humanistic systems. Fuzzy decision attempts to deal with the vagueness and non-specificity inherent in human formulation of preferences, constraints, and goals. (Zadeh, 1965)Introduce the concept of fuzzy logic to handle the concept of partial truth from completely false and completely true phenomena.

A Crisp set is a set consisting of well-defined objects called elements or terms or members. In a crisp set, it's only discussed whether the element is there in the set or not. In this case, there are two possible options. If a member belongs to a set, if a member does not belong to a set, then the membership function is denoted by '1', otherwise '0'.(Zadeh, 1965)(Jyothi et al., 2016).

$$\mu A(X) = \begin{cases} 1 \; If \; x \; \in A \\ 0 \; \; Otherwise \end{cases} \qquad (4)$$

But in real world situations, elements have a chance of belonging between yes or no. Which is the value of the element in the set denoted by A, denoted as A (x) can vary from 0 (full non-membership) to 1 (full membership)(Zadeh, 1965)(Mamdani et al., 1998).Zadah contributed to a solution for such conditions through the concept of fuzzy set, where all elements have some degree of belong, which is a super set of crisp set (Jyothi et al., 2016).

Fuzzy modeling consisted of three producers: fuzzification, inference, and defuzzification. (Yahya, 2019) And (Georgieva, 2016)the fuzzification process starts by bringing together crisp input data and fuzzy sets using linguistic terms and membership functions. An inference is made based on a set of rules, using fuzzy operations or/and relating sequentially network. Finally, the result output (result of modeling) is mapped to a crisp output using a membership function (can be fuzzy value or mathematical expression). This is the defezzification step.

In developing such a system, the main parts identify (Mamdani et al., 1998)the membership function of data points and create the rule base for linguistic rules. At this stage, membership functions and if rules are designed using a strategic approach.

Fuzzy modeling is the process of creating a fuzzy system. Different designations are given, such as fuzzy logic controller, fuzzy associative memory, fuzzy rule base

system, fuzzy model and fuzzy expert system. Due to their transparency and having an easy human interpretable structure, fuzzy rule base approaches gain attention in solving problems which have complex and uncertain situations. Fuzzy modeling can be interpreted as qualitative modeling due to the way it describes system behavior using fuzzy quantities (You Chen et al. , 2003).

Generally, the development of a fuzzy rule base system model is; first identification of the overall structure. This includes determining output and input variables and determining the number of rules. The second one is identification of the system in depth, which consists of choosing and defining the value of the membership function and finally adjusting the value(Georgieva, 2016) and (Dutta et al, 2010).

2.6.2.1. Types of fuzzy inference system

In the way output is determined; an inference system is numerous in type. (Dagnachew, 2016) . This are:-

a) Mamdani fuzzy inference system

The Mamdani inference method is the most commonly seen inference system. It is built based on fuzzy set theory. It was introduced in 1975 by Ebrahem Mamdani as an attempt to control a steam engine and boiler combination by synthesizing linguistic control rules obtained by 31 operators. After aggregation of all rules in the Mamdani inference system, the result of the output variable is fuzzy set defezzification is needed (Georgieva, 2016).

Mamdani fuzzy inference is also called linguistic system rules are represented as:

$$If\ X1 is\ A1 and\ X2\ is\ A2\ and\ \ldots\ and\ Xn\ is\ Xm\ then\ y\ is\ B \qquad (5)$$

Were X_i, i=1, 2…n is the output variable A_j, j=1, 2…m and B are linguistic terns (e.g. small, large, high, low etc) defined by fuzzy set and y is output associated with the given rule (Dutta et al, 2010).

In many cases, using a Singleton output membership function is much more efficient than using a distributed fuzzy set. The Singleton output membership function is thought to be a predefuzzified fuzzy set. It enhances the efficiency of the defuzzification process because it greatly simplifies the computation required by the more general Mamdani method, which finds the centroid of a two-dimensional function rather than integrating across a two-dimensional function. To find the centroid, it uses the weighted average of a few data points (Georgieva, 2016) and (Dagnachew, 2016).

Advantages of the Mamdani Method (Dagnachew, 2016)

- Its intuitive
- It has widespread acceptance
- It is well suited to human input

b) Sugeno fuzzy inference system

The Sugeno fuzzy inference system generates fuzzy rules from a given set of input and output data. This is called the TSK type. These types have a form:

$$If\ X1is\ A1and\ X2\ is\ A2\ and\ \ldots\ and\ Xn\ is\ Xm\ then\ y\ is\ ao + a1x1 + \cdots anxn \quad (6)$$

Were Xi. i=1, 2…n is the input variables, are linguistic terns and output variables associated with rule respectively and a_o, a1….a_n are the consequent parameter and this model was proposed by Takagi, Sugeno and Kang(Dutta et al, 2010)(Georgieva, 2016). The result is constant function which is called a zero order Sugeno model. This is suitable for managing a set of linear and dynamic nonlinear system. Sugeno type inference system particularly good in case with small continues changes applied on input space and for modeling nonlinear system by multiple leaner components (Georgieva, 2016). (Dagnachew, 2016) Summarized advantage of Sugeno method:

- Its computationally efficient
- It's well with linear techniques
- It's well with optimization and adaptive techniques
- It has guaranteed continuity of the output surface
- It's well suited to mathematical analysis

2.6.2.2. Data Driven or Knowledge Base Fuzzy Models

Fuzzy inferences can be done through two approaches: data-driven or knowledge-based.(Georgieva, 2016)Mention that in both ways, it has to be designed so that experience of experts can be applied easily to it or if there is existing data (input and output), standard techniques have to be applied in order to generate an intelligent system. The success of developed system models depends on understanding of the research area (Adoko et al, 2013) .

Knowledge base models use human experience, opinion and guide lines to assign membership functions and develop linguistic rules (Rajabi et al, 2014). Knowledge base fuzzy systems have their own advantages and limitations; (Salgado et al, 2004), (Adoko et al, 2013) (Nasiri et al, 2010) and (Dagnachew, 2016) and summarized below:

- Compact representation of general knowledge: knowledge about a problem domain.
- Homogeneity: Rule based representation has uniform syntax, interpretation of each rule can be easily analyzed.
- Independent: In rule-based knowledge representation, a new rule can be added without affecting the existing rules. Each rule is an independent piece of knowledge about the problem domain.
- Naturalness of representation method with a high level of comprehensibility. Rules can emulate an expert's way of thinking in natural expression.
- Each rule is a discrete piece of knowledge that uniforms the knowledge base without taking care of any other technical details. This characteristic grants flexibility in rule development of the knowledge base.
- Provision of explanations: A conclusion is in a straightforward manner. This feature of symbolic rules is a direct consequence of their naturalness and modularity.

A Rule-based reasoning prototype knowledge-based system has the following limitations.

- Knowledge acquisition bottleneck: The standard way of acquiring knowledge through interviews with domain experts is bulky and time-consuming.
- Brittleness/fragility of rules: when there is a missing input data or value, it is not possible to draw conclusions.
- Inference efficiency problems: In certain cases, the performance of the inference engine is not the desired one, especially when the rules are too large.
- Difficulty in maintenance of large rules: The maintenance of large rules is becoming a difficult process as the size of the rules increases.
- Interpretation problems: The general nature of rules may create problems in the interpretation of their scope during the reasoning process.

For this study, the system chosen is a data-driven rule-base system approach. Due to the limitation of the knowledge base system, which gets expertise at different managerial levels from different disciplines, time-consuming in structuring the rule base, membership functioning depends on experts' ability and use of mathematical equations not easily applicable by the experts. Data driven models use observation data and the relationship between dependent and independent variables numerical value (quantitative nature) to assign membership functions and develop linguistic rules(Rajabi et al, 2014).Data driven fuzzy modeling is applicable in different fields, such as data mining,

prediction, pattern recognition, classification, nonlinear system approximation, and process control (You Chen et al. , 2003).

(You Chen et al. , 2003) generalized data driven fuzzy modeling as given the n input/output pattern p(x,y) and specified model error $\in$>0obtaining minimum number of p of fuzzy rule and optimal parameter including membership function Θ in antecedent part and linear weightage w in consequent part of rules , for fuzzy model f(Θ,w,p) such that the error function E=||y-f|| satisfy in equality(Θ,w)<$\in$. Based on a collection of s dimensional data point {p1, p2……pn} a multi input and single output, fuzzy model is represented as a collection of fuzzy rules in the following rule form

$$Ri = if\ xi1\ is\ Ai\ and\ x2\ is\ Ai2\ \ldots.xs\ is\ Ais\ then\ yi = zi(x) \quad (7)$$

Were

- X=x1, x2…xs are linguistic variable
- Aij fuzzy set a universe of discourse
- Ri represent i^{th} rule
- Yi is the output of i^{th} rule
- Zi(x) can takes the from i.e z=(bi) this can be represented as mandani or Linear model or $Zi(x) = bio + \sum_j^s bijxj$ which is Takagi Sugeno(TS) model

Also in circumstance availability of input and output data generating intelligent system with help of clustering technique is additional option used by researchers to solve uncertainty and complex problem (Salgado et al, 2004) and (Adoko et al, 2013). there are many type of clustering algorithm but (Mohsen et al , 2011)generalized them under four category : exclusive clustering which is one data point belong to one cluster no overlapping (K- means , any linear classifier belong to this class), the overlapping clustering data point can be in to two more clusters (fuzzy C-means), hieratical clustering and probabilistic clustering. Among the above overlapping clustering method to handle uncertain data and hence can have good utility in any practical application. Data clustering is the process of dividing elements in two classes which is the same class similar as possible and different class as dissimilar as possible. Fuzzy c means is one technique which applies for cluster the data and the data point belongs to a cluster to some amount with is specified by membership value. The higher the membership value give a greater confident in the assignment of data point to the cluster (Elena, 2013). In addition pattern recognition is the main benefit of data driven fuzzy rule base system modeling and it is searching a structure in a data (Cuevas et al, 2014). Fuzzy c means clustering is iterative optimization algorithm based on objective function (Alata et al , 2008) and (Cuevas et al, 2014).

$$J = \sum_{K=1}^{N} \sum_{I=1}^{C} \mu_{ik}^{m} ||Xk - Vi||^2 \quad (8)$$

m: any real number greater than one it was set 2 by bezdek

N: The number of data point

C: The number of cluster

X_k: k^{th} data point

V_i: i^{th}cluster center

μ_{ik}: Degree of membership function

|| ||: a norm which express the similarity between any data and the center

Degree of membership function is defined by:

$$\mu_{ik} = \frac{1}{\sum_{j=1}^{c} \left(\frac{||Xk-Vi||}{||Xk-Vj||}\right)^{2/(m-1)}} \quad (9)$$

$$C = \frac{\sum_{I=1}^{N} \mu_{ij\times xi}^{m}}{\sum_{I=1}^{N} \mu_{IJ}^{m}} \quad (10)$$

Iteration will stop

$$Max\left\{\left|\mu_{ij}^{(k+1)} + \mu_{ij}^{(k)}\right|\right\} < \in \quad (11)$$

K: iteration step

∈: termination criteria between 0 and 1

This can be done with the help of machine learning with application of program such as mat lab, c^{++} etc... This method was introduced first by Dunn 1973 and improved by Bezdekin 1981(Elena, 2013). Fuzzy c means algorithm follow the following four procedure (Elena, 2013),(Alata et al , 2008) and (Cuevas et al, 2014).

