LHI Journal (2011) 2(4):479-489 DOI: 10.5804/LHIJ.2011.2.4.479
http://lhi.lh.or.kr

Enhancing Value of Public Construction Projects by Improving Contract Review Process

Sang-Hoon Song[1], Jong-Dae Bang[2], Gun-Hee Cho[3], Jeong-Rak Sohn[4] and Sang-Ho Jung[5]

(Received September 5, 2011 / Revised October 14, 2011 / Accepted October 24, 2011)

ABSTRACT

This study aims to suggest the method to enhance the value of public construction project during contract review process considering budget reduction for project profit and public interest enhancement simultaneously. The main results of this study are as follows: ① Current method are considered to be improved from the point that cost reduction through current method could influence performance of the object of contract without conforming to user requirements or facilities' function. ② In order to supplement current process, the method to evaluate the variation of performance and value was established based on facility type, participants on each phase, and their requirement. ③ Case study was conducted to verify suggested method, and showed the successful application in enhancing the value of construction projects on public sector.

Keywords: Contract review, Value engineering(VE), Value, Performance, Cost reduction

1. Introduction

1.1 Background and Purpose

As enormous finances with the scale of 40 trillion won of the country and local government are invested into the public construction projects every year, various policies and techniques have been introduced to prevent the waste of budget by removing underlying inefficiency and waste factors in each phase of the construction project. Recently, public institutions including each central government and local government have shown the achievement of the large-scaled budget reduction for their own projects that the corresponding institute is in charge of through the contract review system.

In spite of this budget reduction, it has been pointed out that the qualities of public projects such as functionality for users or consideration for project participants are overlooked during the contract review. This opinion is based on the fact that public projects should satisfy the additional needs by increasing the profit of stakeholders and public as well as the budget reduction. As the purposes of current contract review system are to enable the efficient and transparent execution of the budget, and to reinvest the savings, etc., the results of review are mostly reported focusing on the budget reduction of owner. This kind of reduction might cause non-conformance to user requirement, affect the performance of facilities with inadequate function, and change the site conditions or work difficulties of the contractors. Thus, a method needs to be established to secure project value as public construction with reduced cost by contract review.

This study aimed to suggest the plan to enhance the value of projects in the process of contract review for public construction projects by considering both the budget reduction and the increase of the public profits from the perspective of the stakeholders of projects. By utilizing the method suggested in this paper, the objectivity and reasonableness of the current review works are expected to be improved, and the optimal direction of satisfying project stakeholders to be identified in carrying out public construction projects.

1.2 Scope and Method

Generally, the contract review is conducted on various contents at many stages, but this study was intended to suggest an improvement plan focusing on the review of design documents prior to notice of tender for selecting a contractor under the delivery method of design-bid-build. Furthermore, from current

1) Associate Research Fellow, Land & Housing Institute (Main author: ssong@lh.or.kr)
2) Senior Research Fellow, Land & Housing Institute (Corresponding author: jdbang@lh.or.kr)
3) Research Fellow, Land & Housing Institute
4) Senior Research Fellow, Land & Housing Institute
5) Assistant Manager, Korea Land & Housing Corporation

Table 1. Budget Reduction Record through Contract Review (by Years in Seoul)

Classification		'03	'04	'05	'06	'07	'08	'09	'10
Total	Nos. of Cases	2,020	1,673	2,191	2,337	2,646	3,447	3,711	2,945
	Reduction (100million)	656	2,463	1,355	1,850	2,213	3,652	3,294	2,578
Construction	Nos. of Cases	586	555	637	678	1,099	1,363	1,370	1,021
	Reduction (100million)	499	2,259	1,213	1,675	2,067	3,279	2,881	2,278
	Reduction Ratio (%)	10	8.5	10.4	8.5	8.6	9	12	10.3

contract review process, this study attempted to improve the task of evaluating the revised design, which reflects review opinions, by employing the concept of value.

During the execution of this study, first of all, the process and method of tasks were identified by analyzing the contract review guidelines of major domestic public owners. In establishing improvement scheme, the major techniques used in design VE activities were analyzed, and the method contributing to enhancing the objectivity and publicness of contract review was to be introduced. In the last stage, the availability and practicality of suggested method on working-level was examined by applying that to the real case of contract review for civil engineering works.

2. The Status of Contract Review System

2.1 Overview of Contract Review System

The contract review system was introduced in Seoul in 2003 for the first time and has been applied in governmental agencies as a tool for the health of budget execution and managerial innovation since 2008 in order to support the governmental tasks of reducing 10% of budget of public projects.

This contract review system aims at removing the unnecessary waste factors by searching for the cost reduction factors prior to bidding process for various types of services and construction. Furthermore, it promotes the enhancement of public service through cost reduction, and of product quality by creative alternatives. The reduction review with the purpose of this system, which is executed for construction costs of public projects by department and affiliated organizations under Ministry of Land, Transportation and Maritime Affairs, means 'a series of works reducing budget without hindering the function and safety of structures in implementing the public construction projects, through creative thinking such as recycling of materials, and application of new construction method or new technology, or plan development to reduce project costs by applying other cases successful in reducing budget.' (MLTM, 2008)

Table 1 shows the record of budget reduction since '03 in Seoul that played an important role in introduction and spread of this system. Through this system, 1 trillion 806.1 billion won in total was reduced, and the construction sector, counting for most of the review amount among contract types (construction, service, and purchase), shows the average reduction ratio of around 9.7% up to '10(DCR of SC, 2010).

