CS-211

AN APPLICATION OF AHP METHOD TO APPRAISAL OF DESIGNED QUALITY ALTERNATIVES FOR CONSTRUCTION PROJECTS

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1 – Introduction

The appraisal of designed quality alternatives to select the best designed quality alternative at the feasibility study stage plays a very important role since it greatly influences the output quality of construction projects. This paper introduces an application of the Analytic Hierarchy Process (AHP) method to appraisal of designed quality alternatives at the feasibility study stage for construction projects in order to select the optimum alternative which meets the owners' best satisfaction.

2- Definition of the Quality and Costs of Construction Projects

The quality of construction projects is defined as a complex criterion that includes nine following aspects: (1) serviceability of project for use purpose, (2) benefits of project including economic benefit and social benefit, (3) durability of project, (4) safety degree and working environment in construction and operation, (5) reliability of project in operation, (6) appearance of project, (7) aesthetic and culture values of project, (8) environment friendliness of project (9) construction duration of project.

From viewpoint of owners, the costs for a construction project include total necessary costs to build, operate, maintain, and remove the project. In other words, the costs here are defined as the whole life costs of construction projects.

3- Application of AHP Method to Appraisal of Designed Quality Alternatives

a- Making Hierarchy Analyses for Quality and Costs of Alternatives

Making hierarchy analyses for quality and costs of alternatives is the first step of the AHP method. It is very important that the hierarchy analyses made must fulfill the axioms of the AHP method. Having made hierarchy analyses for quality and costs of alternatives, quality attributes and component costs are determined. Let us denote m attributes of the designed quality (also called component quality criteria) by q1, q2,... qj...qm and u component costs of the whole life costs (also called component cost criteria) by c1, c2, ...cl...cu . If there are n quality alternatives A= {A1, A2, ...Ai, ...An}, we can define a matrix of quality attributes **q= |qij|**, i=1,n, j=1,m, and a matrix of component costs **c=|cil|**, i=1,n, l=1,u for n alternatives

b- Ranking Quality Alternatives In Terms Of Quality.

This step comprises two aggregations, which are aggregation of judgments with respect to all component quality criteria and aggregation of judgments of each component quality criterion with respect to all quality alternatives. To aggregate judgements, a ratio scale must be established first for judgements. The aggregation of judgments with respect to all component quality criteria concerns generating weights for each of the criteria by pair-wise comparison. This involves a subjective assignment of preference weights to each criterion. Let value Iij be assigned by comparing criterion qi to qj. Thus, the resulting factor Iij is the preference weight of qi compared to qj. We have a matrix **I= |Iij|**, which reflects the preference of the pair-wise comparison and in which Iij =1 if i=j and Iij= 1/Iji. Having developed matrix I, a weight vector W pertaining to the component quality criteria can be determined by calculating the eigenvector corresponding to the maximum eigenvalue of the matrix. This vector indicates the set of weights for each component quality criterion reflecting its relative importance to the others **w= {wj}**, j=1,m.

Similarly, we can make pair-wise judgments for each component quality criterion qj with respect to all quality alternatives Ai; i=1,n. Since there are m component quality criteria, we will have m pair-wise judgment matrices Pj of each quality criterion with respect to all quality alternatives **Pjik =|pjik|**, j = 1, m, i&k = 1,n, pjik = 1 if i=k and pjik = 1/pjki. Matrix Pj is the pair-wise judgment matrix of component quality criterion qj with respect to all quality alternatives A= {A1,A2,...Ai,...An}.

Similarly to determining vector W, we can determine vectors **Kj** ; j=1,m pertaining to the all alternatives with respect to each component quality criterion by computing the eigenvectors of matrices Pj ; j=1,m corresponding to the maximum eigenvalues of the matrices. Each vector indicates the sets of weights for each quality alternative reflecting its

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importance relative to the others in respect to each component quality criterion. Gathering vectors Kj, we have a matrix **K= |Kij|**, i=1,n, j=1,m that ranks quality alternatives according to each component quality criterion.

There are important questions about pair-wise comparisons and final decision-making: who makes them and how? In building public construction projects, decision making is usually done by groups rather than by individuals. We suggest to apply Group Decision Support Systems and Delphi Method to deal with these issues.

After aggregating the judgments, ranking quality alternatives in terms of quality is very simple. We just multiply the mast matrix (matrix K) on the right by the transpose of the vector of weights of the criteria (vector w). Let us denote the ranking vector of the alternatives by R, we have **R = W' . K** or **R = {R1, R2, ...Ri,...Rn}**. Ri is called quality weight of alternative i

c- Ranking Quality in Terms of Costs

Completely similar to the procedures of ranking quality alternatives in terms of quality, we can get ranking vector R* that ranks all quality alternatives in terms of costs: **R* = {R*1, R*2, ...R*i,...R*n}**. R*i is called cost weight of quality alternative i

d- Analyzing Quality/Costs Ratio

Having determined quality weights Ri and cost weights R*i, i=1,n, the analysis of Quality/ Costs ratio is done by consider ratios **Ri/ R*i**, i=1,n. The optimum quality alternative is mathematically quality alternative with Max {Quality/Costs ratio}.

e- Sensitivity Analysis

As well as any appraisal method, sensitivity analysis is necessary to be done for the final decision in case of there is two or more alternatives that have very similar Quality/ Costs ratio and in other cases..

4- Conclusion

The aggregations of judgements decide the quality of the application of AHP method to appraisal of designed quality alternatives. Therefore, to make the presented appraisal method applicable, further studies of applying Group Decision Support Systems and Delphi Method to aggregate judgements are essential.

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