Facilitating a Value Engineering Study Using a Web-Based Supporting System

Jong-Kwon LIM, CVS, PhD, IAM Corporation
Coauthor: Min-Jae LEE, Professor, Chungnam National University.
Coauthor: Heung-Min PARK, CVS, PhD candidate, IAM Corporation
Coauthor: Sung-Hun KIM, CVS, IAM Corporation

ABSTRACT

Value Engineering (VE) /Value Management(VM) is a systematic team approach designed to increase the value of construction work. To achieve that, a group of experts conducts a VE workshop and creates value alternatives. A VE workshop usually takes three to five days in order to apply VE job plans into efficient results, but it is not always easy to deal with different opinions among team members with diverse interests.

Especially in Korea, people do not realize how important a proper workshop is and it is very often for people to simply skim or completely skip the process. Moreover, while a VE team is supposed to develop the best value alternatives possible during the limited time of the workshop, they spend an unnecessarily long time in collecting data. We feel that this unnecessary time should be reduced from the workshop process and we need to spend more time on necessary parts.

Therefore, the necessity to develop an efficient management of VE workshop results, and a system that can appropriately apply VE job plans to a workshop setting, are becoming more crucially important. Accordingly in this study, we developed a web-based system supporting the overall VE process within an online environment.

This system was designed to support VE team members and facilitators on the web so that they can efficiently make decisions, share information and make use of a variety of tools for a VE Job Plan. In addition, it observes and systematically applies the VE job plan suggested in Value Analysis Team /Report Guide (2003) by Caltrans, so it makes it easier for the VE leader to access the VE process by using a standardized application for each stage.

The developed system uses the multi-level performance measurement (MLPM) technique, an improved method to more effectively measure performance (Lim et al. 2008). It also enables users to draw automated **FAST** diagrams on their computer screens under internet environment. This helps to induce more active collaboration among team members and drastically reduces the time spent on performance analysis and function analysis. Moreover, it can build up the achievement stage and monitoring process so that constant monitoring and management of alternative DB are maintained.

This system makes is possible for all of us to achieve and manage a systematic VE workshop, so it is envisaged to be widely utilized both in Korea and overseas.

1. INTRODUCTION

Since December of 2005 VE examination has been a compulsory procedure in the basic and implementation stages required to take life cycle cost into consideration, for construction projects that cost 10 billion won or more. ‘Guideline for Design VE.’ was revised in

September, 2010, which made time and opportunities of design VE examination obligatory procedures, and therefore design VE is vigorously implemented in Korea today. <**Fig. 1**> shows institutional development of the VE system since 2000, when it was first legalized, up to 2011.

To effectively pass on the contents of the successful VE design to stakeholders, it can take a lot of time and effort because of examining and arranging images and data used in the proposal documents. This is one of factors hindering efficient achievement of VE design. Many VE teams don't utilize the most efficient techniques and skills in order to improve VE workshop results and quality.

With the purpose of solving such a problem, we developed a web-based support system for fast decision-making and VE. ***iamCVS*** supports the whole VE process with VE job plans and efficiently aids and manages projects when conducting VE workshops.

<Fig. 1> Institutional Development of VE in Korea

2. BACKGROUND

Design VE activities in the Korean construction industry have been expanded from central government to local governments and private sector, but a lack of skillful experts in conducting workshops compared to demands has hindered the development of VE. Due to this reason, there are even those who don't distinguish between VE and design review.

For efficient achievement of VE, value alternatives need to be developed through smooth opinion sharing and quick decision making, and also VE should be achieved in the form of a workshop for mutual communication and information sharing. However, it is time consuming to prepare workshop forms and FAST diagrams depending on the nature of the project and capability of facilitator. This restricts time to deduce results within a VE job plan. Hence, ignorance about the importance of workshops and time constraints makes it difficult to practically deduce VE results.

<Fig. 2> Web-based Computing Support System for Decision Making and VE

We have developed a groundbreaking web-based, all-procedure VE support system that can eliminate those limitations. This software is not simply for use of experts in the authors' group, but it can also be developed as a commercial program so that general users can purchase and use it with ease.

