FUNCTION ORIENTED VE ALTERNATIVES EVALUATION PROCEDURE USING FUNCTION CLASSIFICATION

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ABSTRACT: Two important concepts in VE are "function" and "cost." Cost can be expressed quantitatively. Unlike cost, the function can only be expressed qualitatively. Thus, to accurately evaluate the performance in VE analysis, it is required that the functional aspect should be considered a qualitative one. This study suggests a procedure of function oriented evaluation which can evaluate function enhancement of a VE proposal more logically and objectively. To conduct this study, problems were induced via case analysis, and solutions were found. In addition, the existing simple evaluation procedures were corrected, and a function enhancement evaluation procedure via function classification was suggested. For function classification, the use of the concepts, which were "intended function" and "additionally obtained function," was suggested. Function oriented evaluation procedure to VE proposals which is suggested in this study is expected to be a great help in treating valuable functions through VE job plan.

Keywords: Value Engineering, Alternative Evaluation, Function Classification, Function Enhancement

1. INTRODUCTION

Value engineering (VE) refers to an engineering method of enhancing value by optimizing the objects of analysis in a wide range of aspects, such as cost, quality, performance, and environment, focusing on their inherent functions. VE has two critical factors: function and cost. The cost is expressed quantitatively, and the function qualitatively. Accordingly, the qualitative function must be made quantitative so that the exact outcome of VE analysis could be identified.

In most VE analyses, quantitative evaluation of function is carried out only at the level of function analysis, and little evaluation of enhanced functions through the proposed VE alternatives is so far being conducted. There are few cases in which the evaluation of the enhanced effect of functions (economical merits and aesthetics) through VE alternatives is applied. Indeed, in aggregating the results of VE proposals among the VE analyses conducted in Korea, only the parts that show increased cost are markedly expressed without mentioning the improvement of functions in the case of the proposed enhanced functions without cost reduction (with no change or with only a small increase).

Considering that it is the VE proposal that chiefly draws the attention of the people who originally placed an order following the VE analysis, the quantification of a degree of function that can be improved through the VE analysis will be a critical factor in measuring the outcome of the entire VE analysis. Moreover, without continuous efforts to quantitatively measure functions in the long term, VE could be regarded as a simple method of cost reduction. Accordingly, along with the improvement of the existing method of evaluating VE design alternatives and the consequent identification of their function, this study attempts to propose function-focused procedures of VE alternative evaluation in an attempt to evaluate the function improvement of a VE proposal in a systematic and accurate manner by utilizing the concept of distinguishable function classification.

For this study, the following scope of research was considered:

With consideration given to the effect in terms of cost and improvement required in VE analysis, it is desirable that VE be conducted at the early stage of a project. Accordingly, design VE, which is strongly recommended in Korea's domestic system and which is very effective in practical application, was chosen as a research object in this study.

Table 1. Correlation between Cost and Function

	①	②	③	④
F	→	↗	↗	↗
C	↘	→	↘	↗

Table 1 shows the correlation between cost and function, which are considered applicable VE objects, as follows: ① and ③ were excluded in the study as research objects because the value of a VE alternative can be relatively well presented through cost reduction. ② and

④, however, are considered only in research procedures that show that the cost is maintained or rises as the function improves.

This study was carried out focusing on the evaluation of the degree of improvement of a VE alternative's function. Accordingly, the comprehensive evaluation of cost and function was excluded from the study's research scope.

The study was conducted in the following steps:

- The status quo of the evaluation of the degree of improvement of a VE alternative's function and of its related issues were identified through a VE case analysis that was conducted in Korea.
- By seeking improvement measures for the aforementioned issues, the development directions for the VE alternative evaluation procedures were established.
- By using the concept of function classification, the function-focused evaluation procedures of VE alternatives were suggested, with a summarization of the content by stage.
- Through case application, the practical applicability of the proposed evaluation method was verified, with a summarization of a method that links the utilization of the evaluation procedures to the existing evaluation methods.

2. Literature Review

2.1 The difference between construction VE and production VE

Although construction is generally considered a production process, it has distinguishable characteristics. Furthermore, construction VE also has features that distinguish it from production VE.

According to Male, Kelly [3], and Lee [4], construction and production VE differ in the following areas: VE objects, VE execution time, VE input efforts, and the function analysis process.

The differences between construction and production VE are summarized in Table 2.