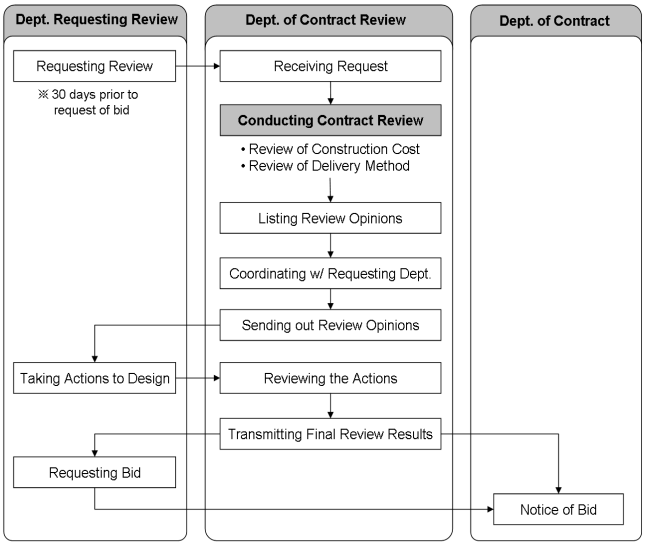

Fig. 1. Current Process of Contract Review

2.2 Process of Contract Review

In this study, the process of contract review was checked through the central governmental agency and local government (DCR of GP, 2009; DAPC of MPAS, 2008).

A department requesting review, which is in charge of conducting project management and placing an order, a department in charge of making a contract, and a department in charge of reviewing are basically involved in the contract review.

Each owner has its own department for contract review, and the projects executed by department and affiliated organizations under MLTM go through additional review by Project Cost Reduction Team.

In general, the department in charge of a project requests review to the reviewing department prior to requesting contractor selection, and the corresponding department should pass the result of review within the designated duration according to the instruction. The requesting department revises the design document reflecting the review contents, and that confirmed review result is attached upon request of contractor selection. If necessary, the requesting department could ask reviewing department to recon-

sider the review result. In addition, it's allowable to utilize a committee consisting of experts or to seek opinions of professional institutions during contract review process.

2.3 Problems and Improvement of Contract Review Method

The problems of the current contract review method can be summarized as below with the aspect of contents and the aspect of method of conducting review task.

① Conducting Review with Owner-oriented View

The contents of contract review are mainly focus on cost reduction from the view of an owner, and the consideration is not sufficient for other goals of a project except for cost reduction or the requirements of other stakeholders of projects such as contractors or users.

② Insufficient Objectivity of Review

Also on the method of contract reviews, as the whole process of review is led by an owner, it's difficult to fully obtain objectivity and rationality about the results of review. Besides, there is no other objective indicators except for cost reduction in quantitatively evaluating the revised design document reflecting review opinions . This absence of proper evaluation methodology along with the insufficient manpower causes the controversy about quality of contract reviews and final design document.

In order to resolve the problems above, the improvement toward the direction as below is required.

① Enhancing Value of Project and Its Stakeholders

Increasing public interests and customers' satisfaction of public projects as well as cost reduction is to be promoted by changing main point of the current review method from targeting owner-oriented cost reduction into improving values of overall project and related stakeholders.

② Tool Development to Induce and Evaluate of Value Improvement

It is necessary to convert the current method into objective value evaluation method through the introduction of VE technique so that the effect of value improvement with each view of an owner, a contractor, and a user can be evaluated. In executing reviews, let experts with sufficient experiences participate in the process and suggest review opinions with reference to the existing best practices, and then evaluate the appropriateness of design revised by the department in charge of a project based on objective and reasonable indicators.

2.4 Requirements for Improvement

To enhance rationality of review task and value of public construction projects, it is necessary to develop the evaluation items for revised design and contract document, and establish a method of granting weights to items according to characteristics of projects and analyzing the degree of improvement in performance and value. Therefore, in following chapter of 3 and 4 in this paper, the available methods will be discussed among existing techniques analyzing the value of design, and the items and detailed methods for evaluating the revision will be suggested based on the selected technique.

3. Process of Design VE and Review of Technique

3.1 Overview of Review on Design VE

In this chapter, a method to evaluate objectively and reasonably the influence caused by revising design document according to the opinions of contract review was examined. Based on the concept that design VE activities dealing with values by the combination of function and cost are closely related to the goal of this study, the process and detailed techniques of design VE were analyzed to find possible implications.

3.2 Process of Design VE

In general, design VE consists of three phases of preparation, analysis and implementation, and the detailed activities of each phase can be summarized as shown in Figure 2 (Dong-Il, 2010; Lee et al., 2010). In the preparation phase focusing on the selection of a object for VE, the demand of a user is measured as selection criteria, and the objects and their priorities are determined. In the analysis phase, the function of the determined object is analyzed, and value-enhancing ideas are embodied and evaluated. Those ideas are reviewed, and appropriate ideas are finally selected in the implementation phase.

