Assessment and Evaluation of Contractor using Analytic Hierarchy Process

Vivek Singh Kushwah[1], Dr.B.P.Mudgal[2], Dr. Manoj Sharma [3]
[1] Research Scholar, IPSCTM Gwalior, Affiliated to RGPV, Bhopal (MP)
[2] Professor, IPSCTM, Gwalior, Affiliated to RGPV, Bhopal (MP)
[3] Professor, IPSCTM, Gwalior, Affiliated to RGPV, Bhopal (MP)

Abstract

This study presents a literature review of the application of Analytic Hierarchy Process. AHP is a multiple criteria decision- making tool that has been used in nearly all the operations related with decision- timber. The Analytical Hierarchy Process (AHP) as a possible deciding system to be used in design operation. The contractor prequalification problem is employed as an illustration. A hierarchical data structure is made for the prequalification criteria and thus the contractors wishing to prequalify for a design. By applying the AHP, the prequalification criteria are frequently prioritized and descending-order lists of contractors are frequently made so on pick the only contractors to perform the design. Perceptivity analyses are frequently performed to see the perceptivity of the ultimate opinions to minor changes in judgements. The paper presents group decision- making using the AHP. The AHP perpetrations way are going to be simplified by using the 'Expert Choice' professional software that is available commercially and designed for enforcing AHP.

Keywords: Analytical hierarchy process, AHP, MCDM, Project Management; Contractor prequalification, Questionnaire.

I INTRODUCTION

The Analytical Hierarchy Process (AHP) is a decision- abetting system developed by Saaty. This aims at quantifying relative precedence for a given set of druthers on a rate scale, supported the judgment of the decision- maker, and stresses the significance of the judgments of a decision- maker also because the thickness of the comparison of druthers within the decision- making process A decision- maker check judgments on knowledge and knowledge, also makes opinions consequently, the AHP approach agrees well with the geste of a decision- maker. The strength of this approach is that it organizes palpable and impalpable factors during a scientific way, and provides a structured yet fairly simple result to the decision- making problems In addition, by breaking a drag down during a logical fashion from the massive, descending in gradational way, to the lower and lower, one is in a position to attach, through simple mated comparison judgments, the bitsy to the massive. The ideal of this paper is to introduce the appliance of the AHP in design operation. This paper will compactly review the generalities and operations of the multiple criteria decision analysis, the AHP's perpetration way, and demonstrate AHP operation on the contractor pre qualification problem. It's hoped that this may encourage its operation within the whole area of design operation.

- **Multiple Criteria Decision Analysis (MCDA)**

Team manager are faced with decision surroundings and problems in systems that are complex. The rudiments of the issues are multitudinous, and thus the nonintercourses among the rainfall are extremely complicated. Connections between rudiments of a drag could also

be largely nonlinear; changes within the rudiments might not be related by simple proportionality. Expert's value and judgment systems are integral rudiments of design problems. Thus, the power to form sound opinions is extremely important to the success of a design. In fact, Schuyler makes it a skill that's clearly near the top of the list of design operation chops, and notices that many folks have had formal training in decision timber. Multiple criteria decision- making approaches are major corridor of decision proposition and analysis. They give to take unequivocal account of further than one criterion in supporting the decision process. The purpose of MCDM styles is to help decision- makers study the issues they face, to find out about their own and other parties ' particular value systems, and find out attributes and objects, and through exploring these in the environment of the problem to guide them in relating a preferred. This tool MCDA is useful in circumstances which bear the consideration of different courses of action, which cannot be estimated by the dimension of a simple, single dimension. Researcher published a comprehensive survey of multiple attribute decision making methods and applications. These are two types of the problems that are common in the project management that best fit MCDA models are evaluation problems and design problems. The evaluation problem cares with the evaluation of, and possible choice between, discretely defined alternatives. Matter is concerned with the identification of a preferred alternative from a potentially infinite set of alternatives implicitly defined by a set of constraints.

