Multi-Criteria Decision-Making Model Using Quality Function Deployment (QFD) Method for the Most Suitable Temporary Earth Retaining System

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***Abstract:** In this study, the multi-criteria decision-making model based on Quality Function Deployment Method is proposed. Multi-criteria decision-making is an attempt to link QFD method with the TOPSIS. By this effort, a model that makes client's decision-making more rational and objective in design phase is suggested. The multi-criteria decisionmaking model confirming to the Owner's requirements will improve the productivity of the construction industry and the satisfaction of the customer. Further study extending the range of the requirements, not only the Owner's requirement will be necessary to cover the various factors as much as possible. And then, finally as a flexible platform to achieve a sustainable quality management, web-based multi-criteria decision-making model can be utilized by the relevant stakeholders simultaneously with the feed-back and sharing the necessary informations.*

***Keywords:** Multi-Criteria Decision Making, Quality Function Deployment (QFD), Design quality management(DQM), TOPSIS, Owner Requirement*

I. INTRODUCTION

1.1 The Background and Purpose of Study

A well-organized quality management system should be established throughout the entire course of construction process. To this end, a system with the method and tools are necessary, which can support to reflect owner's requirements more systematically, to establish an efficient project communication system and to provide the necessary informations for the decision making in the design process.

This time study is to suggest Multi-Criteria Decision-Making Model based on Quality Function Deployment (QFD) method taking owner's requirements only into consideration. Multi-Criteria Decision-Making Model is developed with the combination of TOPSIS and QFD method. This study also provides a tool enabling more objective and rational decisions in the process of design.

1.2 The Scope and Methodology of Study

The decision-making model of this study is established for the design stage only. Among concept design, basic(interim) design and detailed(working) design, this study is dealing with basic design and detailed design phases only.

Sample cases are applied for the temporary earth retaining system only confirming to the owner's requirements. The range of this study is also limited to the fact that only project owner makes the decision. This study, therefore, only addresses and applies owner's requirements and criteria.

II. QFD-CAMOS Model

2.1 Summary of the Model

This multi-criteria decision-making model is suggested to be called as "QFD-CAMOS (Conformity Assessment by Measures of Suitability)."

TOPSIS method is mainly used in the multi-criteria decision-making approaches where an alternative that has the highest degree of suitability is to be selected out of several alternatives having multi-purposes and traits.

Therefore, in the assessment of quality suitability by multi-criteria decision-making model, the measurements of the maximum suitability and the limited suitability are possible through the conformity parameters with requirement criteria. The value of conformity for maximum suitability is +1 while that for limited suitability is 0.

2.2 Implementation of the Model by Steps

[Step 1] Defining Functions and Performances (*F, P*)
In this step, FAST(Function Analysis System Technique) Diagram is applied using VE's definition of functions.

[Step 2] Establishing Degrees of Importance (I_i)
In this step, linguistic assessment principles of Caltrans(2001) are applied, and the grades of degrees of importance are determined by 10 points parameter.
$I_i(i = 1,\ldots,m)$ = 1 point (the lowest) ~ 10 points (the highest)

[Step 3] Establishing Design Alternative and Required Performance
This step establishes the required performance criteria matrix (D_{rz}) and product performance criteria matrix (D_x) as for the m numbers of functions and related n numbers of performances. There are three(3) types of measurement in performance assessment. Nominal Measurement and Binary

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Measurement.

[Step 4] Calculating Degrees of Suitability
This step calculates the points of suitability degree comparing the performance value of the product with the value of required performance. The functional suitability points of a design alternative can be determined by summing up the suitability points of respective functions. If the RPC (Required Performance Criteria) is the same as the performance of alternative, then the degree of suitability is 0. Point 0 becomes the basis of conformity.

[Step 5] Dissatisfaction Index of Functional Suitability (S^-)
This value comes out from the total of all values below 0 of degree of functional suitability divided by total values of the maximum dissatisfying degrees of suitability.

[Step 6] Satisfaction Index of Functional Suitability (S^+)
This value comes out from the total of all values above 0 of degree of functional stability divided by total values of the maximum satisfying degrees of suitability.

[Step 7] Functional Conformity Index (C)
This value equals functional suitability points divided by maximum total suitability. Functional conformity index is calculated in three(3) different ways according to positive numbers, 0 and negative numbers of functional suitability points.

[Step 8] Functional Conformity Variations (CV)
Based on required performance, the conformity of the functions of alternative design can be assessed with absolute value. This value indicates the functional conformity index between satisfaction based suitability index and dissatisfaction based suitability index.

Ⅲ. Case Study and Reviews

3.1 Application of the Model

Five(5) construction methods(H-Pile with Wood panel, Sheet Pile, CIP, SCW and Slurry Wall) are considered for the selection of temporary earth retaining system in this case study. The optimal alternative is selected according to the requirements through the alternative selection processes by two(2) users.

[Table 3-1] Users' Requirements for the Selection of Temporary Earth Retaining System

Functions	Measurement Classifications	Case 1	Case 2
Is it possible to respond the surrounding environments, (sink-hole, noise/ vibration, etc) ?	Set Condition	Yes	Yes
Is the construction method suitable to the elevation, size and configuration of the site ?	Nominal Measurement	Good	Normal
Are such structural conditions as the strength, connecting spots of structure and nature of structure excellent ?	5 Points Measurement	5	3
Isn't the method affected by such soil conditions as soil characteristics, level of underground water, water infiltration coefficient, etc ?	Set Condition	Yes	Yes
Is the method possible to cope with narrow work space, aggravated conditions of bottom of excavation, etc ?	Set Condition	Yes	Yes
Is the method suitable for inlet/outlet plans for water?	5 Points Measurement	5	2

3.2 Evaluation of the Case Study

User's requirements have been differently set up in connection with various situations, and the study was conducted with regard to the selection process for temporary earth retaining system.

In Case 1, the requirements were set up highly according to the items of function and, as a result of case analysis, the Slurry Wall method could gain the nearest value of 0.00.

In Case 2, on the other hand, the quality conditions as the level of requirements which take the nature of the project into consideration were set up and, as a result of case analysis, the method of H-Pile with wood panel is suitable and the outcome value for the optimal alternative of which turned out to be -0.03.

Ⅳ. Conclusion

This model can be applicable not only to design phase but also to the entire process of the project. This model can also be extended for the view point of contractors and users.

In conclusion, the suitable decision-making model which takes all the requirements into account can meet both the improvement of productivity and customer satisfaction.

Further study extending the range of the requirements, not only the Owner's requirement will be necessary to cover the various factors as much as possible.

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