3.3 Analysis of VE Technique by Phases

From the phases of design VE, the techniques, evaluation items, and the criteria of evaluation applied in activities of preparation and analysis phase are examined as follows.

In preparation phase, the main items used for the evaluation of an object are selected, and the priorities of objects are determined (Jeong et al., 2008). First of all, a quality model representing properties of final facilities is established through the questionnaire to owner and users. In evaluating VE objects, costs and those selected properties in the quality model are considered simultaneously, and lastly, the priorities for VE activities are decided according to the organizational capability. See the Table 2 to check the major evaluation items and criteria.

In analysis phase, the functions of each object are broken down, and the improvement for the detailed functions with high importance is attempted. The optimal plan is selected by evaluating ideas derived for improving those corresponding functions. See the Table 3 to check the major evaluation techniques and criteria.

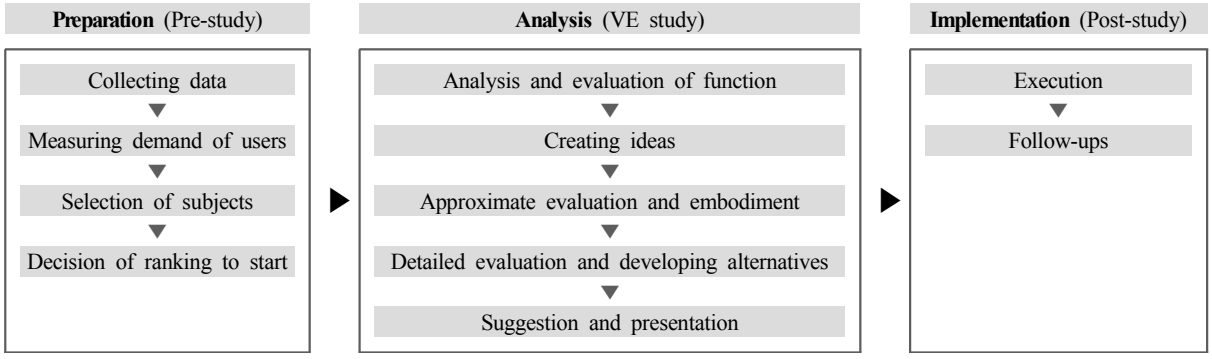

Fig. 2. Conducting Phase of Design VE and Activities

Table 2. Evaluation Items and Criteria of VE Preparation Phase

Activity	Applied Technique	Evaluation Item	Criteria of Evaluation(Selection)
Measurement of User's Demand	Quality Model	Economic Feasibility, Environment, Convenience, Accessibility, Repetitiveness, Variability, Durability, Symbolism, Maintenance, Safety, Workability, Public Interest, Energy Saving, Reduction of Construction Duration	
Selection of Subject	Selecting technique of high cost field		High cost field
	Cost-to-Worth		Large-cost part compared to value
	Evaluation technique of costs·performance	Cost and performance (Client/User's Demand, Construction Duration, technical feasibility)	Considering cost and performance simultaneously
	Composite Evaluation Technique	Effectiveness, input efforts, site organization, limits	Compositive consideration of evaluation items
	Weighing compositive evaluation technique	Quality improvement, cost reduction, reduction of construction duration, safety, limits	Considering weights of evaluation items and prospective satisfaction
Decision of the Ranking to Start	○× Method	Effectiveness, Easiness of Handling, Solving Ability	Evaluating items as ○, × for the selected subject of VE and deciding in the order of subjects that have more ○

3.4 Implications from Analysis of VE Techniques

The available findings in terms of evaluation items and evaluation method from analyzing VE technique by phases so far could be summarized as follows.

In that the items in a quality model in preparation phase reflect the demands of users, those items providing additional views other than an owner can be utilized in establishing evaluation items for results of actions taken according to review opinions. The items used in selecting VE objects are also candidates for evaluation items because they contain requirements of users and contractors during construction execution stage.

In the analysis phase, implications about applicable and practical techniques for evaluating the actions could be obtained rather than evaluation items. AHP, Matrix Evaluation Method as well as FD & IWDM technique could be proper techniques for evaluating the results of the value-enhancing actions(Yoon et al., 2008; Kwon, 2004).