- **Multi-Criteria Decision Making (MCDM)**

Multi-criteria decision-making (MCDM) is one of the main decision-making problems which aims to determine the best alternative by considering more than one criterion in the selection process. MCDM has manifold tools and methods that can be applied in different fields from finance to engineering design. This entry aims to provide a survey on the MCDM concept, its applications, main categories, and different methods. The final section provides manifold information and statistics on the published works in the MCDM fields. The following steps for applying the MCDM.

1. Alternatives are "different possible courses of action".
2. The attribute is defined as "a measurable characteristic of an alternative".
3. Aggregation refers to "considering the performances of an alternative on the specific criteria for deciding on the alternative".
4. Decision variables are defined as "components of alternatives' vector".
5. Decision space is represented as "feasible alternatives".
6. Measures are defined as "elements utilized to quantify an alternative to its attribute by assigning to the attribute numbers or symbols"
7. Criteria are defined as "tools for evaluating and comparing alternatives from the viewpoint of the consequences of their selection.
8. Preferences are defined as "how an alternative fulfills the need of a decision-maker regarding a given attribute".
9. Decisions are different based on the type of problem that can include choice, ranking, and sorting problems

- **Analytic hierarchy process**

AHP is one of the main mathematical models currently available to support the decision theory .It is a powerful tool for decision-making technique and had been delivered by Saaty ,

and developed a decision method for measuring the priorities of all alternatives according to the ratio scale. This tools approach depends on evaluating pairs' options, within pertinent criteria. This value compares the criteria consistent with their intensity and preferences. This tool is a procedure of evaluating options that meets a selected group of criteria and goals. Risk magnitude might be assessed by considering two parameters: Risk severity and Risk likelihood. The result is based totally upon a number of alternative evaluations in terms of some of criteria. These application strategies offer a powerful tool to handle subjectivities and uncertainties arising in the construction procedures and assist for solving complex problems. It was used by hierarchical multilevel of objectives, sub criteria hierarchical structure, criteria hierarchical structure with alternatives hierarchical structure using pair wise comparisons. All value were utilized to find importance weights for decision-making criteria plus relative performance of alternative measures of individual criterion, in case of comparisons are not consistent completely, there after it improves consistency mechanism. Saaty developed the following steps for applying the AHP:

1. Define the problem and determine its goal.
2. Structure the hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which sub- sequent levels depend) to the lowest level which usually contains the list of alternatives.
3. Construct a set of pair-wise comparison matrices (size n x n) for each of the lower
4. Levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table 1. The pair-wise comparisons are done in terms of which element dominates the other.
5. There are n (n -1) / judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
6. Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.
7. Having made all the pair-wise comparisons, the consistency is determined by using the eigen value, λ_{max}, to calculate the consistency index, CI as follows: $CI = (\lambda_{max} - n) / (n - 1)$, where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table 2. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a con- sistent matrix, judgments should be reviewed and improved.
8. Steps 3−6 are performed for all levels in the hierarchy.

Table1. AHP Pair Wise Comparison Between two Parameter Scales.

Rating	**Preferences judgments**
09	Excessively agree
08	Very strongly – excessively
07	Very strongly agree
06	Strongly – very strongly
05	Strongly agree
04	Moderately – strongly

Rating	Preferences judgments
03	Moderately agree
02	Equally – moderately
01	Equally agree

Table 2. Average values of random consistency index (Data from Saaty 1980)

Matrix size	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Pair wise and Consistency

AHP help for measures of evaluation with provide helpful technique for examine evaluations consistency for reducing all conflicts in decision making. This structure is divided into detailed appropriate level, recognizing more criteria included, less important of each individual criterion. Between top and bottom levels establish decision problem relevant attributes such as objectives and selection criteria. Next, each item's relative weights are established at corresponding level. All criteria summation should be equal to 1. It can be said the matrix of (i&j&k) ai,j=ai.k ak.j ai,j= 1/aj,i where i&j & k are alternatives of studied matrix.

II LITERATURE SURVEY

Many researchers have studied the analytical hierarchy process in the construction industry.