Step- 1: InitializationU = [U_{ik}]matrix

Start with the required number of cluster N,2<N<K

Step- 2: At k^{th} step Calculate the center vector using equation 3

Step- 3: Modify membership measure using equation 2

Step- 4: If the criterion set at equation 4 is fulfilled stop, otherwise return to step 2

2.6.2.3. Bid decision model using fuzzy rule base system

Torng et al, (2004)the study focused on minimizing the time and cost wastage in preparation of non-winning proposals and, in doing so, preserve company energy for project match frame work and use the organization in the future. In the reviews section, the author categorized four decision making tools to assist managers in bidding. One type of approach used is the fuzzy set theory linguistics approach. This approach gives an opportunity to express factors in linguistic terms in a flexible way and includes qualitative factors in decision making.

The study is a case study taken from a bid no bid evaluation international co development compression air plane project in China. The methodology used is procedural. It includes, selecting a group of decision makers, selecting main and sub criteria, setting a brief meeting to consider the general crater, determining a scale to measure the merits and important weightage of scoring craters, measuring the criteria and weightage using linguistic terms, aggregating the fuzzy number with the fuzzy attractiveness rating, and matching the attractiveness with the appropriate linguistic term.. The Fuzzy set theory has an output of a fuzzy set. The author also generalized that the result is reliable and convincing. But as a limitation, the methodology adopted for fuzzy logic membership functioning depends on the expert's ability to consider all the relevance and application of fuzzy average weightage calculation is not easily applicable by experts.

You Chen et al. , (2003) the study shows from data driven rule base fuzzy model generated from numerical data redundancy exists in the form of redundant rule or similar fuzzy set which result reduce interpretability and unnecessary structural complexity. To this as solution the study propose rule base self-extraction and simplification method to develop interpretable fuzzy models from numerical data. Clustering technique also applied fuzzy partition validity index is used to extract the initial fuzzy rule base and find out optimal number of fuzzy rules. For simplify rule base approximate similar measure and parameter one tuning mechanism is introduced. As a result, the models also have good model accuracy and linguistically interpretable. Finally the study also demonstrate using case such as prediction of mechanical property of hot rolled, steel , non-leaner function approximation , dynamic system identification.

Bagies and Fortune., (2006) study foucs on discovery of problem which is the reason construction bussiness fail. In review the author address the cause for failure from an increase project size from normally handled, taking a new type of work, losing personnel in key operation area construction operation, administration and accounting, lack of

managerial maturity in expanding operation, lack of equipment cost control, poor accounting system, failure to evaluate profitability and poor billing collection produce. Through literature review identified 94 factors. The factors identified were then divided to ten main groups and the above 94 factors sub categorized. Fuzzy approach is used as technic to detect uncertainty arise in bid decision making.

Mohan et al, (2016) The study generates fuzzy inference system in Mat lab application of fuzzy c means clustering technique and for the study used three data sets. The first data set one box and Jenkins's gas furnace. this include y(t) is the output Co_2 concentration and u(t) is the input as flow rate .the output issued to predict based on [y(t-1),y(t-2),y(t-3),y(t-4),u(t-1),u(t-2),u(t-3),u(t-4)]. The system performance checked in two methods average absolute error of 0.0112 and root mean square error of 0.059. The second data set was compressive strength. The model used to predict compressive strength. The input is cement, blast furnace slag, water, super plasticizer, coarse aggregate and age. The average absolute error is 8.2143 and root mean square error of 10.3536. The third dataset forest fire data set this is used predict the burned area as input parameter include temperature, relative humidity, wind speed and other index's. With absolute error is 30.316 and root mean square error of 67.15.in this study fuzzy c means clustering in generating of system performance is also competed with other clustering technique which is subtractive clustering.

2.7. Summary of Chapter

The literature review has contribution to why unsuccessful in implantation of the project as per the contract signed to take responsibility. This may have different answers and a different outlook. As of its significance to both project performance and company performance, bid no bid decisions have been the subject of inquiry by many researchers in other countries. Some research Ayalew, (2009), Fekadu, (2013) and Tebeje, (2016) indicate that some of the causes for not performing according to contract the fault of the contractor making first bid no bid decision. They recommend for improvement but couldn't find research match with the topic which enhance decision making, done at Addis Ababa. Accordingly, the study involves a construction company bid decision at the beginning.

Consequently literature review organized well to give information in a time of bidding and introducing a system which facilitates decision making. Revised the process of bidding for a construction company by classifying the process into three steps: brief on procurement methods and evaluation criteria which are applicable to bidder.

The output/success or failure of a project also depends on how much information and knowledge you rehearse related to the objective. This starts to identify which parameter affects you more in your bid decision. Totally, 86 factors have been identified through review of literature. Research shows that the effect of this parameter varies in different backgrounds and purposes. Knowing this, it's necessary to optimize the relevant one according to its existence.

Learning from others, which applies better techniques in decision making, is also covered. This includes study research which applies different machine learning techniques used for prediction and interpretation/analyze. It is wide open for all. It has been helpful in knowing how to structure the subject and finding a solution in countless ways.

Multiple linear Regression analysis has the benefit of identifying if there exist a relationship between the dependent variable and the independent variable, its strength, and also prediction. Further, data driven fuzzy rule base more beneficiaries identify expert's assessment in evaluation of subject concept to decision yes or no. Gives an opportunity to lead forward based on circumstances. In the case of having input and output data, clustering techniques have a significant role in the minimization of time and accuracy in creating membership functions or classification of data. Fuzzy c means clustering has a role in accommodating fuzziness in creating membership functions and or generation of rules. This machine learning technique has been applicable for decision

making in uncertain and complex situations, but not with regard to bid or no bid decision making, considering the scope of this paper. This will be implemented in this study.

In general, literature review is structured with both theoretical and technical knowledge which are necessary in bid or not bid decision making for a construction project.

3. Methodology

3.1.Introduction

This chapter describe the research methodology, data collection methods, steps carried out for model development and also the procedures followed which will be used to ensure the research is reliable and valid. As mentioned in chapter one, it will start with a literature review, designing a questionnaire to gather information from those who are in charge of the bidding process, obtaining the actual data, analyzing the data using Excel, selecting variables, and developing a predictive model. The applications are WEKA, SPSS 26 and Mat Lab 2018 software.

3.2.Research Type

The research tries to advance knowledge and improve practice in decision making to participate in bid. It is implemented using a quantitative approach.

3.3.Research approach

The study was conducted in a way to use using experts' knowledge to apply to the assessment project on acquisition of the project by means of bid.

3.4.Research Scope and Limitation

The study will focus on identifying the factors which affect contractor decision making and developing a model that can support decision making. The study was conducted in Addis Ababa. The study takes population size general contractor category one. The assumption is that they are found in a well-organized manner and due to many obligations and an interest in working continually in the sector. The number of experts participating and previous data scenarios taken for model development by contractors are limited to this chosen category.

3.5.Research Design

The research questions are oriented towards investigating research objectives, collecting data and analyzing it.

3.6.Sources of Data

To achieve the intended objective and to answer the research questions of the study, different sources of data will be used. As secondary data literature, standard documents and a primary data questionnaire survey were used. From secondary sources, the number of factors that affect decision making summarized from the literature review is 86 and categorized.

3.7.Research Population and Sampling

The targeted population included construction firms at General Contractor level grade one. The study was conducted in Addis Ababa. The population took a list of general contractors category one from the ministry of construction. The list consists of 39 contractors. Sample size 20 considering confidence interval of 95%, precision level 10%, and degree of variability P=0.5. The sampling technique applicable is simple random sampling using MS excels. The procedure followed:

Step-1 raw one list of all contractors licensed in the category of general one
Step-2 rename the second column as random and use the function = random ()
Step-3 selects raw one and two columns, click data, then sort, finally select 20 companies.

Focus of questionnaires

Questionnaire number one has a three-section. Part I: Personal and Organizational Profile of the Respondent. Used to asses professional and organizational statues of experts and companies considering experience and exposure. Part II: Perception of company's benefits of bid decision. Used to examine the awareness of experts, asses the actual practice, and to understand the relationships and challenges encountered in a topic area. Part III: factors affecting the decision to bid or not to bid making process. It is used to measure the level of importance of factors. The questionnaire distributed one and/or a maximum of two opportunities given to experts working in a company. This will add value to the combination of experts participating in the examination of the significant factors. A total of 29 copies Questionnaires given to experts in the area This includes bid

experts, estimators, contract managers, construction or project managers, project performance controllers, commercial managers, project managers, and other key personnel involved in tendering activities.

Questionnaire number two applied to collect datasets used for model development using selected factors, independent variables, and dependent variables. Independent variables are factors that represent contractor consideration. After identification using questionnaire number one, using simple statistics, the top two ranked factors in each of the nine categories are selected. Furthermore, six additional variables included taking assumption that they give a better understanding of the project and some of them are used for evaluation of the contractor as must-meet measures. This included the clarity of client requirements, delivery method; bid documents must meet requirements, turnover requirements, resource requirements (equipment) and resource requirements (manpower). A total of 24 variables were selected as independent variables.

Output variables indicate the outcome of the decision-maker/model receiving the result extracted from the input, which is a dependent variable. In this case, the result represents the score they got after evaluation. The result of the decision maker/model is put into percentage (0-100%). The target was to have 60 datasets.