4. Development of Value Improvement Method for Public Construction Projects

4.1 Overview of Process of Developing Value Improvement Method

As mentioned in the section of improvement direction of the current contract review system, in order to enhance the value of projects the evaluation items and a quantitative method are essential. The former makes it possible to evaluate design document in terms of value, and the latter is necessary to measure and

Table 3. Evaluation Items and Criteria in the Analysis Phase of VE

Activity	Applied Technique	Evaluation Item	Criteria of Evaluation(Selection)
Evaluating Function	Evaluation based on achievement data	Required cost for conducting function	Selecting the minimum value as function cost(F) among the required costs
	Forced Decision(FD) & Investing Weights Decision Method(IWDM)	• 1:1 Importance between functions • Relative importance of functions, Accumulated value, Weights, Revision value, Current cost(C), Function cost(F)	• Decision of ranking according to scores of importance • Estimating V(F/C) and C-F by current cost(C) and function cost(F) • Decision of ranking according to the size of C-F
	Delphi	Survey	Repetitive interview of experts
	Function Evaluating Table	V(Function, F/C), Pi(Possible improvement amount, C-F)	The subject for improvement with a function having large possible improvement amount
	AHP	Structural survey	Estimating weights based on mathematical computation (matrix)
Approximate Evaluation and Embodiment	Approximate evaluation of ideas	Economic feasibility, Constructability, Stability, Beauty	After evaluating with O, △, ×, deciding whether to adopt it or not
	Matrix Evaluation Method (Selection Technique of Optimal Plan)	Economic Feasibility, Constructability, Durability, Amenity, Maintenance, Designer's intention, Construction duration, Safety ※ Selecting 5 to 10 items ※ Evaluation criteria of construction projects	Calculating total score after multiplying scores of each alternative by weights followed by estimating weights between evaluation items
Detailed Evaluation and Developing Alternatives	LCC Analysis	Calculating life cycle cost(LCC)	Computing LCC based on historical data

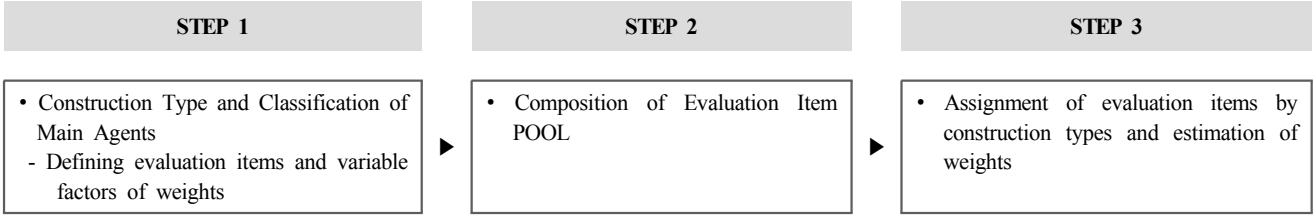

Fig. 3. Development Process of Evaluation Items

compare the influence of change in design. In this context, the value-enhancing plan is suggested including those two significant matters of development of evaluation items and measurement and evaluation of value variation in this chapter. In addition, the term value evaluated in the suggested method is used similarly as used in VE process. However, the point of time, purpose, area or object, and techniques of application of those two tasks are different.

4.2 Developing Evaluation Items

Items for evaluating the results of action according to review opinions are developed through the process of classification of factors affecting weights, composition of evaluation item Pool, assignment of evaluation items, and determination of weights as shown in Figure 3.

4.2.1 Defining Evaluation Items and Variable Factors of Weights

First of all, it is necessary to define factors that affect the classification of evaluation items and weights of each item. The value improvement of construction projects is considered to begin with satisfying the requirements of each participating stakeholder. Therefore, considering that items and weights are to be developed separately according to stakeholders of construction, and those stakeholders vary depending on facility (project) types, i.e. final result of construction, facility types and their stakeholders are defined as influence factors.

① Classification of Facility Types

The stakeholders of the project can be more specifically defined in accordance with types of the facilities. The facilities

Table 4. Example of Stakeholders Classification by Construction Types

Construction of (Industrial) Complex			Housing Construction		
Planning & Design	Construction	Use & Operation	Planning & Design	Construction	Use & Operation
• Client Institute • Ministry of Land, Transportation and Maritime Affairs • Design Company	• Contractor • Subcontractor • Service Company	• Occupying Company • Complex Management Company	• Client Institute • Ministry of Land, Transportation and Maritime Affairs • Design Company	• Contractor • Subcontractor • Service Company	• Residents • Manager (Management Office)

Source: Classified by separate awarding a contract of Design-Construction.

Table 5. Example of Evaluation Items by Views

Client	Contractor	Resident & Manager
• Cost Reduction • Quality Improvement • Improvement of Customer Satisfaction*	• Easiness of Constructability & Improvement of Productivity • Easiness of Management of Construction Progress • Easiness of Quality Control • Easiness of Safety Control • Easiness of Environmental Management • Easiness of Site Management	• Improvement of Convenience(Functionality) & Safety • Reduction of ratio of construction inferiority and defects • Reduction of maintenance cost(Reduction of energy, management cost, maintenance cost etc.) • Improvement of beauty and scenery • Environment-Friendly • Increasing value of complex

Source: customers mean constructors and users.