Armin Jabbarzadeh et.al (2018) - This paper presents a multi-criteria decision making method for contractor selection. The proposed study uses six criteria, namely; Experience, Financial stability, Quality performance, Manpower resources, Equipment resources and Current workload for evaluating different contractors. Using analytical hierarchy process, the study ranks these criteria and finds the relative importance of them. Next, The technique for Order of Preference by Simi-larity to ideal Solution (TOPSIS) is used to rank the alternative contractors according to these criteria.

P Z Razi,et.al (2019) - This paper aiming in identifying the criteria and suitability for selecting different kind of construction delivery method in construction by using the multi-criteria decision making (MCDM) namely the Analytical Hierarchy Process (AHP) method. Results provides some empirical finding which contractor for Grade 7 is suitable employing the industrial building system(IBS) method while the traditional method is appropriately for the Grade 1 contractor.

Amin Ullah Khan (2020) - This research aims to analyze a literature review of publications that have incorporated the Analytical Hierarchy Process (AHP) and Analytic Network Process (ANP) methods. The AHP and ANP methods have contributed to decision-making in complex situations in recent years and possess widespread applications. Such applications are spread over the years with publications in various major areas such as engineering/technology/applied sciences, social sciences, health sciences, and environmental

studies. These two methods provide multiple solutions to researchers in these fields, which is why they are being considered in the current study.

Shruti Belekar et.al (2021) - The present study focuses on developing multi-criteria decision-making models to assist in bidding decisions and the criteria used for contractor selection in the model have been identified, and the significance of each criterion has been arrived at by conducting a questionnaire survey in public organizations in Mumbai.

Kleopatra Petroutsatou et.al (2022) - The aim of this research is to recognize and prioritize the criteria affecting the performance of construction equipment operators. Scientometric analysis, using VOS Viewer software, was implemented for the formation of different kinds of bibliometric networks, proposing a holistic approach to this research field. Those networks delineated the field with regard to construction equipment operators and revealed the correlations between the network's items, which were formed because of previous research, and finally, conclusions were drawn. An extensive literature review in conjunction with structured interviews with experts and operators determined the factors affecting the operators' performance, with a view to creating a hybrid decision model based on the Analytical Hierarchy Process as implemented by the transparent choice tool. Many experts evaluated the criteria affecting the operators' performance, leading to remarkable conclusions. Moreover, a few pointers for future research are provided.

III. METHODOLOGY

A questionnaire was developed to assess the comprehensions of those in the Indian construction industries on the relative significance of causes of detainments. Also the questionnaire was filled out by construction professionals and contractor. The collected data were analyzed through the AHP. Analytical hierarchy process was used for the analysis because it results was indentify for the purpose of this study.

Part One: Demographic

1	Name :-
2	Designation with Company Name :-
3	Contact No. :

. **Factors**	**Contractor**
Work Experience	
Financially Secure	
Quality Performance	
Materials	
Staff Resources	
Machinery Resources	
Assigned work	

IV CONCLUSION

Project management involves complex deciding situations that need sapient capacities and methods to form sound opinions. This study has presented the analytical hierarchy process as a decision-making method that permits the consideration of multiple criteria. Study of contractor requalification was created to demonstrate analytical hierarchy process application in project management.

