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AN INTEGRATED APPROACH FOR ENHANCING READY MIXED CONCRETE SELECTION USING TECHNIQUE FOR ORDER PREFERENCE BY SIMILARITY TO IDEAL SOLUTION (TOPSIS)

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ABSTRACT

The use of Ready Mixed Concrete (RMC) by the construction industry in most industrialized countries is now well established. With the help of going over expertise of experts and their relevant specialized literature, effective Criterias in Ready Mixed Concrete (RMC) selection and the Criterias which will be used in their evaluation is extracted. For TOPSIS, the computations were carried out using Microsoft Excel 2013. The weight of the Criterias is calculated first through Analytic Hierarchy Process (AHP) and then it is analyzed by Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. The respondents were selected from various construction occupancy mainly Ready Mixed Concrete (RMC) Plant Managers, Consultants and Contractors. Total 100 Survey Questionnaires were distributed to Respondents in Anand, Nadiad, Vadodara, Ahmedabad, from which 60 Responses were collected as per sample size calculation, in that 21 were from Ready Mixed Concrete (RMC) Plant Managers, 26 were from consultants and 13 were from contractors.The problem solution result shows: Respondent no. 3 (R3) is best because of its largest weight age and Respondent no. 25 (R25) is worse because of its smallest weightage.

Keywords: Ready Mixed Concrete, Analytic Hierarchy Process, Technique for Order Preference by Similarity to Ideal Solution, Respondents, Questionnaires

INTRODUCTION

Without doubt the Ready Mixed Concrete industry is now a major sector of the construction industry. It makes an effective contribution to that industry's performance. More understanding of its activities by engineers and contractors would lead to a further step forward in the overall efficiency of all sectors.

Several Roles regarding Ready Mixed Concrete are mention below:

First Role - To Provide A Product:For the engineer to have confidence in Ready Mixed Concrete, he requires assurance that the concrete is of the required quality, contains suitable materials, has been manufactured under conditions of quality control by experienced staff using reliable equipment.

Second Role - To Provide A Service:For the contractor to have confidence in Ready Mixed Concrete, he requires assurance that the supplier can meet all his delivery requirements and has sufficient capacity of production, material supplies and vehicles, and that the supplier will provide the correct quantities.

Third Role - To Provide Value for Money:There is a growing demand by customers for the assurance that any product or service is suitable for the purpose and of uniform quality.

NEED OF THE STUDY

Present approach lacks scientific methodology and does not consider multi-criteria in decision making. There is a need of scientific methodology for Ready Mixed Concrete selection approach.

Hence, the need of this Research work based upon various utility measures like quality control, cost, delivery, quantity at which owners or plant managers have to concentrate for enhancing profit as well as maintaining standard by Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

OBJECTIVES OF THE STUDY

1. To Study,Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).
2. To derive the relation between various Criterias for enhancing utility of Ready Mixed Concrete.
3. To achieve optimization by Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

SCOPE OF THE STUDY

The scope of this research work of development of Ready Mixed Concrete selection process is limited to four cities of Central Gujarat Region of India: Ahmedabad, Nadiad, Anand, and Vadodara.

RESEARCH METHODOLOGY

To apply TOPSIS to our problem, numeric score is required to generate for each criteria. So, each criteria were given an evaluation scale from 1 to 9. Evaluation pattern was decided and finalized with expert advice. A Survey Questionnaire was prepared in the form of numeric value for each criteria and distributed to selected stakeholders and then data for the collected survey questionnaires was analyzed by Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

TECHNIQUE FOR ORDER PREFERENCE BY SIMILARITY TO IDEAL SOLUTION (TOPSIS)

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) was developed by Yoon and Hwang [1980] as an alternative to the ELECTRE method and can be considered as one of its most widely accepted variants.
The basic concept of this method is that the selected alternative should have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution in a geometrical sense. The method evaluates the decision matrix, which refers to n alternatives that are evaluated in terms of m criteria. The only subjective input needed is relative weights of attributes.

STEP BY STEP PROCEDURE OF TOPSIS

Step 1: Construct the Normalized Decision Matrix.
The TOPSIS method first converts the various criteria dimensions into non-dimensional Criterias:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{m} x_{kj}^2}} \qquad \text{...(1)}$$

Step 2: Construct the Weighted Normalized Decision Matrix.
A set of weights $W = (w_1, w_2, w_3 \ldots w_n)$, (where: $\Sigma w_i = 1$) defined by the decision maker is next used with the decision matrix to generate the **weighted normalized matrix** **V** as follows:

$$V = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & w_3 r_{13} & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & w_3 r_{23} & \cdots & w_n r_{2n} \\ . & & & & . \\ . & & & & . \\ w_1 r_{m1} & w_2 r_{m2} & w_3 m_3 & \cdots & w_n r_{mn} \end{bmatrix} \qquad \text{...(2)}$$

Step 3: Determine the Ideal and the Negative-Ideal Solutions.
The **ideal**, denoted as A^*, and the **negative-ideal**, denoted as A^-, alternatives (solutions) are defined as follows:

$$A^* = \{(\max v_{ij} \mid j \in J), (\min v_{ij} \mid j \in J'), i = 1, 2, 3, \ldots, m\}$$
$$= \{v_1^*, v_2^*, \ldots, v_n^*\} \qquad \text{...(3)}$$

A⁻ = {(min vij | j ∈ J), (max vij | j ∈ J'), i = 1, 2, 3,…,m}
= {v_1^-, v_2^-,…,v_n^-} **...(4)**

Where: ***J* = {*j* = 1, 2, 3... *n*** and ***j*** is associated with benefit criteria},
J'* = {*j* = 1, 2, 3... *n and ***j*** is associated with cost/loss criteria}.