Table 2. The Difference between Construction VE and Manufacture VE

	Manufacture VE	Construction VE
VE Target	Components (parts)	Project's whole space
VE Execution Time	Project's Whole duration	Specific design step
VE Input Effort	Several weeks or months	Several days
Function Analysis	Relatively easy	Relatively difficult

2.2 Derivation stage of the VE proposal

According to a general VE job plan, the VE proposal is derived through the following procedures, as shown in Fig. 1 [5].

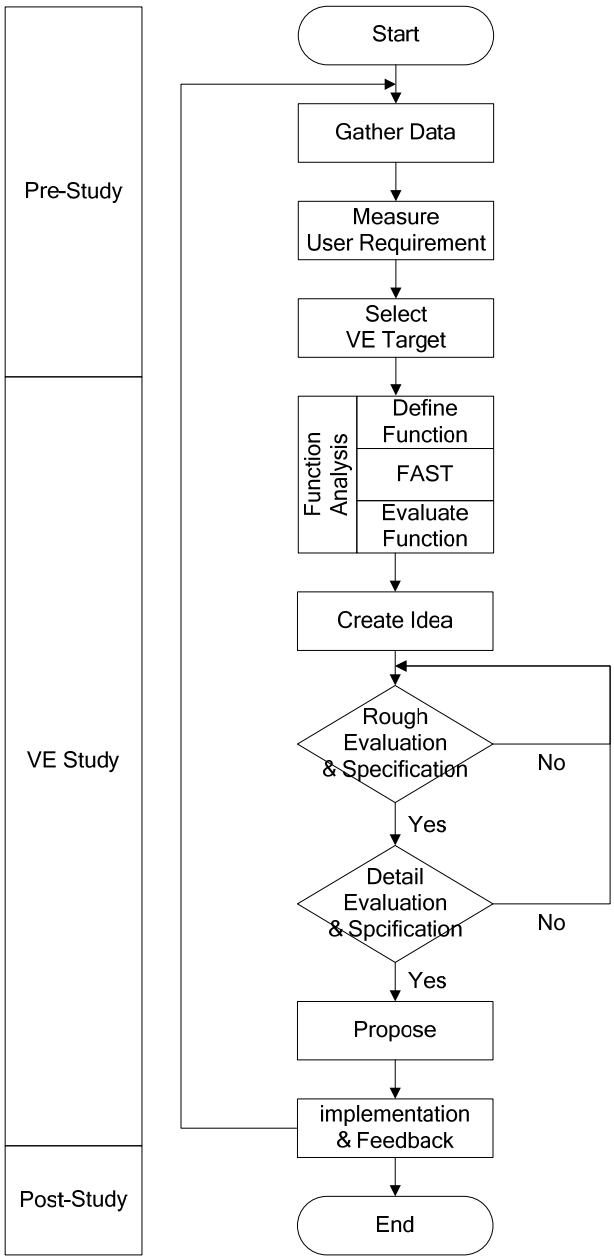

Figure 1. VE job plan in the design phase.

Among the foregoing, the function is considered after function analysis through the following procedures:

- Function definition: the definition of the functions of the analysis objects
- Function summarization: the identification of the omitted or overlapping functions by summarizing the defined function in a systemic manner
- Function evaluation: the identification and derivation of the function that is necessary for the conception of ideas among the many defined functions
- Idea creation: The conception of ideas based on the function that was decreased by the function evaluation
- Proposal development: The formulation of a VE proposal following the development of conceived ideas

3. Issues related to VE Alternative Evaluation Method

3.1 Case introduction

To identify the issues associated with the existing VE alternative evaluation method, how an evaluation of the degree of improvement of the VE alternatives' functions is actually carried out in the VE cases conducted in Korea was looked into in this study.

A total of 24 cases conducted within the period of 2001 to 2007 were used in the analysis. In their classification according to the type of order, the public orders were 7, the private orders were 6, and the competition VEs were 11. A total of 16 companies and research institutes carried out VE analysis.

The analysis of the existing cases was conducted considering four different aspects: the method employed in evaluating the VE alternatives, the evaluation of the performance (function) improvement, quantification efforts, and others.

3.2 Issues regarding the existing VE alternative evaluation method

(1) Mixed use of function and performance

Among the VE analyses conducted in Korea, performance-focused evaluation is chiefly carried out for VE alternatives. Performance may refer to "the total value as a construction environment given in response to the endless changes in the social environment and to human beings' demands" [6]. Such performance includes not only quantitative aspects of the technological and physical factors inherent in facilities, products, and services but also qualitative aspects such as customers' demands and favors, and aesthetic elements. In other words, the concept of performance is very extensive and abstract [7].