3.8.Data measurement

In questionnaire number one part three, factors categorized under competition, company situation, bidding situation, client and project characteristics, the contract, business benefits, economic situation, and project finance. Each of these categories is divided into subcategories. To measure the level of importance in main, sub categories and 7 point Likert scale frequency is applied accordingly, experts can easily express their judgment regarding the subject. Respondents were asked to give scores from least to most significant factors in ascending order. The numbers assigned (1, 2, 3, 4, 5, 6, and 7) one being very less significant and seven being the most important, and the score from each participant for each criterion was given equal weight to find an average score. Equal weight was given to all participants because they were all considered to have experience in tendering.

Table 3: Scale measurement level of importance in bid decision

Scale measurement	Description
1	Very Poor
2	Poor
3	Below Poor
4	Average
5	Above Average
6	Good
7	Very Good

In questionnaire number two, the data collected by generating a setup which helps them to recall their situation or bidding scenario they participated in previous years. Ask experts what their assessment was in consideration of selective factors and the final evaluation score they got. To measure their assessment, a fuzzy concept is implemented. By asking about their situation, which implies value should approach 1 if it is easy/qualified or value should approach 0 if it is difficult/unqualified to be qualified. Range of Value 0 to 1. Other measurements are used as per the variable.

3.9.Data analysis

The method of analysis of questionnaire number one was a quantitative approach. The quantitative data collected using questionnaires will be analyzed using an excel application of simple statically analysis mean and rank. The responses were processed to measure the level of importance. First, to calculate the mean for each factor, add all the scores given by participants divided by the total number of scores. Finally, rank the rated factors as per the weightage. The highest importance weight would be the most significant factor for decision making in the respondent's view.

Using datasets collected, then develop predictive models using multiple linear regression analysis and a data-driven fuzzy rule base system, as per mentioned in chapter two. The detailed process of developing a model and interpretation or analysis will be discussed in chapter four.

3.10. Summary

The research problem was introduced from observation of actual contractor challenge and reading literature in the construction industry. The literature review has also helped structure the subject by means of research methodology and the above process starting from 3.1 to 3.9 implemented in their order. Consequently, analysis of the data obtained from questionnaires involves simple statistical approaches and software. The findings and results will be discussed. Finally, conclusions and recommendations will forward base on the analysis and discussion.

4. Results, Analysis and Model Development

4.1.Introduction

This chapter will discuss and analyze answers made to the research questions and objectives. The data collected through questionnaires will be presented and analyzed. Used as input or output, understanding of relationships between variables and development of a model. It is important to note that the information presented in this chapter is initially used for model development, then the basis for conclusions and recommendations that shall be drawn in the subsequent chapter.

4.2.Personal and Organizational Profile of Respondent

In this research, 20 general contractors' category one were invited to fill out the questionnaires. Out of 20, 16 companies were interested in filling out the questionnaires. A maximum of two experts are given the opportunity to measure the level of importance. 29 copies of questionnaires are distributed and 21 responses are received. In questionnaire number two, the response was 46 actual bidding scenarios were collected.

Table 4: Respondent rate

Item	questionnaire Distributed	Returned	Response Rate
questionnaire Number One	29	21	72%
questionnaire Number Two	60	46	76.67%

The following chart shows the distribution of the respondents, i.e., Operation manager (5%), Bid Experts (19%), Quantity surveyor (5%), Senior Office Engineer (33%), Contract Engineer (19%), Senior Project Follow up Engineer (5%) and Project Manager (14%).

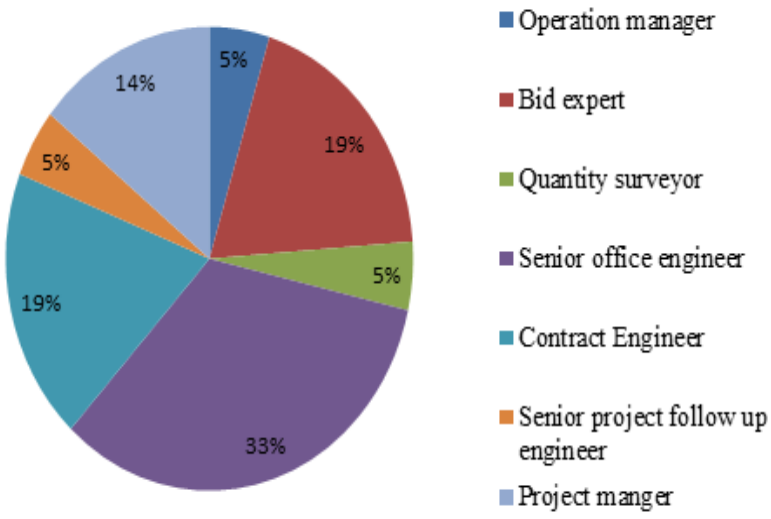

Figure 2: Respondents Occupational Statuses

Among those respondents, 61.90% have a bachelor's degree, 38.10% have a master's degree. Respondents' general experience with the construction industry. 38% of the respondents had less than 5 years of working experience, 52% had 5 to 10 years of experience and 9.52% had 20 to 31 years of experience. Respondents had specific construction experience related to bids. 38.1% of the respondents had less than 5 years of working experience, 52.38% had 5 to 10 years of experience and 9.52% had greater than 20 years of experience.

Out of the 16-construction companies, 6.25% had 5-10 years of working experience, 62.50% had 10-20 years of working experience and 31.25% of the respondents had greater than 20 years of working experience in the construction industry.

Among the construction companies, 33.33% had less than 500 million birr peak construction turnover, 40% had 500 million birr -1.2 billion birr peak construction turnover from, and 26.67% had greater than 1.2 billion birr peak construction turnover from the last three years.

4.3.Perception of construction companies on the benefits of bid no bid decision

The respondents agree with the necessity of the bid no bid decision and its effect on project performance. These construction companies, out of 16 companies, 25% had a chance of getting jobs 0%-25% through competitive bidding, 25% had a chance of getting jobs 26%-50% through competitive bidding, 31.25% had a chance of getting jobs 51%-75% through competitive bidding, and 18.75% had a chance of getting jobs 76%-100% through competitive bidding.

Table 5: Percentage of jobs companies acquire through bid

Company number out of 16	Percentage of jobs get through competitive bidding
4	0%-25%
4	26%-50%
5	51%-75%
3	76%-100%

50% of companies rejected their bid in the process among their submittals isup to 25%, 37.5% of companies rejected their bid in the process among their submittals is26% to 50%, and 12.5% of companies rejected their bid in the process among their submittals is51 to 76%.

Experts acknowledge that before decision, they analyze the content of the bid document. This includes Check a contract-information given on the bid document, Check Employer Requirement Design Document, Carry out site visit and submit clarification requests to the employer and attend bid clarification meetings.

Internal procedures that are taken into consideration in making the decision to bid, check the location of the project, material availability at the site, Existing projects at hand during the bidding stage and percentage of accumulation, Availability of sufficient resources, qualification requirements for participation in the bid. While in execution, there is no clear systematic method to help through making the decision. Which helps relate the gathered information to their performance. Mathematic equations need software like MS Excel, which is applicable only for doing break down.

The average percentage of the total number of contracts terminated due to performance is 2.17%. This includes a maximum of 10% and a minimum of 0%. Out of 16 companies, 90.48% had a technical team that was capable of bid preparation. But only 38.10% of experts get an opportunity to attend training or seminars related to cost estimation, marketing, contract administration, or any other relevant course for bid preparation.

4.4.Selection of significant factors to bid decision

Not all those factors are equally important. Some have more effect and others may not have that much effect on the decision. The respondents had measured the factors' main category and sub categories and weighted the importance of each criterion relative to the other criteria. This factor was subdivided into nine main categories; the following table shows the order according to their relevance to respondents.

Table 6: Main category factors rank

Bid Decision Factors	Mean	Rank
Project characteristics	6.52	1
Business benefits	6.33	2
Project finance	5.95	3
Company characteristics/situation	5.95	3
Economic situation	5.76	5
The contract	5.62	6
Competition	5.14	7
Bidding situation	5.1	8
The client characteristics	5	9

From main category respondent project characteristic, business benefits and project finance are the most significant which influence their bid no bid decision.

Aggregation of all factors the following in table 6, placed in top ten as the most important factor.

Table 7: Top ten significant factor in bid no bid decision

Item	Bid Decision Factors	Mean	Rank
1	The overall economy's	6.48	1
2	Size of the contract	6.38	2
3	Project tie with company future	6.38	3
4	Prequalification requirements	6.38	4
5	Security	6.29	5
6	Work capital required to start the job	6.29	5
7	Type of project	6.19	7
8	Availability of required cash	6.19	7
9	Ability to do the job	6.19	7
10	Past experience in managing similar projects	6.19	7

Aggregation of all factors the following found in the top ten as the most important factor. This includes the overall economy's mean value of (6.48) as number one. The second size of the contract, project tie with company future and prequalification requirements mean value of (6.38), fifth security and work capital required to start the job mean value of (6.29), seventh type of project, and availability of required cash, ability to do the job and past experience in managing similar projects mean a value of (6.19).

The expertise give least attention to job start time mean value of (3.86), attention to anticipated value of liquidated damage mean value of (4.19), use of nominated sub-contractor mean value of (4.52), type and number of supervisory and labor requirements mean value of (4.52).

4.5.Decision Model Development

In this section, selection of variables, assessing the relationship between variables, model development process and interpretation of results are reflected below.

4.5.1. Selection of variables for model development

The decision making-model consists of two types of variables: independent variables and dependent variables. Using 46actual bidding scenarios collected next step was getting meaningful input data from the data set. Using WEKA as a tool and filter method. (Samsuddin et al., 2019)Filter method attribute selection uses statically correlation to determine important future data with low complexity. Furthermore, attribute selection has the advantage of removing irrelevant and redundant variables from the data set. Doing this, the variables are selected for regression analysis and the fuzzy models are shown in table 7 below.

For dependent variables, the minimum threshold for saying yes to participate in project gets an evaluation or prediction score of 80% and above. This takes the consideration of the pass mark for lowest bidding award of PPA 70% minimum requirement. It also reduces the time wasted on participating in fruitless bids. It's also allowable to vary the cutoff point in circumstances. Such as financial plus technical result sum-up out of 100%, it's better to go for higher results and less when thinking about such projects may add up to value or transform the company in terms of having experience or other relevant reasons.

