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DEVELOPMENT OF CONCEPTUAL MODEL FOR EFFECTIVE SELECTION OF SUBCONTRACTOR FOR BUILDING CONSTRUCTION PROJECT

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Abstract - *This research paper focuses on the development of conceptual model for selection of subcontractor in various construction project. A large portion of the work done in construction projects is carried out by subcontractors. Thus it is very much essential to select a right subcontractor for project's success. On many construction projects, especially building projects, 80–90% of the tasks are performed by subcontractors. Since the success of the project highly depends on the performances of the subcontractors, selecting the right subcontractor for the right job is critical. This paper proposes an integrated decision approach, which employs relative important index (RII) and preference ranking organization method for enrichment evaluations (PROMETHEE) together, for the subcontractor selection problem. In the proposed approach, RII is used to analyse the structure of the subcontractor selection problem and to determine the weights of the criteria, and PROMETHEE is employed to obtain complete ranking and perform sensitivity analysis by changing the weights of criteria. The proposed approach is applied to a problem of selecting the most appropriate subcontractor to be worked with in Surat city of Gujarat. Case study of construction project of Surat city taken and to analysing this approach.*

Key Words: **Subcontractor selection, Construction projects, RII, PROMETHEE**

1.INTRODUCTION

A subcontractor is a construction company that contracts with a main contractor to undertake specific tasks on a project as part of the overall contract and may supply laborers, materials, equipment, tools, and designs. Nowadays, in most construction projects, main contractors only act as construction management agents and are more involved in site organization and management tasks and subcontract large portions or all of the specialized work on their projects to subcontractors. This pushed many of researchers to study this phenomenon especially building projects, 80– 90% of the tasks are performed by subcontractors of construction is accomplished under subcontracts. The main objective of this study is to propose an integrated decision approach, which employs RII and PROMETHEE together, for the selection of the most appropriate subcontractor among a set of available alternatives considering several compromising and conflicting criteria. In the proposed approach, RII is used to analyse the structure of the subcontractor selection problem and to determine the weights of the criteria, and the PROMETHEE method is employed to obtain complete ranking and perform sensitivity analysis by changing the weights of criteria. In order to illustrate how the proposed approach can be used in a real situation, it was applied to a problem of selecting the most appropriate subcontractor to be worked with in an international construction project.
The integration of RII and PROMETHEE methods have been successfully implemented in various fields such as information systems outsourcing, equipment selection policy scenario selection, supply chain risk prioritization, and mining method selection.

2. LITERATURE REVIEW

Albino and Garavelli (1998) discussed an application of neural networks to support general contractor management in subcontractor rating.

Okoroh and Torrance (1999) proposed a fuzzy model for the selection of subcontractors in refurbishment projects.

Luu and Sher (2006) developed a case-based reasoning procurement advisory system for subcontractor selection.

Ko. Manzaci (2007) developed Subcontractor Performance Evaluation Model (SPEM) using an Evolutionary Fuzzy Neural Inference Model (EFNIS) as a learning and inference engine to perform the assessment process

Arslan (2008) developed a web-based subcontractor evaluation system (WEBSES) that enables main contractors to evaluate the subcontractors based on a combined criterion.

Mohamed M. Marzouk, Ahmed A. El Kherbawy , Mostafa Khalifa (2013) identifies the most important factors that influence the selection of sub-contractors.

Gul POLAT (2014) suggest an integrated decision approach, which employs analytic hierarchy process (AHP) and preference ranking organization method for enrichment evaluations (PROMETHEE) together, for the subcontractor selection problem.

H.W.L. Chamara, K.G.A.S. Waidyasekara and Harshini Mallawaarachchi Evaluating Subcontractor Performance in Construction Industry using RII method

3. SUBCONTRACTOR SELECTION CRITERIA

Criteria for Identification: On the basis of the critical literature review from Literature published in various national, international and other online and local journals; national, international and other conferences; various reports; master and Ph.D. dissertations; books; various standards published by various authorities; etc. the various factors affecting the selection process of subcontractors in construction industry. Total 52 factors were found.