Function is a special process that has to be conducted by design/item. In other words, function can be an answer to the question "What does it do?" in the development of alternatives [1]. Such function-focused consideration can be regarded as a unique approach in VE that helps develop creative ideas.

Performance and function have marked differences, although their mixed use is often observed in general VE analysis. This results in the occurrence of illogical situations, such as the use of performance in evaluating VE alternatives as to whether they satisfied the objects' functions.

(2) Abstract evaluation item

The case analyses that were conducted in this study showed that the existing performance-focused evaluation gave rise to many problems. Such problems, however, seem to have been due to the fact that the abstract meaning of performance (such as economical merits and aesthetics) was set up as an evaluation item, rather than the problems in relation to the nature of performance-focused evaluation. For instance, in evaluating VE alternatives according to performance-focused evaluation procedures, the following evaluation items are established: economical merits, constructability, maintainability, and efficiency. Although these evaluation items are highly abstract, the evaluation items in all the cases have not been defined. As a result, the following issues arise: the uniform application of the evaluation items to all alternatives, or the setting up of evaluation items that are inappropriate to the corresponding alternatives, which could lead to the decreased reliability of the results of the VE alternative evaluation.

(3) Insufficient quantification efforts

To measure the outcome of VE analysis, the quantification of cost reduction and function improvement is necessary. As mentioned in the introduction (chapter 1), however, the quantification of function (or performance) is somewhat difficult as opposed to cost, which can be immediately quantified by the corresponding amount.

Indeed, it is certain that VE results in cost reduction. Cost reduction through VE, however, involves seeking an appropriate balance between time, performance, and cost through function-focused verification. Accordingly, the quantitative evaluation of the functions that have been improved or decreased through VE alternatives should be carried out. In actual cases, however, there is a tendency to emphasize the aspect of cost reduction. Moreover, in the case of function improvement without cost reduction (cost maintenance or gaining a small increase), the term, 'performance improvement' is simply used without quantitative evaluation. Such a case could lead the reader to conclude that it is a least efficient alternative because of the aggregation that is done only by the cost-increased proposals in measuring the outcome of VE analysis. According to the analysis results, 22 out of the 24 cases were evaluated in terms of the degree of improvement of the VE alternatives' functions. A closer look at the cases will reveal, however, that 13 of the cases show this only in the expression of "function improvement" or "performance improvement," without an accurate evaluation of the degree of function improvement. Only nine cases quantitatively expressed an improved degree of function of the existing ones compared to those of the VE alternatives.

(4) Non-evaluation of the degree of function improvement

VE can be defined as "a set of organized efforts at analyzing the functions of products or services so as to achieve the necessary functions of the life cycle cost [2]." Likewise, many experts believe that the identification of functions plays an important role in VE analysis.

Nonetheless, in conducting actual VE analysis, it has been revealed that the functions are identified only at the function analysis stage. Thereafter, no consideration is given to how the functions are increased or decreased.

Fig. 2 shows the conceptualization of the consideration of the function changes according to a VE job plan. As shown in Fig. 2, ideas are conceived, based on the objects selected as object functions, from the stage of function analysis. Through the development of these ideas, a single VE proposal is completed. In evaluating the VE alternatives, however, no consideration is given to how

the function affected the VE alternatives, and to what extent such function improved or decreased.

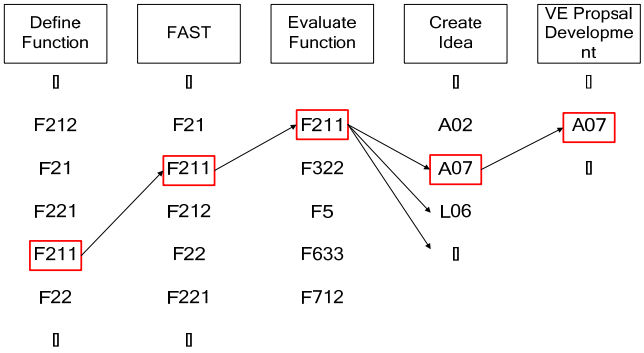

Figure 2. How the considered functions were changed according to the VE job plan.

3.3 Suggestions for improvement

In this chapter, solutions to the derived issues are suggested through case analysis. Such issues derived from case analysis can be classified into four categories, as follows:

① the mixed use of function and performance;
② an abstract evaluation item;
③ insufficient quantification efforts; and
④ non-evaluation of the degree of function improvement.