Table 6. Example of Evaluation Items by Types of Construction

Library		Industrial Complex		Road	
Connectivity of Each Room	7	Connectivity of Super Ordinate Plan	11	Connectivity of Super Ordinate Plan	7
Constructability	15	Constructability	20	Constructability	14
Publicity	7	Minimization of Public Complaints	13	Minimization of Public Complaints	20
Economic Feasibility	21	Environment	9	Environment	13
Efficiency	15	Safety	19	Safety	17
Maintenance	14	Maintenance	11	Maintenance	8
Beauty	11	Scenery	7	Scenery	10
Applicability	10	Easiness of Passage	10	Easiness of Passage	11

Source: Data from VE Implementation Report of A Construction.

produced by construction could be classified variously, and the facilities types on several levels in Construction information Classification System (MLTM, 2009) could be referred in determining facility type in a specific organization such as 'Land Development', 'Transportation & Traffic Facilities', 'Environmental Processing Facilities', 'Resource Supply Facilities', 'Residential & Commercial Facilities', 'Public Buildings', 'Health, Recreation, and Religious Facilities', 'Heavy Industry Facilities', 'Light Industry Facilities', 'Petroleum & Chemical Industrial Facilities' etc. For project managers on working-level, each owner organization needs to identify its own project(facility) types and build a classification, and then define the stakeholders of execution phase and use/operation phase accordingly.

② Stakeholders by Phases

The stakeholders and their requirements on the project have more significant influence on developing evaluation items than facility type itself. Thus, evaluation items are determined by the process as shown in Figure 4.

In this study, the stakeholders of each phase of a project are specified along with planning and design, execution (construction), use and operation phase. In a real project, they are defined in a more complex manner due to additional aspects such as project delivery system as well as facility types.

4.2.2 Building Pool of Evaluation Items

In identifying the possible items for evaluation, the performance categories that a project or the final facilities may have are collected without limitation. Among the methods used in the procedure of VE implementation, items in a quality model can be usefully utilized.

4.2.3 Assigning Evaluation Items and Calculating Weights

Items in the pool of evaluation items are assigned to each project type according to stakeholders' perspectives and requirement,

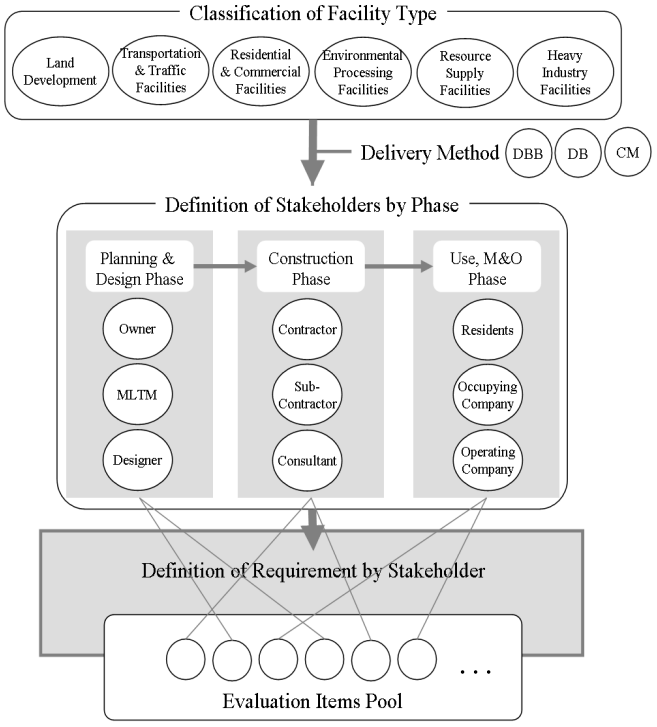

Fig. 4. Definition Process of Evaluation Items

and weights are granted to items. Items and weights in a template for each project type should be broken down as much as possible, and reviewers are to use them after judging their appropriateness when stating opinions upon request of review. In determining weights, various methods such as a simple weights estimation method(FD, DARE, IWDM, Matrix Evaluation Method, etc.), Scale Method, Dipole Method, Ranking Method, Pairwise Comparison Method(Analytic Hierarchy Process(AHP), etc.) can be applied.

4.3 Evaluating Value Variation

A plan to increase the value of a public project focusing on design document is established based on the evaluation items by project types defined in the previous step. The person in charge of contract review suggests opinions, and estimates the degree of change in value by evaluating the design, which is revised according to those review opinions by the department conducting the project and making the drawing, with the evaluation items. These evaluation activities could be executed by following procedure.

4.3.1 Determination of Evaluation and Weights

As starting the contract review upon the request, the evaluation items(i) and their weights(w_i) in a template are to be confirmed considering the project type and characteristics of a site, and if necessary, they are finally determined through adjustment. These weights by items are used in evaluating performance by being summed up into weights by views.

4.3.2 Classifying Types of Actions and Determining Objects for Evaluation

The opinions suggested from the contract review for construction can be variously classified. The main contents of cost reduction or the contract review include the evaluation of the appropriateness of estimated quantity, unit price, and materials and construction method in specification and drawings, and these contents can be categorized into correction of simple errors and improvement of the current state. In this study, the latter, which is closer to active improvement of value than the former, is adopted as the object to be evaluated.

4.3.3 Estimating Performance Improvement Index for the Objects for Evaluation

After estimating the weight(w_a) for each object(a) and measuring the degree of performance improvement by views($P_{p\text{-}a}'$) of the object according to the scales, the total performance improvement are estimated by calculating weighted sum. The weight(w_a) of the object for evaluation is to be the ratio of the amount of cost(C_a) through the corresponding object to the total cost(C_t) after improvement.