V REFERENCES

[1] Aitah RA. Performance study of lowest bidder bid awarding system in government projects. Master thesis, King Fahd University of Petroleum and Minerals, KFUPM, Dhahran, Saudi Arabia, 1988
[2] Al-Alawi MA. Contractor prequalification: a computerized model for public projects in Bahrain. Master thesis, King Fahd University of Petroleum and Minerals, KFUPM, Dhahran, Saudi Arabia, 1991
[3] Al-Ghobali KHR. Factors considered in contractors pre-qualification process in Saudi Arabia. M.S. thesis, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia,1994
[4] Belton V. A comparison of the analytic hierarchy process and a simple multi-attribute value function. European Journal of Operational Research 1986; Vol.26:pp.7-21.
[5] Belton V. Multiple criteria decision analysis Đ practically the only way to choose. In: Hendry LC, Eglese RW, editors. Operational research tutorial papers. 1990, pp. 53-102
[6] Belton V, Gear T. On a shortcoming of Saaty's method of analytical hierarchy. Omega 1983;Vol No.11, Issue No.3, PP. 228-30.
[7] Belton V, Gear T. The legitimacy of rank reversal Đ a comment. Omega 1985;Vol No.13, Issue No.(3), PP.143-4.
[8] Clough R. Construction contracting. New York, NY: Wiley, 1986.
[9] Dyer JS. Remarks on the analytical hierarchy process. Manage-ment Science 1990; Vol No.3: pp.249-58.
[10] Dyer JS, Wendel RE. A critique of the analytical hierarchy pro cess. Working Paper 84/85-4-24, Department of Management, The University of Texas at Austin, 1985
[11] Expert Choice, Inc., Expert Choice software and manual. 4922 Elsworth Ave., Pittsburgh, PA 15213, USA
[12] French S. Decision theory: an introduction to the mathematics of rationality. Chichester: Ellis Horwood, 1988.
[13] Harker PT, Vargas LG. The theory of ratio scale estimation: Saaty's analytic hierarchy process. Management Science 1987; Vol.No.33, Issue No.(1):pp.1383-403.
[14] Hwang CL, Yoon K. Multiple attribute decision making: Methods and applications: A-State-of-the-Art Survey. Berlin: Springer-Verlag, 1981.
[15] Lifson MW, Shaifer EF. Decision and risk analysis for construction management. New York: Wiley, 1982.
[16] Lower J. Prequalifying construction contractors. American Water Works Association Journal 1982; Vol. No.74: pp. 220-3.
[17] Moore MJ. Selecting a contractor for fast-track projects: Part I, principles of contractor evaluation. Plant Engineering 1985; Vol.No.39: pp. 74-5

[18] Nguyen VV. Tender evaluation by fuzzy sets. Journal of Construction Engineering and Management, ASCE 1985; Vol No.3, Issue No.(3):pp. 231-43.
[19] Perez J. Some comments on Saaty's AHP. Management Science 1995; Vol No.41, Issue no.(6): PP. 1091±5.
[20] Russell JS. Surety bonding and owner contractor pre qualification: comparison. Journal of Professional Issues in Engineering, ASCE 1990; Vol. No.116, Issue No. (4): pp.360±74.
[21] Russel JS. Contractor failure: analysis. Journal of Performance of Constructed Facilities, ASCE 1991;Vol.No.5, Issue No.(3):pp.163-80.
[22] Russell JS, Skibniewski M. A structured approach to the con-tractor prequalification process in the USA. CIB-SBI Fourth Int. Sym. on Building Economics, Session D:240±51Danish Building ResearchCopenhagen, Denmark.
[23] Russell JS, Skibniewski MJ. Decision criteria in contractor pre- qualification. Journal of Management in Engineering, ASCE 1988; Vol No.4, Issue No.(2): pp.148±64.
[24] Saaty TL. The analytic hierarchy process. New York: McGraw- Hill, 1980.
[25] Saaty TL. Decision making for leaders. Belmont, California: Life Time Leaning Publications, 1985.
[26] Saaty TL. How to make a decision: the analytic hierarchy pro- cess. European Journal of Operational Research, North-Holland 1990; pp.48:9-26.
[27] Saaty TL, Kearns KP . Analytical planning: the organization of systems. The analytic hierarchy process series 1991; Vol. 4RWS Publications Pittsburgh, USA.
[28] Schuyler JR. Decision analysis in projects. Upper Darby, PA, USA: Project Management Institute, 1996.
[29] Skibniewski MJ, Chao L. Evaluation of advanced construction technology with AHP method. Journal of Construction Engineering and Management, ASCE 1992;Vol. No.118, Issue No.(3): pp.577±93.
[30] Stephen A. Contract management handbook for commercial construction. CA: Naris Publications, 1984.