To address such issues, the following efforts will be required:

- Function-focused evaluation: Through the VE alternatives, the function that can be improved should be identified, and a quantitative evaluation of such functions should be carried out.
- Attempt at quantification through the establishment of an evaluation unit: By establishing a definite evaluation unit other than the existing abstract evaluation item, evaluation results should be made convincible to the evaluator and the user (the person who placed an order).
- Establishment of systematic evaluation procedures: Logical evaluation should be made possible by coming up with systematic evaluation procedures and not only by changing the procedures according to the time.

4. Development of a Function-focused VE Alternative Evaluation Procedure

4.1 Function classification

Function classification was conducted for the function-focused evaluation of VE alternatives in this study. It identifies the functions that can be improved or decreased through a single VE alternative and classifies these into two functions: intended functions and additionally obtained functions.

The intended functions are those that were used as function objects among the improvable functions, with the aim of improvement from the beginning, through VE alternatives when proceeding with the VE job plan.

The additionally obtained functions are the additionally improved functions, excluding the intended functions that were the basis of idea conception in the development of VE alternatives.

4.2 Proposal of a function-focused VE alternative evaluation procedure

(1) Basic concept

A function-focused VE alternative evaluation procedure was proposed in this study, with the aim of improving the VE alternative evaluation method that is currently being used, as mentioned in chapter 3. Such evaluation procedure is conducted in four different stages. Each stage was developed according to the development directions, as shown in Figure 3.

(2) Function-focused VE alternative evaluation procedure

In the function-focused VE alternative evaluation procedure, the simple comparison between the original and the alternative in the existing procedure was revised. In this procedure, an evaluation unit is set up by classifying the functions that have been improved through the alternative into the intended function and the additionally obtained function, as suggested earlier. Afterwards, an evaluation of each unit is carried out. By synthesizing the results and the weighted values, a degree of improvement of the corresponding VE alternative's function is evaluated. The proposed function-focused VE alternative evaluation procedure is shown in Figure 3.

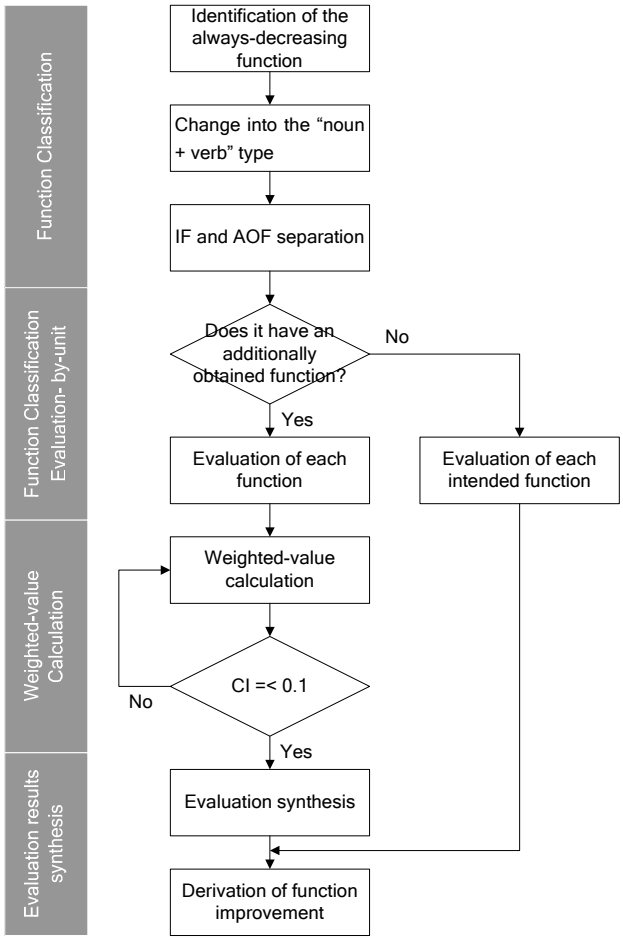

Figure 3. The Evaluation Procedure of VE Alternative

4.3 Details according to the evaluation stage

(1) Function classification stage

In the function classification stage, a function is classified into an intended function or an additionally obtained function so it could be included in the function-focused evaluation of VE alternatives.

In function classification, the identification of the improved or decreased functions is preferably done through VE alternatives. After this, the identified functions are transformed into the "noun+ verb" form.

The functions are classified into intended function (IF) and additionally obtained function (AOF). Then, each function is marked (+) or (-) to indicate whether it has a positive or negative effect on the corresponding VE alternatives.

