Comparative Study of Different Contractor Selection Methods

K. Khaja Masood Fakrulla[1], Chandra Mouli [2]

[1]*M.Tech (Construction project management), Dept of Civil Engineering, Shri Shirdi Sai Institute of Science and Engineering*

[2]*Assistant professor, Dept. of Civil Engineering, Shri Shirdi Sai Institute of Science and Engineering*

Abstract- **Contractors are very important in construction projects for the completion of project and selection of the best contractor for the project is a crucial decision for clients or owner. Selecting the right contractor for the right project is the most crucial challenge for any construction clients. Selection of the contractor to whom the client can trust and give the responsibility to execute the project has been primarily on the basis of bid price alone and the lowest price (tender) is usually described as being the key to win the contract, despite the fact that the tender sum is a major consideration because of instability and competitiveness of the construction industry, the selection of lowest bidder is one of the major reason for project failures. Recently there has been a trend away from a lowest price wins principle and subjective judgments to a multi criteria selection approach.**

In the present study A Comparative Study of Different Contractor Selection Methods has been done. Multicriteria decision approach considers both price and nonprice related criteria's for the selection of the contractor. Based on the past research done by the professionals the criteria's are selected. The important criteria's are listed out by survey for the selection of the best contractor and by using those criteria comparative study of different contractor selection methods has been done. Here I have used Analytical hierarchy process (AHP), TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) and Weighted Score Method (WSM) for the selection of a contractor among the bidders and those methods were compared.

It is observed from the comparative study that the contractor who is having more weightage for the criteria which is having more weightage is selected as the best contractor and it is also observed that the contractor who is having more weightage for quality performance is selected as best.

I. INTRODUCTION

The contractor selection issue is one of identifying a contractor who can undertake the client's project and take it to satisfactory conclusion. It is a decisive event for project success. It corresponds to an interface between variety arrays of construction companies. As the contractor plays vital role in the overall project performance, selecting the right contractor for the right project is the most crucial challenge for any construction client.

Selection of contractor to whom the client can trust and give the responsibility to execute the project has been primarily on the basis of bid price alone and the lowest price (tender) is usually described as being the key to win the contract. Despite the fact that the tender sum is a major consideration because of instability and competitiveness of the construction industry, the selection of lowest bidder is one of the major reasons for project failures. When the contractors are faced with shortage of work, wantedly quoted low bid price to win contract and to remain in business. To decrease the project failures multiple criteria's are to be considered while selection of contractor so that we can improve the contractor selection process.

Hwong & Yoon describes multiple decisions making as follows: Multiple decisions making is applied to preferable decisions (such as assessment, making priority and choice) between available classified alternatives by multiple attribute. People generally use one of two following methods for making decisions:

1. Trial &Error method 2. Modelling method

In trial & Error method decision maker face the reality so he chooses one of alternative and witness the results. If decision errors are great and cause some problems, he changes the decision and selects other alternative. In modeling method decision maker

models the real problem and specifies elements and their effect on each other and get through model analysis and prediction of real problem. Many mathematical programming models have been developed to address contractor selection problems. For the selection of best contractor multi criteria decision making models are used. However in recent years, multi-criteria decision making (MCDM) methods have gained considerable acceptance for judging different proposals.

Recently there has been a trend away from lowest price wins principle and subjective judgment to a multi criteria selection approach. To assist the owners or clients in making the decisions, the selection of the contractors for construction projects should be on the basis of multiple decision criteria that are both price and non price related. So that we can select the good contractor who is well suited for the project work. In the present study first contractor selection criteria's are identified and contractor selection methodologies Analytical Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Weighted Score Method (WSM) are used for the selection of contractor and then comparative study of contractor selection methods have been done. The main scope of the present work is to select the best contractor suited for the project and compare the different contractor selection methods.

Problem Statement:

Contractor selection is done by using multiple set of selection criteria includes experience, financial stability, current work load, quality performance, equipment resources, and technical capability of contractors firm and quoted project duration. The contractor selection is a decision making process, requiring simultaneous consideration of multiple criteria and the model developed should have the characteristics of multiple criteria and dealing with the uncertainty associated with the nature of decision making and comparing contractor selection methods.