Table 8: List of dependent and independent variables

Code	Description
X_3	The benefits expected in terms of the company reputation
X_5	The client financial capacity
X_6	The clarity of client requirements
X_{10}	Turn over requirements
X_{13}	Resources requirements (Equipment)
X_{14}	Project tie with company future
X_{15}	Availability of required foreign currency
X_{16}	Ability of doing the job
X_{17}	Past experience in managing similar project
X_{18}	Prequalification requirements
X_{20}	Overall economy (availability of work)
X_{21}	Project area security

$\mathbf{X_{22}}$	Market condition (stability of material prices)
$\mathbf{X_{24}}$	Future project
Y	The total evaluation score

For simplicity purpose for both dependent and independent variables, the code designation is use in the document

4.5.2. Categorization of datasets

A training data set is a data set used to train the algorithm which predicts the output. It's the main and most important data and more than 70% of the data is used to train the algorithm. The Test Dataset is necessary to verify whether the system function is in compliance with the requirements and/or evaluate the performance. In this study, 90% of the data was used for training algorithms. The Test Dataset also 10% (data) used for the test model.

4.5.3. Examining the relationship between Dependent and Independent Variable's

The relationship between variables is assessed statically using the correlation coefficient (Schober et al., 2018). The objective of this paper is to examine if there is any relation between the variables (between dependent and independent variables). Before going to further analysis, it is a must to know the bivariate characteristics of the data. (Schober et al., 2018)Review the Pearson correlation coefficient, one of the most commonly used. It is abbreviated by "r". Also, the value ranges from +1 to-1. This can be interpreted as anything between no association =0 and a perfect monotonic relationship =+1or-1. Analysis of Pearson correlation coefficient between dependent and independent variables was carried out using a software package for social science (SPSS – 26). In this case, the null hypothesis is that there is no relation between the variables.

Table 9: Pearson correlation coefficient matrices between dependent and independent variable

Item	Description	Pearson Correlation(y)	Sig. (2-tailed)
X18	Prequalification requirements	.672**	0.000
X10	Turn over requirements	.481**	0.001
X16	Ability of doing the job	.436**	0.002
X14	Project tie with company future	.394**	0.007
X24	Future project	.377**	0.010
X20	Overall economy (availability of work)	.365*	0.013
X17	Past experience in managing similar project	.341*	0.020
X22	Market condition (stability of material prices)	.328*	0.026
X5	The client financial capacity	0.269	0.071
X13	Resources requirements (Equipment)	0.227	0.130
X21	Project area security	-0.227	0.129
X3	The benefits expected in terms of the company reputation	0.128	0.397
X15	Availability of required foreign currency	0.124	0.412
X6	The clarity of client requirements	0.079	0.603

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Interpretation of result

- **Determining the direction of the relationship**

In a monotonic relationship between dependent and independent variables, the value of one variable increases while the value of the other variable decreases. In correlated data, the magnitude of one variable is associated with the magnitude and direction of the other variable, either in the same direction or the opposite direction. This implies that if one variable increases, so does the other, or if negatively correlated, one variable increases while the other variable decreases. (Schober et al., 2018)

Prequalification requirements

The prequalification requirements factor has a positive correlation with bid decision. These indicate contractors are interested in participating in a bid if they are eligible for prequalification requirements.

Turn over requirements

Turn over requirements also have a positive correlation with the decision to bid. According to PPA Commonly, it's estimated, consideration project estimation and duration of the project for completion. This also has relation to their decision.

Ability to do the job

The ability to do the job also has a positive correlation with the decision to bid. It can also be interpreted as having more efficiency encourage contractors to participate in bids.

Project tied with company future

Project tie with company future factor has a positive correlation with bid decision. This tells us the company's forecast vision, value, and goals have an effect on the choice of project to bid on.

Future projects

The availability of future project has a positive impact on the decision to bid. This implies if the project is having other extension phases and/or help for the company to have an experience-based similarity and complexity on future competitive advantage. This will add value to the link for predicting upcoming company opportunities.

Overall economy (availability of work)

The overall economy has a positive correlation with the decision to bid. Invitation increases in the market attract companies to participate in bids.

Past experience in managing similar projects

Having past experience in managing similar projects has a positive correlation with decision. This is explained as contractors who accomplish successfully and substantially similar projects are more interested in going further or indicating contractors are

interested in participating in bids if they have equivalent experience of project in pervious.

Market conditions (stability of material prices)

Market conditions (stability of material prices) have a positive correlation with the decision to bid. This implies the stability of material enriching contractors to participate in bidding.

- **Assessment of the significance**

The Sig values in table 6 show whether the null hypothesis is correct or not, the association between each independent variable and the dependent variables. Five factors have a significant relationship at the level of 0.01 (their sig value is less than 0.01) and three factors have a statically significant relationship at level 0.05 (their sig value is less than 0.05) with the decision to bid. Except the above eight, the rest have no statically significant relationship with the decision to bid or not, which is based on the selected level of significance, which is 0.05, incorrectly considering the null hypothesis is acceptable.

- **Determining the strength of the relationship**

Schober et al., (2018) mention that most researchers agree that correlation coefficients less than 0.1 indicate negligible relationships and correlation coefficients greater than 0.9 have very strong correlation coefficients. Several approaches have been suggested to translate the correlation coefficients into descriptors like small, medium and large relationships. They summarize the cutoff point used as the conventional approach for interpreting a correlation coefficient as follows: -

Table 10: Different cutoff point of correlation coefficient summarized by (Alemu, 2020)

Correlation Coefficient+-	Interpretation
0.00–0.29	Small strength
0.3–0.49	Medium strength
0.50–1.00	Large strength

Considering the above factors, such as prequalification requirements, have large strength to decision. Resources turn over requirements, ability to do the job, project tie with company future, future projects, the overall economy (availability of work), past

experience in managing similar projects and the market conditions (stability of material prices) have medium strength to decision.

4.5.4. Multiple linear Regression Model Development

The general overview of multiple linear regression analysis is discussed in chapter two. In statically analysis, not meeting the assumption first will lead to untrustworthy results (Osborne and Waters , 2002). Here is a brief discussion about the basic assumptions.

- **Normality distribution**

Regression analysis take into consideration variables have equal distribution. Assumption asses the normality of residual or error (Wulandari et al. , 2021)There are different methods for checking normality for small data. skewness and kurtosis tests or usually inspection of histogram or frequency distribution. skewness measures the symmetry distribution of variables. Skewness equals zero normally distributed. Positive or negative value indicates the direction of the tail to the right and left. Kurtosis also measures the distribution of peakdness. In this case, the normality assumption is checked through visual inspection. This is shown in figure 3 shown below. There is no major deviation. It's symmetrical. In addition, the normality probability plot obtained standard residual versus the expected value. As a result, we can say the normal distribution is expected to lie near the diagonal line (Alemu, 2020). In this case, all the results lie near to the diagonal line and there is no major devotion.

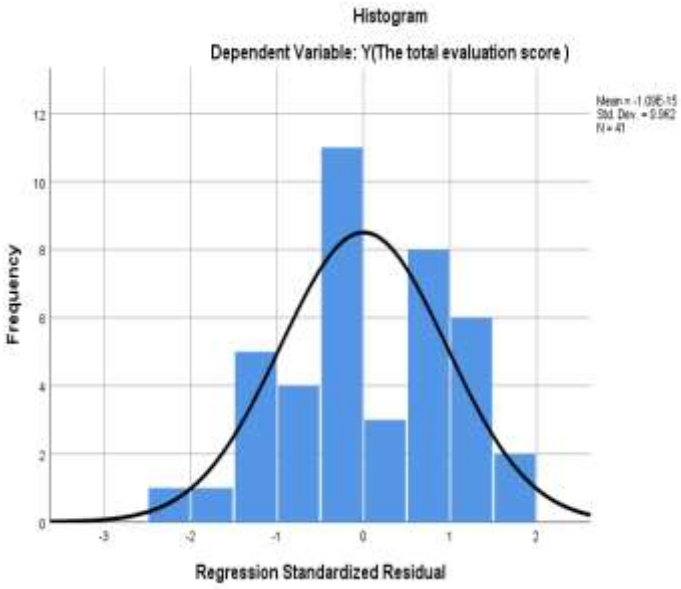

Figure 3: Histogram

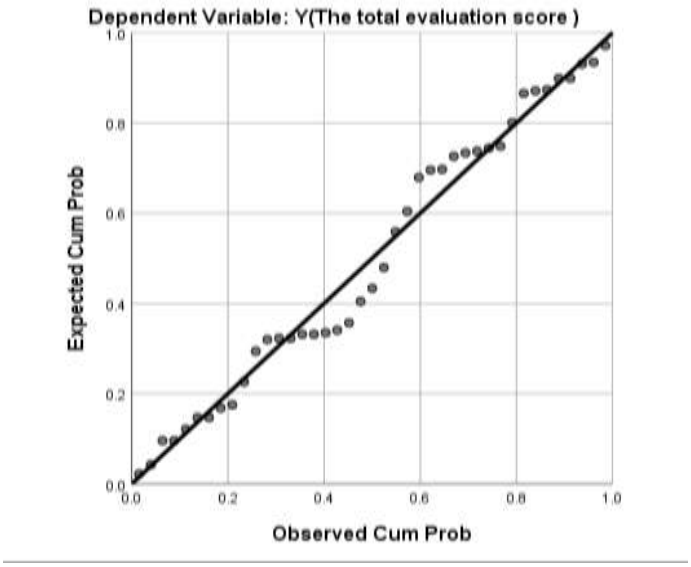

Figure 4: Normal p-p plot of regression standardized residual

- **Linearity between dependent and independent variables**

Osborne and Waters,(2002) The result of regression can be accurately estimate if the relationship between dependent and independent variables is linear and if not, it will underestimate the true relationship. The most widely used method to check the linearity is the inspection of the scatterplot between standard predicted value and standard residuals.

As shown in figure 5 below, the scatter plot is not curved near the center and equally distributed; we can say that it has a linear relationship.