Weight of the object to be evaluated(w_a)

$$= \frac{Original\ Cost of\ the\ corresponding\ Object(C_a)}{Total\ Cost\ of\ Original\ Design(C_t)} \quad (1)$$

Total Degree of Performance Improvement of the Object

$$= \sum_{a=1}^{n}(w_a \times P_{i-a}') \quad (2)$$

where $P_{i\text{-}a}'$ = performance change of object by item

4.3.4 Computing Value Improvement by Objects and Views

With the change in performance and cost of each object, its value improvement can be computed. The cost variation is estimated as cost reduction ratio($\triangle C_a$) by dividing reduced amount by original cost. This variation is combined with performance change of perspectives($P_{p\text{-}a}'$) to compute changed value of single object.

Changed value of each object(V_a')

$$= \sum(w_a \times \frac{P_{p-a}'}{1-\triangle C_a}) \quad (3)$$

where $P_{p\text{-}a}'$ = performance change of object by perspective

Based on the computed sum by objects or perspectives, the total value of revised design as follows.

Total value of revised design(V')

$$= \sum V_a' \quad \text{(sum of all objects' value)} \quad (4)$$

$$= \sum V_p' \quad \text{(sum of three views' total value)} \quad (5)$$

where V_p' = total value by each perspective

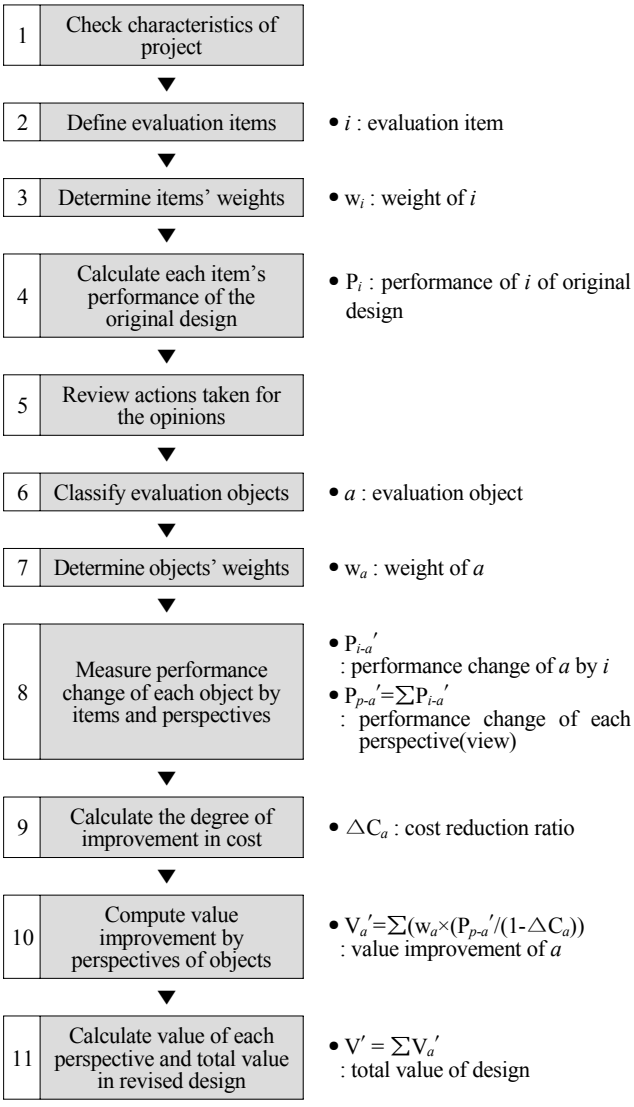

Fig. 5. Overall Process of Value Evaluation

As summing up, the overall process of value evaluation could be listed as Figure 5, and the case study in Chapter 5 will be explained accordingly.

4.4 Requirements for Practical Application

Preparation for the following items is necessary to apply the improvement method using value evaluation suggested in this study to the real project.

Current process is needed to be changed in order to add the task of evaluating the degree of actual value improvement in assessing the revised design document and asking for further action if value improvement does not meet the certain criteria. Figure 6 shows the changed process of contract review, and the tasks in dotted line are added for value improvement of public projects.

It is also necessary to develop the document format required in determining evaluation items, evaluating results by review opinions, and judging the degree of value improvement.