- Dealing with the multiple criteria and also consistent.
- The model should be capable of dealing with the qualitative and quantitative parameters.
- Handling risk and uncertainty associated with the nature of decision making.

Objectives:

The main objective of this study is to develop a contractor selection system that is well structured in approach and capable of assisting the owners or clients in making decisions regarding contractor selection in a systematic, consistent and more productive way. The objectives of this study are:

1. To establish a set of multiple criteria in selection of contractor.
2. To find out the best contractor for each project based on project owner's requirements by using multi criteria decision making models.
3. To compare the different contractor selection methods and to find out the effective method to evaluate contractors.

Significance of the Study:

The proposed contractor selection system is set to deal with uncertainty and vagueness surrounding the subjective nature of decision making. AHP method is applied to many selection problems in project management which is meant to be a successful model. Similarly TOPSIS is also applied in ranking and decision making situations in projects. WSM is another common approach used for evaluation and selection of the best alternative in multi criteria decision making problem.

The use of the proposed contractor selection system has the following benefits:

- It should help the construction clients to select the best contractor in a systematic and consistent way.
- It will help in decreasing the project failures by adopting multi criteria in selection of contractor.
- It will help the construction industry to improve the contractor selection process and to find out the effective contractor selection method by comparing them.

II. LITERATURER SURVEY

This chapter covers a wide range of literature including books, published journal articles and conference papers covering the issues relating to contractor selection criteria's used in construction industry and evaluation techniques used. It also includes a brief review of multi- criteria decision

making models that are potentially useful for the contractor selection process.

Review of works done on contractor selection criteria's:

The development of research on contractor selection criteria's as reported in literature are briefly presented in the following paragraphs:

Jeffrey S.Russell and Miroslaw J.Skibniewski [12] (1988) have done research on Decision Criteria in Contractor Prequalification. Contractor prequalification is a decision making process involving a wide range of criteria for which information is qualitive, subjective and imprecise. Contractor prequalification involves the screening of contractors by project owner, according to given set of criteria in order to determine their competence to perform the work if awarded the construction contract. The criteria considered for the prequalification of contractor in this paper are cost of the project, time required for completion, quality of finished products, safety achieved during construction.

Zohar Herbsman and Ralph Ellis [26] (1992) have proposed Multi parameter Bidding System-Innovation in Contract Administration. This paper proposes a more comprehensive approach to bid award criteria. A presentation of multi parameter bidding system is made. The multi parameter bid evaluation system would include various owners selected parameters such as cost, time and quality. Qualification of these parameters and bidder evaluation methodologies are included.

challenge for any construction client. Numerous and often conflicting objectives and alternatives, such as tender price, completion Date and experience need to be considered .Recently ,to assist owners in making decisions. Increased project complexity and higher requirements have recently demanded the use of multi criteria decision-making methods for contractor selection. Two multi criteria decision methods ,the technique for order Preference by similarity to ideal solution(TOPSIS) and vlsekriterijumska optimizacija I kompromisno resenje (VIKOR) methods, are applied to the selection of a contractor for the road building project "LaBraguía" undertaken during2002.

Review of Methodologies:

Evangelos Triantaphyllou, Stuart H. Mann [8] (1995) applied analytic hierarchy process for decision making in engineering applications. In many industrial engineering applications the final decision is based on the evaluation of a number of alternatives in terms of a number of criteria. This problem may become a very difficult one when the criteria are expressed in different units or the pertinent data are difficult to be quantified.

Kamal M, Al-Subhi, Al-Harbi [14] (1999) applied analytical hierarchy process (AHP) as a potential decision making method for use in project management. The contractor prequalification problem is used as an example. A hierarchical structure is constructed for the prequalification criteria and the contractors wishing to prequalify for a project. This research presents group decision-making using the AHP.

Thomas L Satay [24] (2002) "Decision making with the AHP" why the principle Eigen vector is necessary. This research work shows that principle Eigen vector is a necessary representation of the priorities derived from a positive reciprocal pair wise comparison judgment matrix. The matrix is a small uncertain varies on the decision makers. When providing numerical judgments an individual attempts to estimate sequentially an underling scale and its equivalent consistent matrix of ratios, the new information is able to improve inconsistency to near consistency then that could improve the validity of the priorities of a decision.