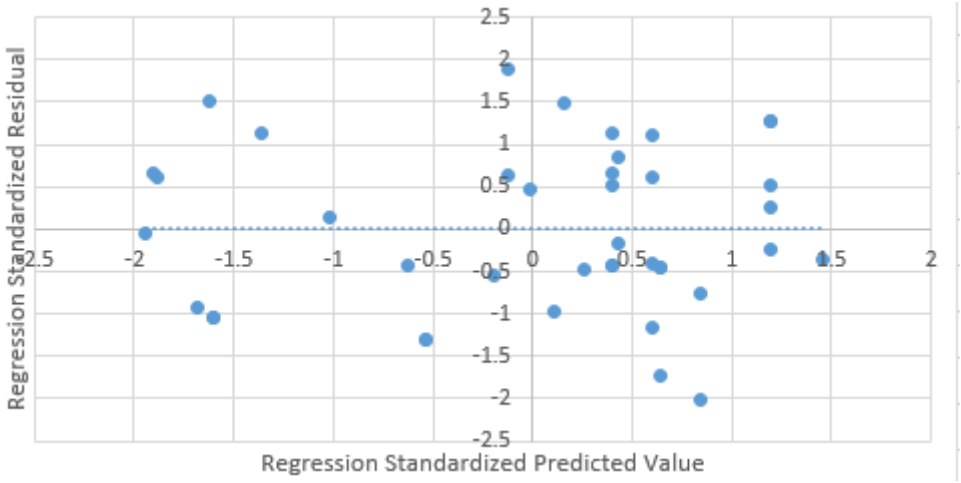

Figure 5: Scatter plot residual as a function of prediction value

- **Multicollinearity**

Mooi et al. , (2016) review Collinearity arises from the involvement of two independent variables and they are highly correlated. If more than two variables are highly correlated, multcollinearity occurs. This occurs if independent variable redundancy information. Using SPSS, it is simply detected easily by estimating the value of different parameters, such as using simple linear regression analysis inspecting the value of tolerance and variation inflation factor (VIF). In Tolerance and variance inflation factor (VIF). The result of VIF is more than 10 and tolerance more than one multcollinearity occurs. As the result shown in table 10 below, less than 10 VIF and tolerance below one. The above two points do not fulfill, therefore there is no multicollinearity. (Alemu, 2020). If the correlation matrix coefficient is 0.9 and above, there is a high problem of multicollinearity with independent variables. As a result, no value has 0.9 above the inspecting Pearson bivariate correlation matrix.

- **Homoscedasticity**

Osborne and Waters , (2002) Define the homoscedasticity variance of error is the same across all levels of independent variable. If not, heteroscedasticity exists. He also mentioned that the existence of heteroscedasticity may weaken the analysis and increase errors. This leads to distortion of the finding, but heteroscedasticity has less effect on the significance test. Inspecting figure 5, residuals are randomly scattered along the

horizontal line, relatively distributed equally. Seeing this, we can say that error variance homoscedasticity.

Hence, none of the assumptions of multiple linear regression analysis were violated. Model can be constructed and developed using a software package for social science (SPSS – 26). The approach used a stepwise method. In my case, the chosen model for interpretation is the third (model-3), which has more participant variables, less errors, and dependent variables explained more portions by the independent variable. Accordingly, evaluating model and interpretation of results from model summery, ANOVA table and coefficient table are detailed as below;

The Model summary contains the results used to determine how the multiple regression model fit the data. It consists of standard error, R, R^2, adjusted R^2. The main definition of coefficient is taken from (Prasad, 2018) and (Alemu, 2020). The result is shown in table 11 below.

Table 11: Regression Model Summery

Model	R	R2	Adjusted R^2	standard error
1	0.676	0.457	0.443	5.09
2	0.765	0.586	0.564	4.5
3	0.83	0.689	0.664	3.95

R:-represents multiple correlation coefficients, used to measure the quality of prediction of the independent variable (the decision or the total evaluation point). As a result, model four was 0.83, which is good.

R2:-represents the coefficient of determination, used to measure the percent of the dependent variable explained by the independent variable. In this case, 0.689 this explains that the decision made by experts 68.9% is described by Prequalification requirements, overall economy (availability of work) and future projects. Nearly 31.1% is affected by unknown other variables. On the other hand, (Prasad, 2018)maintains in his article that small R^2 needs supportive explanation. Small value always does not tell us if there is a problem and higher values are always not good, mentioning predicting human behaviors as an example.

Adjusted R^2:-as the name implies, it adjusts the criteria by penalizing the unwisely measured in the model. This is supported by R^2 because every dependent variable will be affected by the independent variable in an equal percentage, which is not true, but adjusted R2 is correct, this can control over estimation resulting from a small sample (Prasad, 2018). Used for accurate reporting results, the value or adjusted R^2 has to be less than or equal to $R^{2.}$ The gap between the values is large. It shows that the model is a poor fit to the data. In this case, 0.664 or 66.40%. The gap is small.

Standard error:-measure how wrong it will be if someone uses the model in making a prediction. R2 increases, the error will decrease. In this case, 3.95 is small. It's better to have a small value to increase the certainty of using the model. Prasad, (2018) Show that the value may increase if multi-collinearity happens, but in this case, as checked above, it does not exist. Therefore, we can accept the error. In addition to this, in table 13, the standard error of the independent variable has to be as small as possible. In this case, the significant variables have errors of 0.046, 2.684 and 2.377respectively. Prequalification requirements have less error compared to other variables.

ANOVA table 12 F value or Ration: -measure whether the overall regression model is a good fit for the data F (x18, x20, x24) = 27.345, P (0.001) 0.05, sig value which is 0.000 explains why the model is a good fit for the data.

Table 12: ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig
1	Regression	850.84	1	32.76	0.00
	Residual	1012.9	39		
	Total	1863.74	40		
2	Regression	1092.06	2	26.88	0.00
	Residual	771.68	38		
	Total	1863.74	40		
3	Regression	1284.43	3	27.345	0.00
	Residual	579.3	37		
	Total	1863.74	40		

The Significance of the model:- In table 12, the given t and sig value inform us from 14 variables, prequalification requirements, future projects, and the overall economy (availability of work) have a value of P is less than 0.05, which is significant. X3, X5, X6, X10, X, 13, X14, X15, X16, X17, X21, and X22 are not included in the model which has a value of P is greater than 0.05, not significant.

Unstandardized coefficient:-B this indicates how much the dependent variable varies with an independent variable when other independent variables are held constant. This indicates one unit increase in being qualified in the overall economy (availability of work). Our decision mark will increase by 11.577 units. This will also increase the tendency to participate in the bid.

Zero order correlation:-its correlation between the independent and dependent variable which ignores the effect of another independent variable could or not influence the dependent variable.

Partial correlation:-its correlation between the independent and dependent variables in which the effect of another independent variable could be constant.

Part correlation:-its correlation between the independent and dependent variables in which the effect of other independent variables could be excluded.

Referring to the results shown in table 12 below, considering this in bivariate correlation or zero order correlation for Prequalification requirements large strength, the overall economy (availability of work) and future projects have medium strength. In other words, prequalification requirements and the overall economy (availability of work) are highly correlated with dependent variables when other variables are kept constant compared to zero order. Future projects also show improvement in the same category. Future project and project area security have a higher correlation compared with zero order having medium strength. In excluding the effect of other independent variables, the overall economy (availability of work) and future projects have medium strength. Prequalification requirements with less value stile have large strength. This will lead to the idea that in decision making, prequalification requirements have strong relationships compared to other variables.

Under standard coefficient beta :-this explains how much the dependent variable increases in standard deviation when the independent variable increases by one standard deviation by taking into consideration other variables are constant. Measure the rank of

contribution of an independent variable without consideration of the sign. Accordingly, prequalification requirements have a higher contribution. The second is the overall economy (availability of work) and the third is the future project.

According to (Prasad, 2018) knowing overlap predictive capacity of independent variable also calculated using subtracting sum up square value of β from R^2 in this case =0.689- $(0.606)^2$+$(0.398)^2$+$(0.330)^2$which is 0.0544 overlap contribution of independent variable 5.44%.

Construct the model: - The general multiple linear regression model equation to predict the decision

$$Y = 41.659 + 0.299X18 + 11.577X20 + 8.33X24 \quad (12)$$

In real practice the value of independent variable all the same time cannot be zero. There for the constant have no interpretation that will give sense.

Table 13: Coefficient

Model		unstandardized coefficient		stand coff	t	sig	95% confidence interval for b		correlations			collinearity statistics	
		b	Stnd .error	Beta			lower bound	upper bound	zero order	partial	part	tolerance	VIF
3.00	(constant)	41.65	4.64		8.90	0.00	32.25	51.06					
	X18	0.30	0.05	0.61	6.48	0.00	0.21	0.39	0.68	0.73	0.59	0.96	1.04
	X20	11.58	2.68	0.40	4.31	0.00	6.14	17.02	0.37	0.58	0.58	0.99	1.10
	X24	8.33	2.77	0.33	3.51	0.001	3.52	13.15	0.40	0.50	0.50	0.95	1.05

Test the model for unknown data is also necessary. Accordingly, the result is reasonably good. Multiple linear regression model is checked for 10% Categorized test data as shown below:-

Table 14: Test data for multiple linear regression models

Project	Y(actual result)	Predict over all evaluation point by MLRM (%)	Error of estimate
P1	78	79.6975	-1.6975
P2	79	84.1825	-5.1825
P3	92	84.1825	7.8175
P4	78	78.2025	-0.2025
P5	90	89.971	0.029

4.5.5. Fuzzy Rule-Based Model Development

The development of a Data Driven Fuzzy Rule-Base System Model which integrates significant factors generally follows the following procedures.

1. Determination of factors used for model development (input and output variables)
2. Collect datasets and categorization of datasets
3. Define membership function and generation of rules base
4. Evaluation of the system model

Step 1 and 2:-Determine the factors and datasets categorization

Step one and two are done in the above section. 14 input variables and one output variable are identified. 90% of the data is used for generating the system. In relation to this, forty-one data is used to generate the system. Mat lab 2018 is software used for system development. The feed is a numeric matrix. The data is organized as an input parameter (A) 14 ×41 matrix and an output parameter (B) 1×41 matrix.

