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Application of Fuzzy Delphi Method for the selection of factors influencing the selection of best bridge site

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ABSTRACT: The present paper describes about the application of one of the well structured technique called Fuzzy Delphi Method for the selection of factors influencing the selection of best bridge site. Selection of bridge site depends on various factors and it requires expertise knowledge of the domain Experts. Fuzzy Delphi Method which relies on expert opinion is one of the efficient technique to identify the influential factors which are to be considered for the selection of bridge site. Fuzzy Delphi Method involves two stages. The first stage involves set of interviews with the experts and responses are collected using Likert scale which is then reduced to 1-10 point scale for the selection of influential factors. In the second stage some of the non influential factors are eliminated by appropriate threshold value.

KEYWORDS: Fuzzy Delphi, Expert, Threshold, Knowledge, Domain.

1 INTRODUCTION

The selection of site for a bridge is usually influenced by engineering, aesthetic, social and economic considerations. The existing roadway or railway alignments may also govern the bridge site to be selected in which case the choice is very limited. On the other hand, in the case of a new alignment, the consideration of providing maximum commercial and social benefits is also not to be ignored. For river bridges in rural areas, usually a wider choice may be available. To the extent possible, it is desirable to align the bridge at a square crossing and sometimes, a skew crossing has to be provided in order to avoid costly land acquisition or sharp curves on the approaches. In selecting a site, care should be taken to consider all the factors which really influence the selection of site which is likely to serve the needs of the bridge at the least cost. Identification of factors is usually done by studying the problem domain and by negotiation with the domain experts. The present paper introduces one of the well structure techniques called Fuzzy Delphi Method to collect the Experts opinion.

2 SCOPE OF STUDY

Selection of a bridge site is one of the important steps to be carried out before planning and design of a bridge. Selection of bridge site involves selection of influential factors, which requires expert knowledge. Knowledge from the experts can be collected in the form of interviews using set of questionnaires. In this context, Fuzzy Delphi Method which relies on Expert opinion is used as an effective method to select the influential factors which are to be considered in the selection of best

Bridge site. The Scope is fulfilled by the following stages of work: Indentifying the Experts, Interaction with the Experts, Data collection and Research, Selection of factors.

3 METHODOLOGY

To establish a set of influential factors for the selection of bridge site, a questionnaire survey of experts and academics in the domain is done as described below.

1. A total of 11 experts in the industry, profession, academia and government organizations were selected for the survey. A set of questionnaires were consigned among all the experts. Experts give a set of factors for the selection of best bridge site. All these responses are combined and listed together.

2. In the second round a set of questionnaires are prepared on these listed factors and the questionnaires are distributed among the experts. The questionnaires are prepared in such a way that the responses are collected in the Likert scale, which is one of the effective tool to handle the ambiguous knowledge. Responses collected using Likert scale can be easily brought to numbered form and finally expressed in 1-10 point scale.

3. The collected response from the Experts for some of the factors is depicted in Table 1.

Table 1. Experts Response in 1-10 scale

Experts \ Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
E1	10	8	10	8	9	7	9	8	7	6	8
E2	9	8	9	7	9	7	8	7	7	5	8
E3	10	7	9	9	9	6	9	7	8	4	9
E4	9	7	10	7	10	6	9	6	8	5	7
E5	8	9	8	9	8	8	9	5	9	5	8
E6	8	7	10	7	8	7	8	8	7	6	6
E7	9	8	9	8	9	7	8	7	6	7	7
E8	10	8	8	9	10	6	7	6	5	7	9
E9	10	7	8	9	9	8	9	9	7	6	9
E10	10	6	10	7	8	8	9	7	7	6	8
E11	10	7	10	8	7	5	6	5	8	7	7
Experts \ Factors	**F12**	**F13**	**F14**	**F15**	**F16**	**F17**	**F18**	**F19**	**F20**	**F21**	**F22**
E1	9	10	9	10	9	8	9	7	8	9	10
E2	9	8	10	10	9	7	7	8	9	5	6
E3	9	9	10	9	10	7	9	9	8	9	9
E4	9	8	9	10	9	6	7	5	6	5	8
E5	10	7	8	8	8	5	8	8	7	6	6
E6	8	7	8	9	9	8	9	8	9	8	9
E7	9	6	7	9	7	8	10	6	7	6	5
E8	7	5	9	8	8	7	7	8	9	9	8
E9	7	6	9	10	9	7	9	5	9	5	8
E10	8	8	8	10	8	8	9	8	9	8	9
E11	6	7	10	9	10	9	9	5	9	5	8

4. The definite value of each alternate factor are found using equation,

$$Sj = \underline{(Pij+Qij+Rij)} \text{ where, } i= 1, 2,...n.\ j= 1, 2,\ldots m.$$

3

Where,

{Pij} is minimum assessment from expert i for the factor j

{Qij} is average of all the assessment from the expert i for the factor j

{Rij} is maximum assessment from the expert i for the factor j

5. Normalization is done for the values obtained for each alternate factor using suitable normalization technique. Normalization is defined as the more advanced and experienced adjustments, where the objective is to bring the entire probability distribution of adjusted values into alignment. The equation is as given below.

$$\text{Normalized } (e_i) = \frac{e_i - E_{min}}{E_{max} - E_{min}}$$

6. A proper threshold value is selected to eliminate the non influential factors from the selected factors in the second stage. There are various methods to select the threshold value. The type of method depends on the consistency of the normalized values. In the present research the threshold value is selected based on the consistency of occurrence. The normalized value which has the more consistency of occurrence is selected as the threshold value(r). Based on the above said criteria the threshold value is chosen as 0.52. Therefore the factors which have the normalized values less than the threshold value is filtered off and the values greater than the threshold value are selected as the most influential factors for the selection of best bridge site. The principle of screening is as follows:

If $S_j > r$, then no. j factor is the evaluation index

If $S_j < r$, then delete no. j factor.

4 CONCLUSION

The study involves the selection of influential factors for the bridge site selection using one of the effective, well structured techniques called Fuzzy Delphi Method which relies on Expert opinion. In the first step a total of 38 factors are obtained and some of the non influential factors are filtered using suitable normalization technique and finally arrived at 27 most influential factors for the selection of bridge site under Experts concise.

The finally selected factors along with list of their appraisal values given which indicates the importance of the factors brought to 1-10 point scale are listed below.

SL.No.	Factor	Sj
1	Social and economic benefits	9.12
2	Reasonable proximity to direct alignment	7.48
3	location of bridge site	9.06
4	Government interference	8
5	commercial influence	8.57
6	Adjacent property consideration	6.6
7	Future growth	7.75
8	Availability of local material	6.93
9	Traffic volume	7.06
10	Time consideration	5.6
11	Aesthetics	7.6
12	Environmental impact	8.09
13	secure straight approaches without obstacles	7.45
14	Direct alignment	8.39
15	Geological considerations	9.09
16	Well defined narrow channel	8.57
17	Approaches facing upstream	7.09
18	High bank above flood level	8.63
19	Sharp curve in the approaches	8.06
20	under water construction	8.66
21	costly river training work	6.51
22	space for bridge foundation	7.51
23	Navigation purposes	7.96
24	Maintenance and repair work	7.06
25	Confluence of large tributaries	7.57
26	Slope and banking conditions	7.1
27	Community participation	7.06

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