Chun-Chin Wei, Chen-Fu Chien, Mao-Jiun J. Wang [7] (2005) have done research on an AHP-based approach to ERP system selection. An Enterprise Resource Planning (ERP) system is an investment that is very critical which can significantly affect future competitiveness and performance of a company. This study presents a comprehensive framework for selecting a suitable ERP system. The framework can systematically construct the objectives of ERP selection to support the business goals and strategies of an enterprise, identify the appropriate attributes, and set up a consistent evaluation standard for facilitating a group decision process.

Aviad Shapira and Marat Goldenberg [5] (2005) applied AHP to equipment selection model for construction projects. This research presents a selection model based on analytic hierarchy process AHP, a multi attribute decision analysis method, with a view to providing solutions. The model has the

capacity to handle a great number of different criteria in a way that truly reflects the complex reality, to incorporate the context and unique conditions of the project, and to allow for manifestation of user experience and subjective perception. The model was implemented in an in-house developed system that was improved and validated through testing. On the practical side, the proposed model offers an efficient, convenient tool that forces the users into orderly, methodical thinking, guides them in making logical, consistent decisions, and provides a facility for all necessary computations.

Saaty, T.L. [23] (2008) "Decision making with the analytical hierarchy process" decision involves many tangibles that need to be traded off. To do that they have to be measured alongside tangibles. AHP is a theory of measurement through which comparisons were made and depend on the judgments given by the decision maker priority scale. It is a scale which measures the intangibles' in relative terms. The scale represents that the attribute is how much important than the other attributes with respect to a given attribute. The judgment may be inconsistent then how to measure the inconsistency and how improve the judgments when possible to obtain better consistency is the concern of the AHP.

can develop contractor selection approach which can be most useful for the stakeholders. This paper suggests AHP Technique for selection of contractor problem in Indian context. Contractor selection hierarchy model is given and selection criteria's and its importance are given. This explains the limitations of the AHP.

Tanmoy Chakraborty, Tamal Ghosh, Pranab K Dan [22] (2011) have done research in application of analytic hierarchy process and heuristic algorithm in solving vendor selection problem. Vendor selection problem is believed to be a Multi Criteria Decision Making (MCDM) problem which has been a growing research area since past few decades. Several effective techniques have already been proposed by researchers and practitioners to evaluate the suppliers/vendors. Among these Analytic Hierarchy Process (AHP) is assumed to be the mostly exploited method due to its strong ability of attaining near-best solution to the problem in hand. The initial solution of the problem is achieved using AHP and thereafter the quality of the solution is improved using the proposed heuristic technique. In order to validate the proposed methodology the experimentation is carried out on real-life industrial data collected from an Indian construction firm.

Ashish H.Makwana [3] (2013) has done research on an approach for ready mixed concrete selection for construction companies through Analytical Hierarchy Process. The research presents the criteria's for ready mixed concrete selection and the process of Analytical Hierarchy Process. AHP based readymade concrete selection is suggested in this paper. This method was developed by Dr. Thomas L. Saaty in 1970s as a tool to help with solving technical and managerial problems Ready Mix Concrete (RMC) industry is continuously growing all over the world and India is not an exception to it. The pace of mechanization in the past was very slow due to the availability of cheap and abundant labor, lack of capital investment and the highly fragmented nature of the construction sector.

Nor Ashikin Mohammad et.al [19] (2013) Analytical Hierarchy Process in Multipl

instrument to upgrade the status of qualified higher education institutions. The AHP approach is a consensus, inclusive base decision without disregarding any opposing views. It simplifies a complex multi decision making process, makes it more systematic, and introduces transparency while saving cost and resources. Within the framework, three layers of components with different criteria and indicators were built on top of each other. The criteria and indicators are changeable. The instrument is generic, flexible and applicable to any institution.

G.R. Jahanshahloo, F. Hosseinzadeh Lotfi, M. Izadikhah [10] (2006) developed an algorithmic method to extend TOPSIS for decision-making problems with interval data. In this research, from among multi-criteria models in making complex decisions and multiple attribute models for the most preferable choice, technique for order preference by similarity ideal solution (TOPSIS) approach has been dealt with. In some cases, determining precisely the exact value of the attributes is difficult and that, as a result of this, their values are considered as intervals. Therefore, aim of this research is to extend the TOPSIS method for decision-making problems with interval data. By extension of TOPSIS method, an algorithm to determine the most preferable choice among all possible choices, when data is interval, is presented.