Step 3:-Defining membership function and/or rule base generation

The syntax used to generate the system using fuzzy c means clustering. The optimum number of clusters is thirty-eight.

```
opt = genfisOptions('FCMClustering','FISType','mamdani');
```

```
fis = genfis(inputdata,outputdata,opt);
```

As mentioned in chapter two, the Mamdani or linear Sugeno model developed using a data-driven fuzzy approach has the form as shown below

'38. If (in1 is in1cluster38) and (in2 is in2cluster38) and (in3 is in3cluster38) and (in4 is in4cluster38) and (in5 is in5cluster38) and (in6 is in6cluster38) and (in7 is in7cluster38) and (in8 is in8cluster38) and (in9 is in9cluster38) and (in10 is in10cluster38) and (in11 is in11cluster38) and (in12 is in12cluster38) and (in13 is in13cluster38) and (in14 is in14cluster38) then (out1 is out1cluster38) (1)'

Sample input and output parameters Membership function

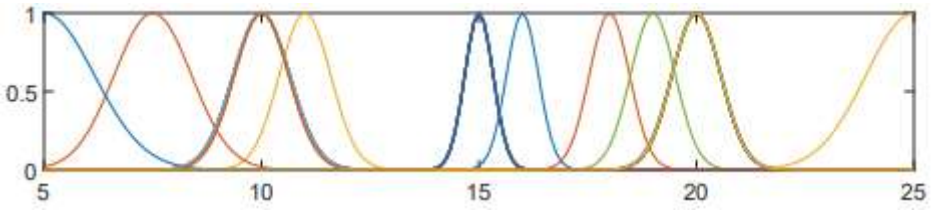

Figure 6: Membership function for the benefits expected in terms of the company reputation

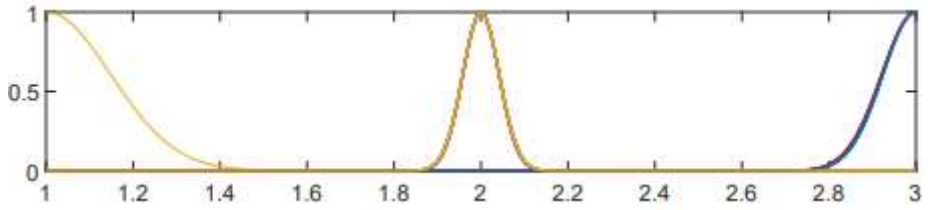

Figure 7: Membership function for the client financial capacity

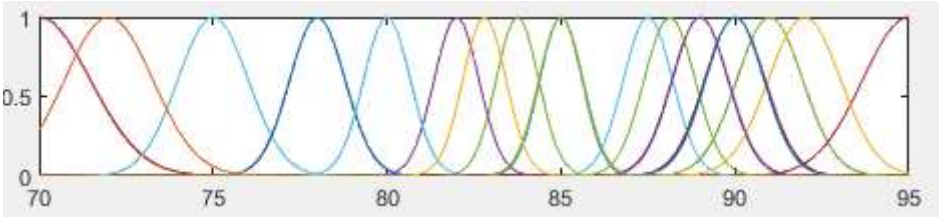

Figure 8: Membership function for decision total evaluation score

Step 4 Evaluation (verification) of system model

Model verification consists building what is required. Accordingly the model has to be evaluated with unknown actual project bidding cases. 10% data or 5 project

scenarios used to evaluate. Accordingly the developed system evaluated using syntax. The model predicts value indicated column 3 of table 15. The result was also good.

Output = evalfis(input1,fis);

Table 15: Test for data driven fuzzy rule base system model

Project	Y(actual result)	Predict over all evaluation point by FRB (%)	Error of estimate
P1	78	79.6547	-1.6547
P2	79	85.6003	-6.6003
P3	92	79.635	12.365
P4	78	79.6547	-1.6547
P5	90	80.7874	9.2126

4.6.Performance measures (validation)

There are different performance measures that exist for the purpose of selecting the best performing system for data (Chai and Draxler, 2014). Root mean square (R_2) , root mean square error (RMSE) and mean absolute error (MAPE) have been used standard statically metrics to measure model performance. Hence, Performance measures are applicable for multiple linear regression and data-driven fuzzy rule base models to evaluate their performance.

Table 16: Summary of statically performance indicator

Model	Performance indicator		
	R^2 (%)	RMSE	MAPE (%)
MLR	67.45	3.81	3.87
DDFRB-38	84.75	2.62	1.17

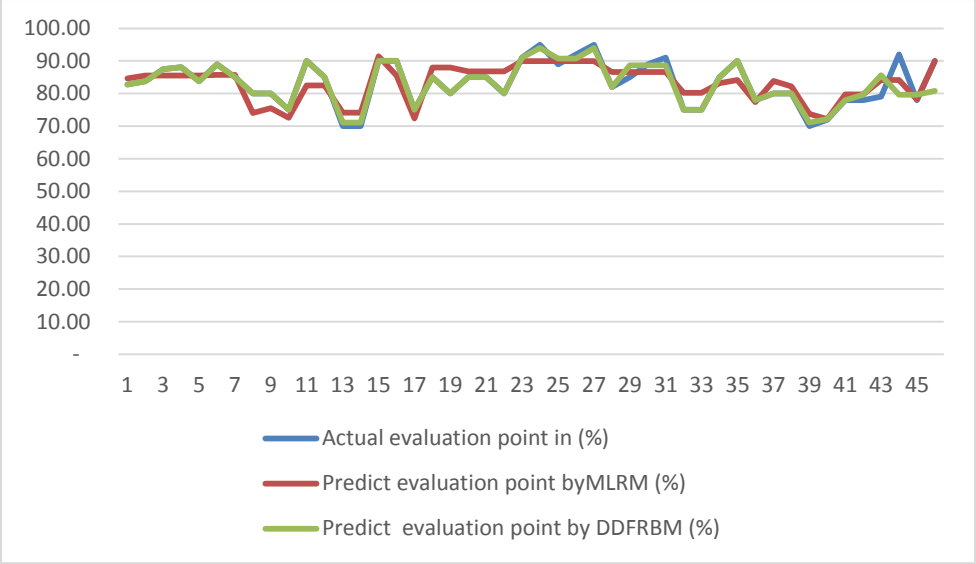

Figure 9: Comparison between the regression model and fuzzy rule base

Using over all bid dataset data driven fuzzy rule base system model using fuzzy c means clustering in predicting capacity has better results than multiple linear regression model. The simple scatter plot shown in the figure below shows the actual value and prediction value of the model. The data driven fuzzy rule base shows predicted value almost in line with actual value.

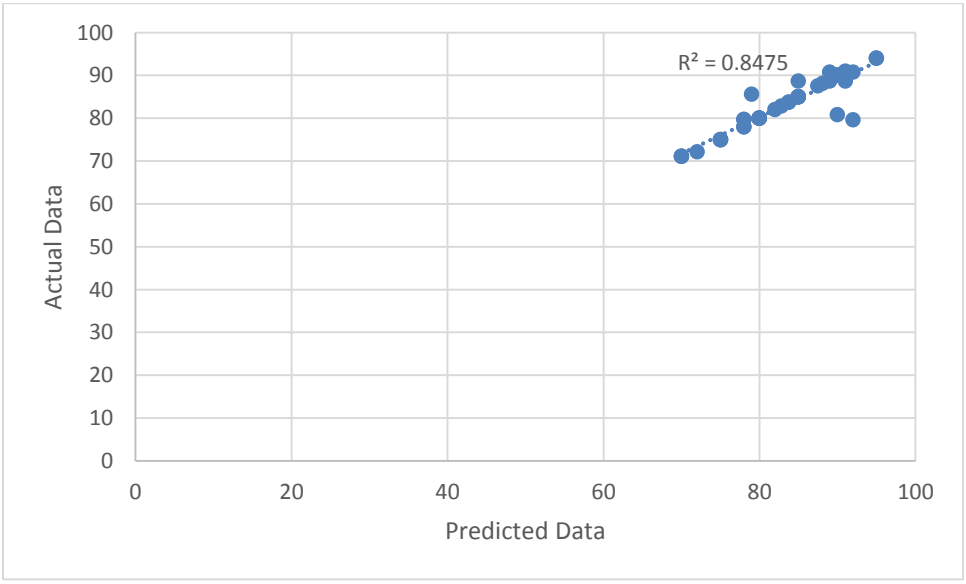

Figure 10: Actual Vs. Predicted for Data Driven Fuzzy Rule Base System Model

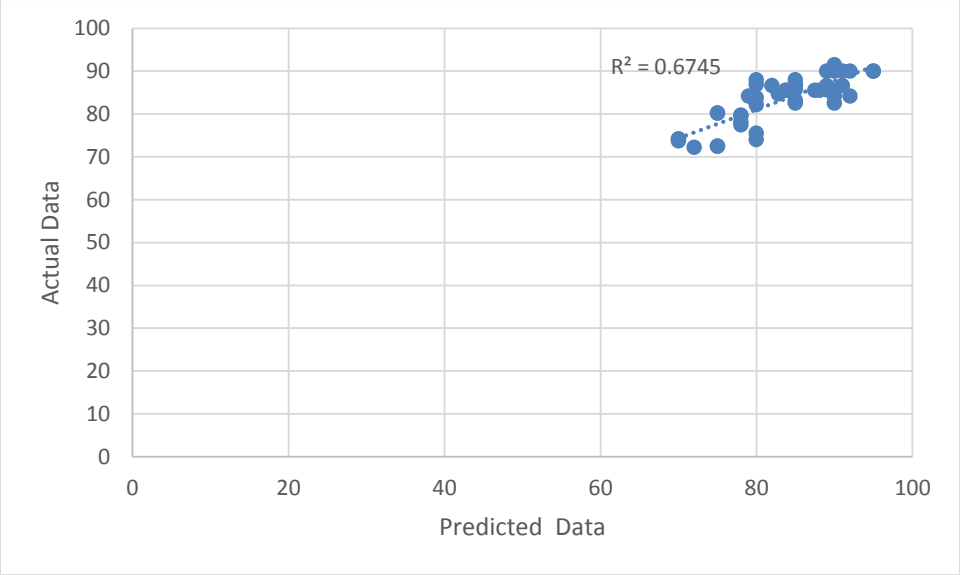

Figure 11: Actual Vs. Predicted by Multiple Linear Regression Model

4.7. Model description

```
load = xlsread('ad.xlsx');
inputdata = ad(:,1:14);
outputdata = ad(:,15);
opt = genfisOptions('FCMClustering','FISType','mamdani');
opt.NumClusters = 38;
opt.Verbose = 0;
fis = genfis(inputdata,outputdata,opt);
showrule(fis)
[x,mf] = plotmf(fis,'input',1);
subplot(3,1,1)
plot(x,mf)
xlabel('Membership Functions for Input 1')
[x,mf] = plotmf(fis,'input',2);
subplot(3,1,2)
plot(x,mf)
xlabel('Membership Functions for Input 2')
[x,mf] = plotmf(fis,'output',1);
subplot(3,1,3)
plot(x,mf)
xlabel ('Membership Functions for Output')
```

The model developed

name: 'mamdani141'

type: 'mamdani'

andMethod: 'min'

orMethod: 'max'

defuzzMethod: 'centroid'

impMethod: 'min'

aggMethod: 'max'

input: [1×14 struct]

output: [1×1 struct]

rule: [1×38struct]

4.8.How to use the model

The above two models introduced to explore different alternative. Used for better understanding of real world system. Always have information as input and expected result output. The expert expected to insert input value assessment of the project. Using the following syntax and the system will result the output by analyzing the input data through if then rules.

```
input1= [20 2   2   1   1   0.5 0   1   2   85  0.8 1   0.5 1];
output = evalfis(input1,fis);
disp(output)
```

For linear multiple regression model using mathematical model equation 12 for prediction evaluation score.