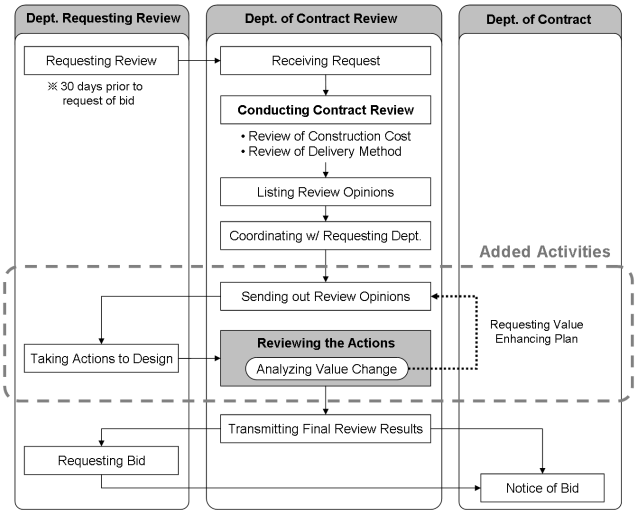

Fig. 6. Changed Process of Contract Review

5. Case Study

5.1 Overview of Case Study

The availability of the improvement method using value evaluation suggested in this study was evaluated by applying it to the actual case of contract review. The procedure and technique of the value evaluation and improvement were applied to the process of contract review of the following construction project conducted under A-public owner.

- Project : Road Construction for Residential Land Development Project in OO District (Civil Works)
- Requesting Department : △△ Division
- Review Date : □□ January 2011
- Total Cost before and after Review : 23.9 billion and 18 million and 996 thousand won / 22.9 billion and 34 million and 448 thousand won
- Reduced Cost : 984 million and 548 thousand won
- Delivery Method : Design-Bid-Build Type

The case study was conducted by the following procedure.

① Defining stakeholders by phases and their requirement of the corresponding project
② Determining evaluation items and their weights
③ Evaluating value change by the design revision reflecting review opinions

5.2 Result of Case Study

5.2.1 Summary of Requirements

According to the characteristics of a civil engineering project of road construction, the requirements of a owner at the whole phases of the project can be defined as construction cost reduction,

Table 7. Selected Evaluation Items(i) by Views in Case Study Project

Evaluation Category		Evaluation Item
A. View of Owner		
A-1	Quality Sector	Degree of quality improvement in facilities
A-2	Environment Sector	Degree of damage of natural environment and minimization of public complaints
A-3	Linkage Sector	Degree of upper planning and linkage to surrounding facilities
A-4	Public Sector	Degree of public appeal by neighboring people
B. View of Constructor(Contractor and Subcontractor)		
B-1	Easiness of Site Management	Degree of easiness of site management including subcontracts
B-2	Construction Progress Control	Degree of possibility of shortening construction duration
B-3	Safety Control	Degree of enhanced safety on site work
B-4	Easiness of Work on Site	Degree of possibility of problems and work difficulty upon construction
C. View of User and Operator		
C-1	Convenience	Degree of satisfaction of service and desire value
C-2	Scenery	Degree of propriety of finishing design considering scenery and harmony
C-3	Maintainability	Degree of reduction of maintaining costs
C-4	Safety	Degree of stability of facility

Table 8. Part of Process of Determining Weights(w_i) of Items (the Result of Step-1 (FD))

Evaluation Item	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	C-1	C-2	C-3	C-4	Subtotal	Ranking
A-1 (a)	a	a	a	a/d	a	a	a	a/h	a	a	a	a/l	9.5	1
A-2 (b)		b	b/c	b/d	b	b	b	h	b/i	b	b/k	l	6	7
A-3 (c)			c	c/d	c	c	c	c/h	c/i	c	c/k	c/l	7	5
A-4 (d)				d	d	d	d	d/h	d/i	d	d	d/l	8	3
B-1 (e)					e	f	g	h	e/i	j	k	l	0.5	12
B-2 (f)						f	f	h	f/i	f	k	l	3.5	9
B-3 (g)							g	h	i	j	k	l	1	11
B-4 (h)								h	h/i	h/j	h/k	h/l	7.5	4
C-1 (i)									i	i	i/k	l	4.5	8
C-2 (j)										j	k	l	2.5	10
C-3 (k)											k	k/l	6.5	6
C-4 (l)												l	8.5	2
Total													65	-

Note: Giving 1.0 for a superior item by relative comparison, and 0.5 for the same thing.

construction duration shortage and public complaints minimization etc. The contractor or subcontractors mainly participating in the execution phase are interested in the easiness of quality control and reduction of public complaints, etc. In maintenance & operation phase, the users(the drivers) demand the enhancement of safety, visual impressions, and performance of the road, and a manager(an operator) requires the easiness of maintenance and reduction of maintenance cost, which is known as maintainability of facilities.

5.2.2 Determining Evaluation Items and Weights

Considering the requirement listed above, the evaluation items were established as shown in Table 7 by three kinds of views as an owner, constructors(a contractor and a subcontractor), and a user/an operator.

The FD and IWDM used in VE were selected as a tool to calculate weights for these evaluation items considering the easiness of use and knowledge of a person in charge about them. Table 8 shows the process of FD setting up weights of evaluation items. The experts in the review department set up these weights in this case study. Final weights for respective items were determined through IWDM conducted based on the results in Table 8.

5.2.3 Classifying the Object to be Evaluated

The total 29 opinions were suggested through the contract

Table 9. Example of Review Opinions and Action Results among the Objects(a) to be Evaluated

Classification	Civil Engineering Works
Review Opinions	In the case of Soil Nailing planned in the sector of STA0+310～0+380 related with slope stabilization measures, since intrusion of Nails on the back into private land is concerned, a review is required for the application of other construction methods such as slope grading construction method etc.
Actions (Design Change)	- Adjusted and reflected by comparison of construction cost of achievement - With review of slope grading of cut slop, it's adjusted into 1:1.8 and the reinforcement of slope with Soil Nailing was deleted.