Majid Mojahed Javad Dodangeh et.al [16] (2009) has done research on using engineering economy techniques with group topsis Method for best project selection. Selecting projects are an important problem, yet often difficult task. It is complicated because there is usually more than one dimension for measuring the impact of each project and especially when there is more than one decision maker. Their paper considers a real application of project selection for Telecommunication projects with using the opinion of experts by one of the group decision making model it is called TOPSIS method .There are five kinds of criteria that they are include qualitative ,quantitative, negative and positive criteria have been considered and also two of them are Net Present Value and Benefit-Cost Analysis that they are engineering economic techniques for selecting the best one amongst five projects and ranking them. They have also used from six experts opinion in Cable Network .Finally the introduced method is used in a case study.

Javad Dodangeh, Majid Mojahed, Rosnah Mohd Yusuff [11] (2009) developed a best

project selection model by using of group TOPSIS method. Selecting projects is an important problem, yet often difficult task. It is complicated because there is usually more than one dimension for measuring the impact of each project and especially when there is more than one decision maker. This research considers a real application of project selection for projects with using the opinion of experts by one of the group decision making model, it is called TOPSIS method. Four kinds of criteria include qualitative, quantitative, negative and positive criteria have been considered for selecting the best one amongst five projects and ranking them.

Omid Jadidi, Fatemeh Firouzi, and Enzo Bagliery [20] (2010) applied TOPSIS method for supplier selection problem. Supplier selection, in real situation, is affected by several qualitative and quantitative factors and is one of the most important activities of purchasing department. Since at the time of evaluating suppliers against the criteria or factors, decision makers (DMS) do not have precise, exact and complete information, supplier selection becomes more difficult. In this case, Grey theory helps us to deal with this problem of uncertainty. Here, application of Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method to

evaluate and select the best supplier. Through this research, it is demonstrate that the concept of TOPSIS is very important for ranking and selecting right supplier.

Alireza Afshari, Majid Mojahed and Rosnah Mohd Yusuff [1] (2010) have done research on Simple Additive Weighting approach to Personnel Selection problem. Selection of qualified personnel is a key success factor for an organization. The complexity and importance of the problem call for analytical methods rather than intuitive decisions. This paper considers a real application of personnel selection with using the opinion of expert by one of the decision making model, it is called SAW method. This paper has applied seven criteria that they are qualitative and positive for selecting the best one amongst five personnel and also ranking them. Finally the introduced method is used in case study. To increase the efficiency and ease-of-use of the proposed model, simple software such as MS Excel can be used. Evaluation of the candidates on the basis of the criteria only will be sufficient for the future applications of the model and implementation of this evaluation via simple software will speed up the process. The limitation of this article is that the decision-making process. Numbers can be used to obtain the evaluation matrix and the proposed model cal be enlarged by fuzzy approach.

Ashish H.Makwana et.al [4] (2013) has done research in an approach for ready mixed concrete selection for construction companies through Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Technique. Ready Mix Concrete (RMC) industry is continuously growing all over the world and India is not an exception to it. The pace of mechanization in the past was very slow due to the availability of cheap and abundant labor, lack of capital investment and the highly fragmented nature of the construction sector. Multi-criteria decision making for evaluation of Ready Mixed Concrete by implementing Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is simple to understand and permits the pursuit of best alternative criterion depicted in a simple mathematical calculation. Due to this, decision making for selection of suitable Ready Mixed Concrete is of special importance. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was first developed by Yoon and Hwang for a Ready Mixed Concrete selection. Using

these weights provides the rank to every Ready Mixed Concrete with the help of a Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

Patcy Paul et.al [21] (2013) has done M.Tech dissertation on selection of a contractor in Indian construction industry using various multi criteria decision making methods-a case study. This paper suggests importance of various multi criteria decision making models for contractor selection problem in Indian context. The study includes identifying the different criteria for bid evaluation and the means by which different decision making models may be used to evaluate the contractors with respect to each criterion. A general comparative study of different models has also beendiscussed.