(2) Evaluation-by-unit stage

The evaluation of a function is conducted according to the evaluation unit that was selected through function classification. The evaluation criterion is how much the effect was increased or decreased compared to that of the original one, and grades within the range of -5 to +5 are given.

(3) Weighted-value calculation stage

In the weighted-value calculation stage, the evaluation grade will be synthesized by adding the weighted value to the evaluation results of each stage. As for the method of weighted-value calculation, AHP through the eigenvalue method was used. Following the calculation of the weighted value, the consistency index was evaluated to identify the degree of consistency of the evaluator's grading. A consistency index of 0.1 or below indicates that there is no issue regarding consistency.

(4) Evaluation results synthesis stage

In the evaluation results synthesis stage, the final degree of improvement of the VE alternative's function is derived by reflecting the improvement grade and weighted value through evaluation by stage. The final evaluation results are derived by adding all the evaluation values of each function unit and multiplying these by the weighted value.

4.4 Applicability verification

To verify the applicability of the function-focused VE alternative evaluation procedure proposed in this paper, case application was conducted by design VE experts. Case application was carried out on the two kinds of VE alternatives, according to the experts' opinions. The two kinds of VE alternatives are as follows:

① an alternative coupled with an intended function (IF) and the number of additionally obtained functions (AOF); and

② an alternative coupled with only one intended function (IF).

As for the case application procedure, performance-focused evaluation was preferentially carried out so it could be compared with the existing evaluation procedures. Afterwards, the function-focused VE alternative evaluation method proposed in this study was carried out. Performance-focused evaluation was carried out by using an evaluation matrix that showed the highest frequency in the case analysis.

As such, through the application of the results obtained from the study in case 1 and 2, the method's easy and practical utilization was verified.

The opinions of the experts who participated in the verification of the proposed function-focused VE alternative evaluation procedure are as follows:

- Although the simple comparison of the performance-focused evaluation results is far-fetched, it appears to be systematic compared to performance-focused evaluation.
- In the VE analyses that are actually undertaken, the application of the function-focused VE alternative evaluation procedure seems reasonable. It seems desirable, however, that it be carried out in combination with the existing performance-focused evaluation considering that this is the first time that it was proposed as an evaluation method.
- The experts can be reminded of the importance of functions as it is to evaluate the improvement of the VE alternatives' functions after the function analysis stage.
- To enhance the reliability of the results of the function-focused VE alternative evaluation, such evaluation method must be applied in many VE analysis cases rather than in only a few VE alternatives.

5. Conclusions

The function-focused evaluation procedure of VE alternatives was proposed in this study following the revision of the simple comparison of the original with the alternatives in the existing methods. Moreover, for a systematic evaluation, the contents by stage were summarized. The evaluation was conducted with four classifications at large. Each stage consists of the function classification stage, evaluation by unit, weighted-value setup, and evaluation results synthesis. In the function classification stage, the functions that were improved through the alternatives are classified into intended functions and additionally obtained functions. In the evaluation-by-unit stage, an evaluation unit is set up. Afterwards, in the weighted-value setup, the evaluation of each unit is carried out. The results and weighted values are then synthesized in the evaluation results synthesis stage, leading to an evaluation of the degree of improvement of the corresponding alternatives' functions.

To verify the applicability of the proposed function-focused VE alternative evaluation procedure, case application was carried out. The verification of the two kinds of VE alternatives was carried out by four experts according to their opinions. The verification of the procedure's applicability showed that the practical application of the proposed function-focused VE evaluation procedure is possible.

This study was conducted with focus on the improvement of function-focused evaluation in the existing performance-focused VE alternative evaluation

procedure. It does not suggest, however, that the existing performance-focused evaluation is not right. The study only sought to improve the abstract evaluation items and the illogical evaluation procedures in performance-focused evaluation. Of course, performance-focused evaluation can be critically used in identifying the outcome of VE analysis. Accordingly, it is necessary to come up with measures for synthesizing the existing performance-focused evaluation and the function-focused evaluation proposed in this study, or for synthesizing such evaluation methods with cost in the future.

Many experts regard the identification of function as an important factor in VE analysis. There is a tendency, however, to overlook the importance of function in some design VE cases conducted in Korea. The function-focused VE alternative evaluation method proposed in this study will serve as a reminder of the importance of function and of the fact that it should thus be dealt with accordingly in all the stages of the VE job plan execution.

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