Questionnaire Survey Approach: The questionnaire designed on the bases of the literature review was distributed among various stakeholders like Contractors, Site Engineer, Developer, Project Manager in the region of Surat City.

Data Collection: The survey work was carried out within the scope of the study and among the selected respondents of the sample.

Questionnaire distribution and collection: Total 252 questionnaires were distributed to different respondents in Surat District. Total 172 respondents provided their response for this research work. A list of the stakeholders who showed their response has been presented. The responses were obtained after personal requests and visits to their respective offices.172 responses collected i.e.68.25% response rate which is considered very good for this kind of survey. Though the total number of questionnaires sent and the responses received were limited, the survey covered most of the known experts and consultants of the construction projects in Surat District. The reliability of the survey results is expected to be high because all the respondents are top-level experienced stakeholders. Table1 shows distribution of responses.

Table -1: Distribution of Responses

Sr. No.	Respondent	Questionnaires Distributed	Responses Returned	Responses(%)
1	Engineers	63	47	74.60
2	Developers	38	23	60.53
3	Contractors	127	89	70.07
4	Project Manager	24	13	58.09
Total		252	172	**68.25%**

4. RII METHOD

Introduction of Relative Important index: The Relative Importance Index (RII) was used to rank (R) the different causes. These rankings make it possible to cross-compare the relative importance of the factors as perceived by the four groups of respondents (i.e. Site Engineer, Developer and Contractors, Project Manager). Each individual cause's RII perceived by all respondents were used to assess the general and overall rankings in order to give an overall picture of the causes of construction delays in Indian construction industry. The formula to calculate RII is given below:

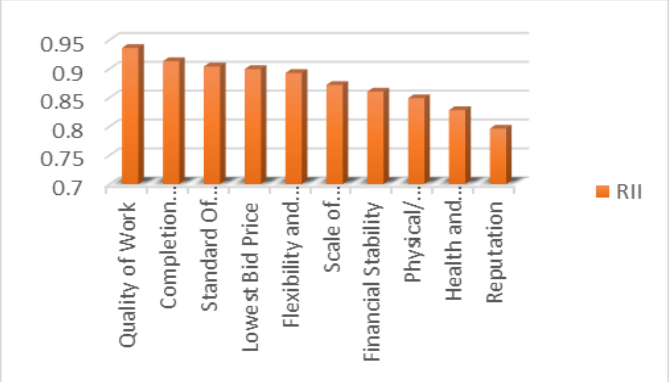
$$RII = \frac{\Sigma w}{A * N}$$

Where, W = Weighting given to each factor by the respondents, A = Highest weight, N = Total Number of respondents.

Table 1.2: Top 10 Factors Overall Ranking by RII Method

RANK	PERSPECTIVE	FACTOR AFFECTING SELECTION OF SUBCONTRACTOR	RII
1	Quality	Quality of Work	0.935
2	Time	Completion work within Time	0.912
3	Quality	Standard Of Workmanship	0.903
4	Cost	Lowest Bid Price	0.899
5	Time	Flexibility and cooperation when resolving delays	0.892
6	Experience Of the Work	Scale of projects completed	0.871
7	Cost	Financial Stability	0.860
8	Adequacy Of Resources	Physical/ Equipment Resources	0.848
9	Safety	Health and Safety Records	0.827
10	Experience Of the Work	Reputation	0.795

Chart -1: RII value



5. PROMETHEE METHOD

After obtaining the relative priorities of the criteria to be used in the selection process using the AHP method, the evaluation matrix was formed by the decision making team. For easily computation we were using VISUAL PROMETHEE software. Thresold values are 1 to 10 % vary data.