Bhavik K. Daxini, Prof. (Dr.) R.B. Bhatt and Prof. Jayeshkumar Pitroda [6] (2013) have done research on An Approach for Supplier Selection for Construction Companies through Analytical Hierarchy Process. In this highly competitive environment construction companies which design and manage their supply chains best will be more profitable and stronger. Supplier is one of the most important components of a supply chain management. At present most of the construction companies are randomly selecting the supplier for the purpose of materials. The present approach of supplier selection does not consider all types of criteria. It also lacks on considering all parts of criteria while selecting a best supplier. This paper proposes supplier selection by using the Analytical Hierarchy Process.

III. TECHNIQUE FOR ORDER PREFERENCE BY SIMILARITY TO AN IDEAL SOLUTION

TOPSIS method was developed by Hwang and Yoon (in 1981) for solving a Multi Attribute Decision Making (MADM) problem. This method is based on the concept that the chosen alternative should have shortest Euclidean distance from the ideal solution and the farthest from the negative ideal solution. The ideal solution is a hypothetical solution for which all attributes values correspond to the maximum attribute values in the database comprising the satisfying solution for which all attribute values correspond to the minimum attribute values in the database.

TOPSIS thus gives a solution that is not only closest to the hypothetically best, that is also the farthest from the hypothetically worst. The method is very useful for solving real world problems and it provides an optimal solution or the alternative's ranking.

TOPSIS method is based on the assumption that m x n decision-making matrix D includes m-alternatives and n-criteria and that the attributes expressed by linguistic terms are quantified. It is also assumed that the benefits of each individual criterion are determined and that relative criteria weights w_i have also been defined.

If m alternatives and n criteria are given for assessment in order to choose the most acceptable alternative a out of the finite alternative group, taking into account all criteria simultaneously.

A = [1, 2, 3. . . m]

Each alternative a_i; i = 1,2,3,........,m is described by attribute values f_j ; j = 1,2,3,........,n marked as follows : x_{ij} ; i = 1,2,......,m; j= 1,2,......,n. Criteria f_j may be of profit (benefit) or expenditure (cost) type. Profit type criteria means that greater value of attribute is preferred to lesser attribute value (herein represented by " max"), while cost type criteria means that lesser attribute value is preferred to greater value of attribute (herein represented by "min"). The above is illustrated with the following matrixD.
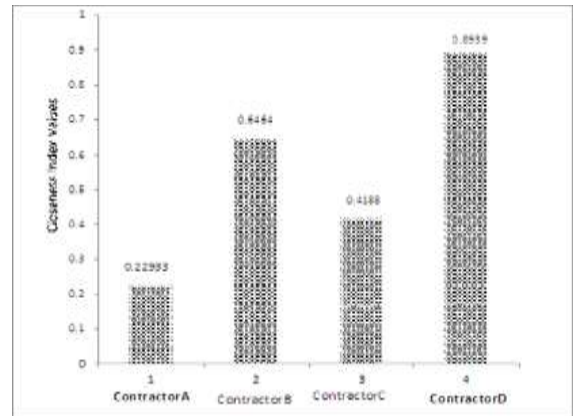
V. CONCLUSION

1. It is observed that from AHP, TOPSIS and WSM method contractor D is given first rank and contractor A has given lastrank.
2. It is concluded that the contractor D is best in his performance followed by contractor B

&contractor C. The overall performance of contractor A is not good enough with respect to different criteria among all thecontractors.

3. It is noticed that experience of contractor A is better than the contractor B, contractor C and contractor D. That means it can also be concluded that in spite of having experience in similar projects of a contractor, he may not be the bestcontractor.

4. It is noticed that the contractor who is having more weightage for the criteria which is having more weightage is selected as the bestcontractor.

5. It is also noticed that contractor who is having more weightage for quality performance is selected asbest.

6. It is observed that checking the consistency is done in AHP but in TOPSIS and WSM it is notthere.

7. It is observed that AHP, WSM Focuses on model from which a vector of global score is obtained by competing alternatives but where as TOPSIS is compromising model with optimal values on all criteria is simultaneouslyselected.

8. It is observed that AHP, WSM considers Relative Importance of criteria where as TOPSIS uses two reference points but it does not consider the relative importance of the distances.

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