5. Conclusion and Recommendation

A bid no bid decision is a critical activity made frequently, quickly, intuitively, and while considering the influencing factors. Following the objective of the paper, in this study, significant factors were identified. Examination of the relationship between dependent and independent variables is done and, finally, supportive predictive models are developed. Consideration of the above chapter leads to the following conclusion and recommendation.

5.1. Conclusion

- The research has shown that experts give prioritization/more attention considering overall factors. The following are found in the top ten as more important factors. This includes the overall economy as the number one most important factor. The second size of the contract, project tie with company future and prequalification requirements, fifth security and work capital required to start the job, seventh type of project, availability of required cash, ability to do the job and past experience in managing similar projects.
- The respondents give least attention to job start time, attention to anticipated value of liquidated damage, tax liability and use of nominated sub-contractor, type and number of supervisory and labor requirements.
- This research shows that construction companies face termination of an average of 2.17% or maximum of up to 10% minimum 0% percentage of the total number of contracts that get through competitive bidding due to performance.
- The research shows most companies have team work in bid preparation. But 61.90% of experts did not get the opportunity to attend training or seminars related to business administration, cost estimation, marketing, contract administration, or any other relevant course which helps them to have multiple points of view.
- A good result has been seen in knowing the consequence of the bid decision and gathering related information about the bid. But we have no methodology to analyze the knowledge, experience, and current capability of new project acquisitions.
- Attribute selection contributes to the study in case input variables are many in the dataset, with the benefit of reducing irrelevant and redundant variables.
- The Pearson correlation shows that prequalification requirements, turn over requirements, ability to do the job, project tie with company future , future project, overall economy (availability of work), past experience in managing similar projects

and market conditions (stability of material prices) have significant relation with the decision to bid.

- Data driven fuzzy rule base system model has been selected as the Mandeni type, using fuzzy c means clustering. The model structure has 38 rules, 14 input variables, and 1 output structure. Over all, the data performance measures have a value of R^2=84.75, RMSE=2.62 and MAPE=1.17, which is a good result. Data driven fuzzy rule base system models have the advantage of giving an opportunity for all variables to be included according to their relevance set by experts. The model showed low values of performance measures RMSE and MAPE and increased the value of R^2 when the number of clusters is 38, approximate to the number of data used for model development, 41. This model has shown better predictive results than multiple linear regression.
- The Multiple linear Regression Analysis model has 3 variables using stepwise approaches. It has multiple correlation coefficient R=0.83, coefficient of determination R^2= 68.9, F Ratio (x18, x20, x24)=27.345, P (0.001) 0.05 with sig value 0.00, which is a good fit. With over all data, performance measure Value R^2 =67.45, RMSE=3.81 and MAPE=3.87 have good results. More benefits for use in decisions to examine relationships and effects of variables.

5.2. Recommendations

Based on the findings of the research, the following recommendations are suggested.

- Contractors should give attention to the decision made at the beginning of the acquisition of a project through bidding. A proper consideration of factors, contribute sureness to see the project in every detail and also helps them to make an informed and improved decision. Informed in way have knowhow about the problem that could be challenging during the construction period. Improved in the manner that reducing uncertainties. Furthermore as result reduces the percentage of termination contract they get through bidding and also reduce rejected bids in submission of proposal.
- The results show construction companies give less attention to the anticipated value of liquidated damage and tax liability, but this factor has influenced the company, therefore advised to take it into consideration.
- Some of the construction projects consist of activities that are new to the contractor. Accordingly, it’s better to alert professionals through training in order to encourage them to have a better outlook on new projects.

- Both regression analysis and data driven fuzzy rule base system model techniques in decision making help to understand the situation in a reasonable and descriptive way. Using this technique will add up to rationality in their decision and efficiently use of time.

5.3. Recommendations for Future Research

- As I have mentioned in research limitations, this research involves very limited participants, who are general contractors at level one in Addis Ababa. Increase sample size or having a large dataset, including other categories of contractors, will result in understanding at different levels.
- Other machine learning techniques, such as k means or subtractive clustering technique, ANN, for use in term papers. This may help better understand the benefits of machine learning in doing research. I think such kinds of practices may help to choose topics wisely to explore more in the short term and have a contribution to publication.
- Bid decision using case study with the application of knowledge-based fuzzy rule base and clustering techniques in the availability of expertise can be an area of research.
- Bid decision by creating successful-not successful project scenarios with the application of binary logistic regression can be another area of research.

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Appendix I: Questionnaire one

ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
(AAIT) SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Research Questionnaire

Dear Sir/ Madam

I am currently undertaking a M.Sc. degree in civil engineering (Construction Technology and Management) at Addis Ababa Institute of Technology. In fulfillment of this M.Sc. degree I am carrying out a study on the topic Identification of Factors Affecting Bid No Bid Decision for Construction Projects in Addis Ababa and Developing Decision Model Using Fuzzy Rule - Based System, Aim of investigating the effect bid decision and to come up with supportive solution. Your genuine, honest and prompt response to the questionnaire will have contribution to the success of the research. Your response will be kept confidential, and anonymity will be maintained.

Objective of the research include:-

- Identify factors that affecting bid no bid decision making.
- Develop a model that will support managers or bid experts in the decision making using fuzzy rule based system.

If you have any questions regarding this document please contact me with the following address Thank you very much for your time and helpful insight.

Your open and prompt response is highly appreciated.

RESEARCHER' S INFORMATION:

Name: MeronWolde
Phone: +251-0912241982
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Field of Study: MSc. In Civil Engineering (Construction Technology & Management)

Advisor: Dr Abraham Assefa

Section I. Personal and Organizational Profile of Respondent

1. Please select your occupation:

   [ ] General Manager [ ] Operation manager [ ] Construction (Coordinator)

   [ ] Commercial Manager [ ] Bid expert [ ] Quantity surveyor

   [ ] Senior office engineer [ ] Contract Engineer

   Other (please specify) _____

2. Type of organization:

   [ ] General Contractor [ ] Building Contractor [ ] Road Contractor

   [ ] Water works contractor [ ] Specialized Contractor

   Others (Please specify) _____

3. How long have you worked in the stated occupation? _____ Year(s) _____ Month(s).
4. Your work experience in relation to construction projects procurement and bid preparation process?

   < 5 years 5 – 10 years > 10 years

5. Demographic Information

   Age: [ ] 20-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ] Over 60

   Gender: [ ] Male [ ] Female

   Education: Please specify all that apply to you.

   [ ] Master's Degree [ ] Bachelor's Degree [ ] College Diploma

   Vocational or trades school other (please specify):_____

6. Year of establishment of your company or organization? _____E.C/GC

7. Company peak construction turnover from last three years (please specify):_____

Section II – Perception of Construction Company on the benefits of bid – no bid decision

8. Do you think bid decision has effect on project performance? Yes [ ] No [ ]

9. What is the percentage of jobs obtained through competitive bidding?
   - 0%-25%
   - 26%-50%
   - 51%-75%
   - 76%-100%
10. What is the percentage of rejected bid in the processes?
   - 0%-25%
   - 26%-50%
   - 51%-75%
   - 76%-100%

11. Did you analyze the content of bid document and?

   - Check a contract - information given on bid document: Yes [ ] No [ ]
   - Check Employer Requirement / Design Document: Yes [ ] No [ ]
   - Carry out site visit: Yes [ ] No [ ]
   - Submit clarification requests to the Employer: Yes [ ] No [ ]
   - Attained bid clarification meetings: Yes [ ] No [ ]

12. If you choose No, please write the reason:

_____

_____

_____

_____

13. Did you use a systematic method to help in making the decision to bid by using (one or more) of the following: - Please check all that apply?
    - Internal procedures.
    - Mathematic equation needs special software.
    - Mathematic equation needs software like MS Excel only.
    - Special equation created by external professionals.
    - Has no specified way
    - Other (please specify): _____

14. What is the number of terminated contracts due to performance, please specify in percentage of total number of contract?

    _____

    _____

    _____

    ___

15. If internal procedures are applied, please mention the main steps and the information needed for each steps?

    _____

    _____

    _____

16. Does your organization bid decision process plan contain the following elements?

    - Validate if the Company can satisfy qualification and evaluation requirements that the bidder need to be fulfilled to participate in the bid. Yes [ ] No [ ]
    - Beyond the evaluation requirement there has to be rational decision using systematic approach considering all relevant factors and alternative.
      Yes [ ] No [ ]

17. For 15(b) if you choose No, please write the reason (difficulties) you have?

    _____

    _____

18. Did you have technical team that is capable for bid preparation? Yes [ ] No [ ]

19. If you choose yes, is there an opportunity to have training or seminars on cost estimation, marketing, contract administration or any other relevant for bid preparation? Yes [ ] No [ ]

Section III – Factors affecting the bid/ no bid decision making process

As company to get a job through bidding the first activity is to accept or not the bid invitation and to do this you have to consider various factors. Therefore, here under the summery of factors which are identified through literature review that affect bid no bid decision. This factor was subdivided into nine categories; competition, company situation, bidding situation, client and project characteristic, the contract, business benefit, economic situation and project finance. Each of these categories is divided into subcategories.