The previous two alternatives are fictitious. However, it is reasonable to assume here that for the benefit criteria, the decision maker wants to have a maximum value among the alternatives. For the cost criteria, the decision maker wants to have a minimum value among the alternatives. In this step, alternative A^* indicates the most preferable alternative or the ideal solution. Similarly, alternative A^- indicates the least preferable alternative or the negative-ideal solution.

Step 4: Calculate the Separation Measure.
The ***n***-dimensional Euclidean distance method is next applied to measure the separation distances of each alternative from the ideal solution and negative-ideal solution.
Thus, distances from the ideal solution is defined as follows:

$$S_{i*} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{j*})^2}, \quad for\ i = 1, 2, 3, \dots, m \qquad \dots(5)$$

Where, Si^* is the distance (in the Euclidean sense) of each alternative from the ideal solution.
Similarly, distances from the negative-ideal solution is defined as follows:

$$S_{i-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{j-})^2}, \quad for\ i = 1, 2, 3, \dots, m \qquad \dots(6)$$

Where, Si^- is the distance (in the Euclidean sense) of each alternative from the negative-ideal solution.

Step 5: Calculate the Relative Closeness to the Ideal Solution.
The relative closeness of an alternative A_i with respect to the ideal solution A^* is defined as follows:

$$C_{i*} = \frac{S_{i-}}{S_{i*} + S_{i-}} \qquad \dots(7)$$

Step 6: Rank the Preference Order.

The best (optimal) alternative can now be decided according to the preference rank order of C^*. Therefore, the best alternative is the one that has the shortest distance to the ideal solution. The previous definition can also be used to demonstrate that any alternative which has the shortest distance from the ideal solution is also guaranteed to have the longest distance from the negative-ideal solution.

RESULTS OF TOPSIS

Table 1: Overall Ranking of Respondents

Rank	Relative closeness (ci^*)	Respondents
1	0.562180827	R3 [BEST]
2	0.558387359	R2
3	0.551909084	R45
4	0.546507279	R47
5	0.535887527	R56
6	0.532909125	R13
7	0.529689378	R30
8	0.529483387	R43
9	0.528939549	R26
10	0.518105777	R53
11	0.517865047	R9
12	0.515199708	R50
13	0.514257412	R10
14	0.510165536	R40
15	0.504832708	R28
16	0.504766006	R18
17	0.504503259	R27
18	0.500215879	R55
19	0.489517005	R58
20	0.484016571	R59
21	0.474961290	R60
22	0.473420146	R31
23	0.472813964	R51
24	0.472375635	R7
25	0.467873551	R24
26	0.467045674	R20
27	0.455194614	R12
28	0.453784050	R35
29	0.449556899	R49
30	0.446141966	R48
31	0.444929380	R34
32	0.443374273	R57
33	0.438709771	R16
34	0.431465487	R8
35	0.429148738	R22
36	0.425613901	R17
37	0.425250493	R5
38	0.411072505	R46
39	0.408179181	R54
40	0.406758924	R33
41	0.400437626	R52
42	0.399121735	R32
43	0.396657799	R19
44	0.394833193	R1
45	0.393538366	R6
46	0.387904518	R38
47	0.386201044	R11
48	0.382785861	R15
49	0.378026694	R29
50	0.372115534	R39
51	0.369306445	R36
52	0.369055533	R37
53	0.368268961	R4
54	0.359377965	R44
55	0.358163682	R41
56	0.357608058	R14
57	0.354201127	R25
58	0.353154447	R23
59	0.320541156	R21
60	0.314084336	R42 [WORSE]

CONCLUSIONS

From this research work, following conclusions are drawn:

- For this research work, three types of stakeholders are selected: Ready Mixed Concrete Plant Manager, Consultants, and Contractors. Targeted cities were Anand, Nadiad, Vadodara, and Ahmedabad. According to population, Sample size was calculated as 60 responses.
- The problem solution result shows: R3>R2>R45>R47>R56>R13>R30>R43>R26>R53>R9>R50>R10>R40>R28>R18> R27>R55>R58>R59>R60>R31>R51>R7>R24>R20>R12>R35>R49>R48>R34>R57>R16>R8 >R22>R17>R5>R46>R54>R33>R52>R32>R19>R1>R6>R38>R11>R15>R29>R39>R3 >R37>R4>R44>R41>R14>R25>R23>R21>R42. Therefore Respondent no. 3 (R3) is best because of its largest value and Respondent no. 25 (R25) is worse because of its smallest value.
- Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) can be effective MCDM tool for ranking and relative closeness of the Ready Mixed Concrete.
- The proposed methodology can also be applied to any other selection problem involving multiple and conflicting Criterias.

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