Table 10. Evaluation of Performance Change by Actions to Review Opinions (for Four Improvement Cases)

Classification	Weights of Objects (w_a)	Performance Improvement($P_{i\text{-}a}'$)*			Value Improvement of Each Object by Views			
		Owner	Contractor	User	Owner	Contractor	User	Total(V_a')
1	0.31	104.5	108.4	103.7	0.35	0.37	0.35	1.07
2	3.47	100.0	100.6	101.1	4.46	4.46	4.46	13.38
3	0.77	102.9	101.6	100.0	0.90	0.89	0.87	2.66
4	0.85	100.5	116.6	116.6	0.88	1.02	1.02	2.91

Note: * performance of original design for the specific object's each view.

Table 11. Estimation of Overall Value Improvement by Vlews (for All Cases)

Classification	Owner's View	Contractor's View	User(Operator)'s View
Value Improvement	5.12%	1.33%	1.30%

review for the corresponding project. Among them, four opinions brought design improvement, six opinions are related to the correctness of simple design errors, and rest of them result in only cost reduction without performance improvement. For those four results of actions causing design improvement, the change in performance and value were computed, and for objects having only cost reduction, the value change was measured with the assumption that performance is not changed before and after contract review. Table 9 shows the example of review opinion and action taken concerning earth works among four improvement cases.

5.2.4 Evaluation of Performance and Value Improvement

First of all, the weights of objects were computed by dividing each object's cost by total cost of original design, and the weights by views previously determined with FD(as shown in Table 8) and IWDM are adjusted after improvement by reflecting the change by revision. Accordingly, the amount of change in performance was calculated by multiplying the weight of object and the adjusted weight by views. The degree of performance improvement of each view can be examined by comparing the performance before and after the improvement through contract review as shown in Table 10 focusing on four improvement cases. Lastly, as shown in Table 11, value improvement calculated by views show that values are enhanced by contract review system in all three stakeholders' perspectives. Total value change of design revision could be calculated either by summing up view's sub-total or object's sub-total.

6. Conclusions

This study was to suggest a method to increase the value of a public project in the process of contract review by considering both budget reduction for profitability and increase of public interest focusing on participants as the unique characteristics of public construction project at the same time. The main results of the study are as follows.

1. The supplementation for current contract review process is necessary in that cost reduction by the contract review system could not be proper for the requirements of users, could affect the performance of the facilities by deterioration of function, or could bring about the difference in site conditions of a contractor or difficulty of works by the improper revision of design document.
2. To supplement current process, the method to evaluate the change, which is caused by design revision reflecting review opinions, of performance and value was established based on the selected items considering the project type, stakeholders by project phases, and their requirements with reference to the techniques utilized in design VE activities
3. Applicability of the suggested improvement method was examined through a case study, which proved that the suggested method in this study could improve current review process in the direction of seeking value enhancement by evaluating the change in performance along with cost reduction.

It will be possible to increase the objectivity and reasonableness of the contract review tasks in the future by applying the verified method to the review process, which is currently conducted mainly based on the experience. In addition, this application will ultimately contribute to the balanced achievement of goals of public construction projects through leading them in the direction of satisfying all participants optimally.

References

1. Dept. of Contract Review of Gyounggi Province (DCR of GP) (2009), "Regulations of contract review process in Gyunggi Province", Gyounggi Province.
2. Ministry of Land, Transportation and Maritime Affairs (MLTM) (2008), *Manual of cost reduction for public construction project*, Ministry of Land, Transportation and Maritime Affairs.
3. Kwon, T. S. (2004), *A study on the methodology to select optimum choice for construction value engineering - focusing on multiple-criteria decision-making technique*, Dissertation for Doctor Degree in Yonsei University.
4. Dept. of Contract Review, Finance Bureau, Seoul City(DCR of SC) (2010). *Regulations for contract review works process in Seoul City*, Seoul City.
5. Yoon, D. J., B. Shin, Y. Jeong and S. Lee (2005), "A study on the subject selection of VE using decision weights techniques", *Journal of the Korea Institute of Building Construction*, 5(3): 83～90.
6. Lee, J. S. and J. Jeon (2010), "A method for selection of optimal alternative and decision-making support process in construction VE", *Journal of Architectural Institute of Korea*, 26(3): 111～118.
7. Jeong, H. G., J. Yan and S. Lee (2008), "Improved method for VE items selection by analyzing the required items of stakeholders on the apartment in design phase", *Korean Journal of Construction Engineering and Management*, 9(4): 111～119.
8. Dong-Il Architectural Technology Architecture Office (2010), *Theory and practical business of architecture VE*, Kunsuldoseo.
9. Dept. of Accounting Public Corporation, Ministry of Public Administration and Security (DAPC of MPAS) (2008), *Guideline of contract review work process for local government*, Ministry of Public Administration and Security.