Table 1.3 Qualitative scale (Visual PROMETHEE)

Qualitative Value	Abbreviation	Numeric Value
Very Bad	VB	1
Very Bad-Bad	VB-B	2
Bad	B	3
Bad- Average	B-A	4
Average	A	5
Average - Good	A-G	6
Good	G	7
Good- Very Good	G-VG	8
Very Good	VG	9

Fig 1: Case study Screen short of visual PROMETHEE software

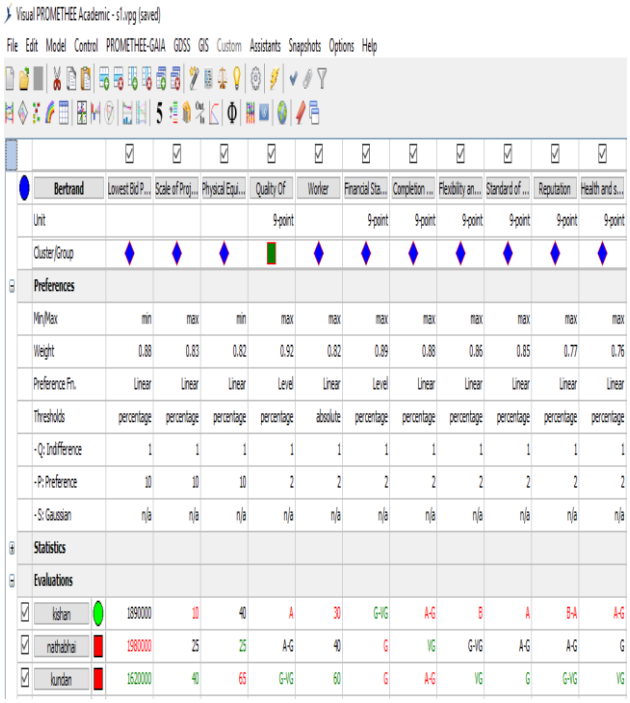


Table 1.4 PROMETHEE flows

Rank	Car	Phi	Phi+	Phi-
1	kundan	0.1446	0.1446	0.0000
2	nathabhai	0.0334	0.0776	0.0442
3	kishan	-0.1780	0.0000	0.1780