Please weight the importance of each criterion relative to the other criteria in that category or subcategory, by circling ***1 for the least important and 7 for the most important.*** (1 = Very Poor, 2 = Poor, 3 = Below Poor, 4 = Average, 5 = Above Average, 6 = Good, and 7 = Very Good)

A	Project characteristics	1	2	3	4	5	6	7
B	Business benefits	1	2	3	4	5	6	7
C	The client characteristics	1	2	3	4	5	6	7
D	The contract	1	2	3	4	5	6	7
E	Project finance	1	2	3	4	5	6	7
F	Company situation	1	2	3	4	5	6	7
G	Bidding situation	1	2	3	4	5	6	7
H	Economic situation	1	2	3	4	5	6	7
I	Competition	1	2	3	4	5	6	7

A	Project characteristics - Which criterion is more / less important?							
1	size of contract	1	2	3	4	5	6	7
2	duration of the project	1	2	3	4	5	6	7
3	type of project	1	2	3	4	5	6	7

4	job start time	1	2	3	4	5	6	7
5	method of construction	1	2	3	4	5	6	7
6	location of the project	1	2	3	4	5	6	7
7	equipment requirement	1	2	3	4	5	6	7
8	degree of built ability	1	2	3	4	5	6	7
9	site accessibility	1	2	3	4	5	6	7
10	the project stakeholder	1	2	3	4	5	6	7
11	design quality	1	2	3	4	5	6	7
12	local clement	1	2	3	4	5	6	7
13	public exposure	1	2	3	4	5	6	7
14	technology difficulty	1	2	3	4	5	6	7
15	safety hazard	1	2	3	4	5	6	7
16	drawing and specification completeness	1	2	3	4	5	6	7
17	public objection	1	2	3	4	5	6	7
B	Benefit of business - Which criterion is more / less important?	1	2	3	4	5	6	7
1	the benefit expected in reputation	1	2	3	4	5	6	7
2	the continues of employment key personnel work force	1	2	3	4	5	6	7
3	establishment long relationship with the client	1	2	3	4	5	6	7
C	The client characteristics - Which criterion is more / less important?	1	2	3	4	5	6	7
1	local custom	1	2	3	4	5	6	7
2	relationship with owner	1	2	3	4	5	6	7
3	the client repetition among other contractor	1	2	3	4	5	6	7
4	the client requirement	1	2	3	4	5	6	7
5	owner private or public	1	2	3	4	5	6	7
6	prompt payment habit of the client	1	2	3	4	5	6	7
7	the client financial capacity	1	2	3	4	5	6	7
8	size of client	1	2	3	4	5	6	7
D	The contract - Which criterion is more / less important?	1	2	3	4	5	6	7

1	type of contract	1	2	3	4	5	6	7
2	clearness of the work and specification	1	2	3	4	5	6	7
3	the ability of modifying contract	1	2	3	4	5	6	7
4	finesse of delay	1	2	3	4	5	6	7
5	number and type of supervisory and labor requirement	1	2	3	4	5	6	7
6	consultant interpretation of specification	1	2	3	4	5	6	7
7	use of nominated sub-contractor	1	2	3	4	5	6	7
8	the contract special requirement	1	2	3	4	5	6	7
9	contract condition	1	2	3	4	5	6	7
10	cost and duration of bid preparation	1	2	3	4	5	6	7
11	terms of payment	1	2	3	4	5	6	7
12	terms of warranty	1	2	3	4	5	6	7
13	claim solution	1	2	3	4	5	6	7
E	Project finance - Which criterion is more / less important?	1	2	3	4	5	6	7
1	original price estimated by the client	1	2	3	4	5	6	7
2	working capital required to start the job	1	2	3	4	5	6	7
3	the possibility of shortage or delay on payment	1	2	3	4	5	6	7
4	project cash flow	1	2	3	4	5	6	7
5	the project markup size	1	2	3	4	5	6	7
6	percentage of insurance payment	1	2	3	4	5	6	7
7	anticipated value of liquidated damage	1	2	3	4	5	6	7
8	tax liability	1	2	3	4	5	6	7
9	financial goals of the company	1	2	3	4	5	6	7
10	degree of difficulty in obtain bank loan	1	2	3	4	5	6	7
11	market share	1	2	3	4	5	6	7
F	Company situation - Which criterion is more / less important?	1	2	3	4	5	6	7
1	availability of cash required	1	2	3	4	5	6	7
2	ability doing the job	1	2	3	4	5	6	7

3	availability of equipment required	1	2	3	4	5	6	7
4	availability of qualified human resource	1	2	3	4	5	6	7
5	uncertainty in cost estimation	1	2	3	4	5	6	7
6	need of work	1	2	3	4	5	6	7
7	general overhead	1	2	3	4	5	6	7
8	current work load	1	2	3	4	5	6	7
9	Project tie with company future	1	2	3	4	5	6	7
10	strength in the industry	1	2	3	4	5	6	7
11	competitive advantage	1	2	3	4	5	6	7
12	availability of qualified sub-contractor	1	2	3	4	5	6	7
13	site condition familiarity	1	2	3	4	5	6	7
14	company ability in design and innovation	1	2	3	4	5	6	7
15	relation with stakeholder	1	2	3	4	5	6	7
16	profit from similar project from the past	1	2	3	4	5	6	7
17	past experience in construction industry	1	2	3	4	5	6	7
18	past experience in managing similar project	1	2	3	4	5	6	7
G	Bidding situation - Which criterion is more / less important?	1	2	3	4	5	6	7
1	required bond capacity	1	2	3	4	5	6	7
2	time allowed for submitting bid	1	2	3	4	5	6	7
3	prequalification requirements	1	2	3	4	5	6	7
4	tendering duration	1	2	3	4	5	6	7
5	bidding method	1	2	3	4	5	6	7
H	Economic situation - Which criterion is more / less important?	1	2	3	4	5	6	7
1	risk involve in investment	1	2	3	4	5	6	7
2	availability of material and equipment	1	2	3	4	5	6	7
3	overall economy (availability of work)	1	2	3	4	5	6	7
4	governmental division requirement	1	2	3	4	5	6	7
5	risk expected in cost fluctuation of resources	1	2	3	4	5	6	7
6	security	1	2	3	4	5	6	7

I	Competition- Which criterion is more / less important?	1	2	3	4	5	6	7
1	who else is likely to bid for the job	1	2	3	4	5	6	7
2	how many bidders will be their	1	2	3	4	5	6	7
3	are the bidder equal similar contract with similar overhead	1	2	3	4	5	6	7
4	future project	1	2	3	4	5	6	7
5	Marketing condition	1	2	3	4	5	6	7

20. Are there any additional factors you think are important? If so, please give reasons.

_____

_____

_____

_____

21. Any other comments you wish to provide:

_____

_____

_____

Name: _____

Address: _____

Email; _____

"Thank you very much for your time and helpful insight, it was greatly appreciated'

Appendix II: questionnaire Two

ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY

(AAIT) SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Research Questionnaire

Dear Sir/ Madam

I am currently undertaking a M.Sc. degree in civil engineering (Construction Technology and Management) at Addis Ababa Institute of Technology. In fulfillment of this M.Sc. degree I am carrying out a study on the topic Identification of Factors Affecting Bid No Bid Decision for Construction Projects in Addis Ababa and Developing Decision Model Using Fuzzy Rule - Based System. From questionnaire-I Reply the following factors are identified that in each category top two most significant. Again for the development of system model I need your support, from your experience and data from the past.

Your response will be kept confidential and anonymity will be maintained. If you have any questions regarding this document please contact me with the following address Thank you very much for your time and helpful insight.

Thanks in advance.

RESEARCHER' S INFORMATION:

Name: Meron Wolde

Phone: +251-0912241982

E-Mail: **wolde.meron@yahoo.com**

Field of Study: MSc. In Civil Engineering (Construction Technology & Management)

Advisor: Dr Abraham Assefa

1. From the past five years 'of experience making decision to bid or no to bid what was the assessment you given for projects, kindly provide your assessment of the total evaluation in real numbers you give for each the factors affecting your bud decision and if your final decision was to yes (submitted a bid) or no (did not submit bid). If it is possible please sure that at least projects where you submitted a bid.

Item	Description	Unit	Projects		
			P1	P2	P3
1	Size of contract	Estimated Contract Amount (ECA) in million birr			
2	Type of project	Incorporated in terms of numerical value Building = 1, Roads=2, Infrastructure =3, Water Works= 4			
3	The benefits expected in terms of the company reputation	Profit expected from the project in percentage (%)			
4	Establishing long relationship with the client	Incorporated in terms of numerical value Necessary =1 , Unnecessary =2			
5	The client financial capacity	The ability to pay for the executed work in cash as per the contract incorporated in terms of numerical value Poor= 1, Good= 2, Very Good=3			
6	The clarity of client requirements	Incorporated in terms of numerical value Poor= 1, Good= 2, Very Good=3			
7	Type of contract	Incorporated in terms of numerical value Admeasurements =1 , Lump Sum =2			
8	Delivery Method	Incorporated in terms of numerical value Force account =1, Design Bid Build = 2, Design Build =3			
9	The Bid document must meet requirements	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
10	Turn over	Value shall approach to 1 if it is			

	requirements	easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
11	Working capital required to start the job	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
12	Resources requirements (man power)	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
13	Resources requirements (Equipment)	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
14	Project tie with company future	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
15	Availability of required foreign currency	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
16	Ability of doing the job	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
17	Past experience in managing similar project	Number of Completed project Similarity in nature and complexity			
18	Prequalification requirements	Bidder is Qualified Evaluation Criteria in Percentage %			
19	Time allowed for submitting bids	Ratio of essential time for submitted the bid proposal by bid flotation period in (days)			

20	Overall economy (availability of work)	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
21	Project area security	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
22	Market condition (stability of material prices)	Value shall approach to 1 if it is easy/qualified or Value shall approach to 0 if it is difficult/unqualified to be qualified {Range of Value 0 to 1}			
23	How many bidders will there be?	Number of Bidder Purchased Bid Document			
24	Future project	Value approach to one it easy/qualified or approach to 0 difficult/unqualified to be qualified { Value start 0 to1, [0,1]}			
Total score given to project in percentage (%)					
What was the decision: Yes or No?					