Fig 2: PROMETHEE I partial ranking

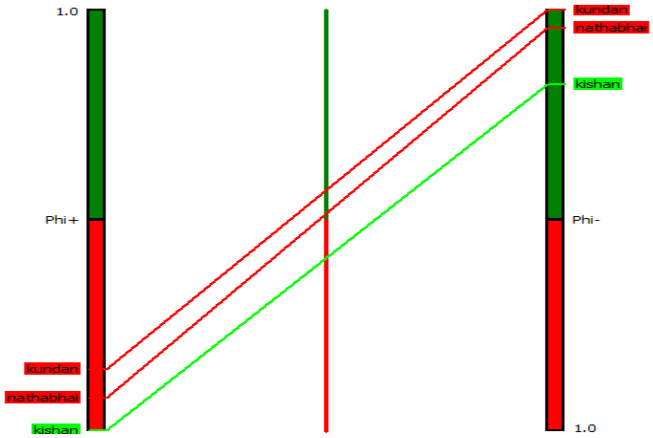


Fig 3: PROMETHEE II complete ranking

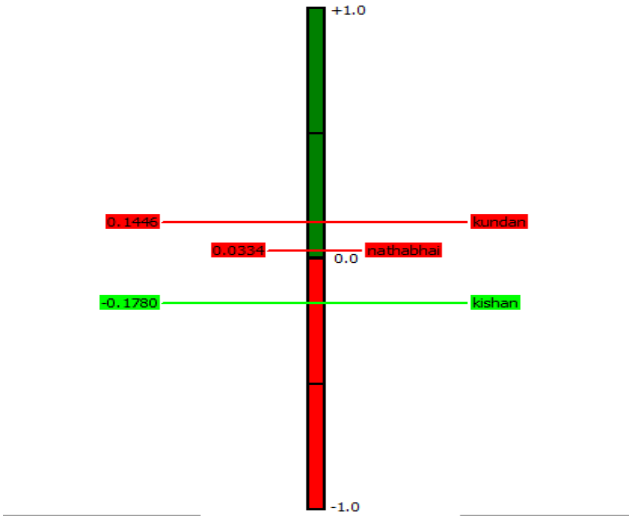


Fig 4: GAIA plane for Subcontractor selection

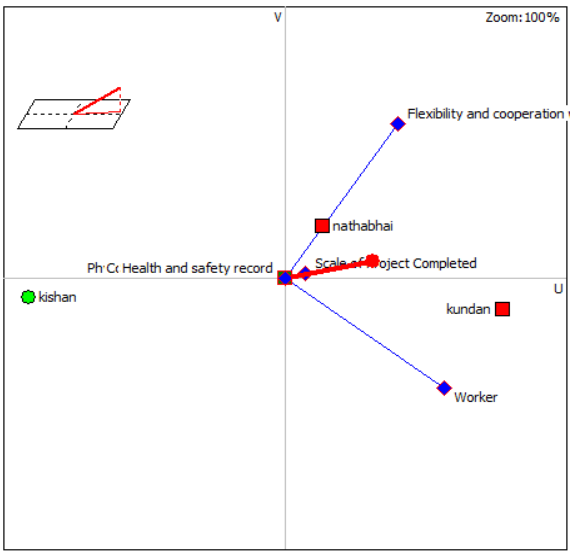
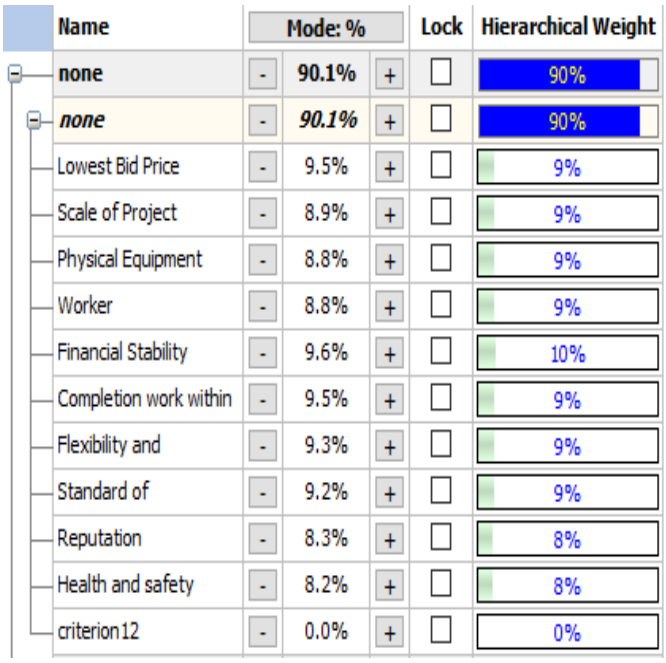


Table 1.5 Weighted and Unweighted Rankings

Alternative	Weighted	Rankings	Unweighted	Ranking
Kishan	0.1400	3	0.1446	2
Nathabhai	0.0800	1	0.0334	1
Kundan	0.0926	2	-0.1780	3

Fig 5: Conceptual Hierarchical weight model



6. CONCLUSIONS

Subcontractor selection problem could have been approached using only RII or PROMETHEE. These two techniques have their own strengths and weaknesses. One of the strengths of RII is that it decomposes a decision problem into its smallest elements and builds a decision hierarchy (i.e., goal, main criteria, sub-criteria, alternatives, etc.). Thereby, it enables decision makers to see the importance of each criterion, obtain a clear view of the decision problem, and evaluate the results. However, PROMETHEE does not provide this structuring possibility. In the RII method, the weights of the elements are obtained through a sequence of pairwise comparisons.

On the other hand, it is not clear how these weights should be determined in PROMETHEE. Two of the most important weaknesses of RII are the need for a substantial number of pairwise comparisons and the artificial limitation of the use of 9-point scale. In contrast, PROMETHEE needs only the evaluations of the alternatives on different criteria and enables users to evaluate the alternatives using numerical data. In this study, these techniques are used together in order to mix the strengths of both techniques and thereby achieve operational synergies.

Case study (Flooring Work=90,000 Sq. ft) has been taken for Surat, Gujarat Construction project taken and analyse the criteria and decision making. Table 1.6 shows Nathabhai (SC-2) best suitable for work.

The proposed integrated decision approach is of benefit to construction companies. The benefits can be summarized as follows:

–Elimination of the dependence on the lowest bid price;

–Consideration of a combination of various compromising and conflicting criteria;

–More systematic evaluation;

–Visual representation of the subcontractor selectionproblem;

–Sensitivity analysis;

–Faster selection process;

–Lower cost of the selection process;

–User friendly system;

–More objectivity.

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