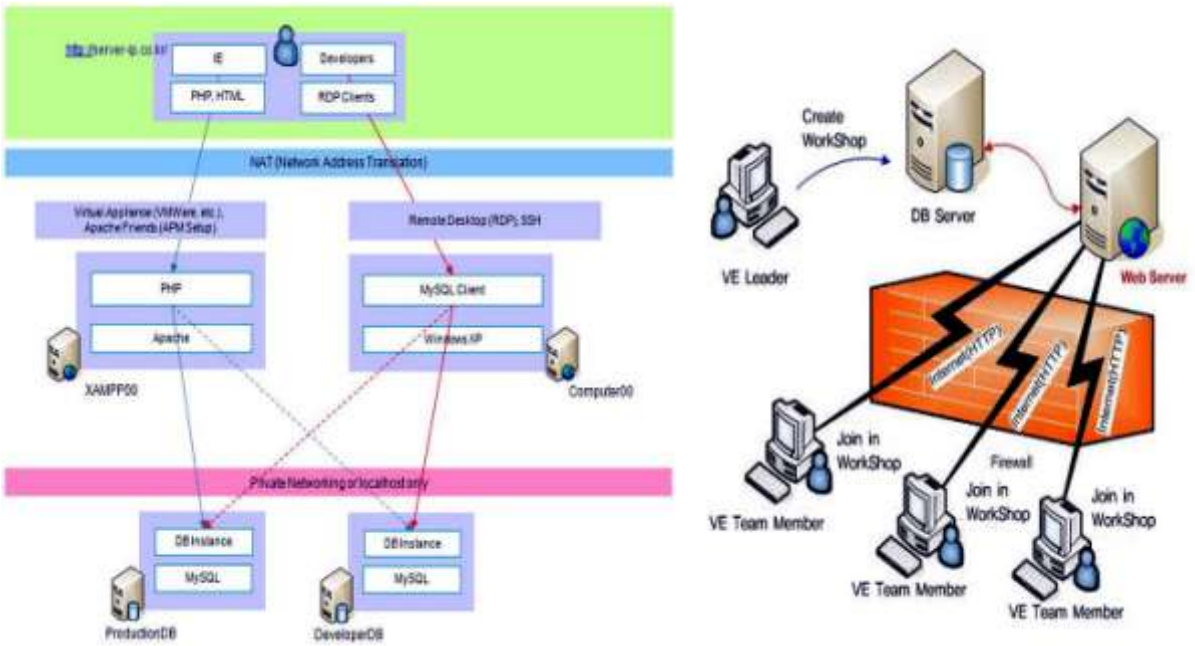
3. WEB-BASED VE SUPPORT SYSTEM

This system supports the entire procedure. It's a web-based VE support system which can analyze each stage and give feed back to the user considering mutual linkages of different analysis processes achieved using a VE workshop. ***iamCVS*** (**I am** the web-based **C**omputerized **V**alue Engineering **S**ystem), a web-based computing support system for decision making and VE, realizes VE job plans standardized by SAVE International (2007) and Caltrans (2003).

3.1 Outline of System Development

This system was developed to efficiently support VE workshops and to improve teamwork between team members in VE activities, and is not restricted spatially or temporally which makes it possible to immediately submit opinions, revise or supplement ideas and continuously examine and fix developed alternatives. As shown in <**Fig. 3**>, Apache X.X, an open system, was used for the server and ASP was used for programming language.

Particularly, Yii Framework is appropriate for the Model-View- Controller structure which has recently gained attention in web application development, so we used it and divided the interface into a database layer, information management and business logic layer and display layer. The user can handle the program like a web service on a web browser, but it is available only on Internet Explorer from Microsoft because of ActiveX controls needed for HTML, CSS and Java functions. Delphi 2009 from CodeGear was used to develop ActiveX for the FAST diagram.

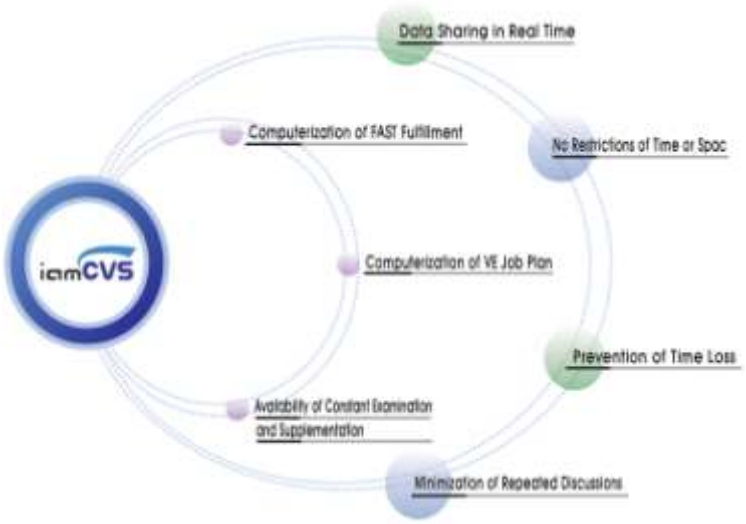


<Fig. 3> iamCVS System Development Environment

Network security is composed of a physical firewall, and an internal private IP address will be allocated for external accesses through NAT (Network Address Translation). Any unwanted access or malicious offences can be blocked by the physical firewall. Connection to the database is restricted to a virtual machine or local host, so unnecessary external exposure or any possible leakage of data is prevented.

3.2 Main Features of *iamCVS*

iamCVS realizes the VE job plan in a detailed manner, from the pre-study phase to the post-study phase through the internet to compensate for the many disadvantages that used to arise when processing a VE workshop. This system realizes the following main functions.



<Fig. 4> Features of iamCVS

3.2.1 Web-based Support System for Decision Making and VE

The core factor of ***iamCVS*** is the evaluation technology that develops the decision making support function with its system through cost model analysis, function analysis and performance and cost evaluation for each stage of VE job plan.

As shown in <**Fig. 4**>, this program enables computerization of the overall VE job plan including **FAST** Diagram, data sharing in real time, elimination of restrictions of time or space, and minimization of repeated discussions.

3.2.2 Mutual Linkage of VE Job Plan

VE achievement accords a unique process; the VE job plan. When using ***iamCVS***, users can link different stages of a VE job plan, immediately revise and supplement material, quickly fill out **FAST** diagrams using function analysis and automation support-function, while supporting the VE process easily, accurately and quickly.

The ***iamCVS*** can facilitate standard VE job plans to achieve each stage and conveniently manage the whole process, such as the generation of projects, in a phase prior to the workshop.

The assignment of the VE team leader and team members can be done on the web. As well, this system divides users in 4 different levels: final administrator, CVS administrator, VE team leader and VE team members, and grants different rights to users in each level. Roles and authorities of ***iamCVS*** users on different user levels are described in <**Table 1**>.

<Table 1> Roles and Authority of *iamCVS* Users in Each Level

User Level	Roles	Authority
Final Administrator	• iamCVS Administrator - in Charge of Dealing with Suggestions And Questions from Users	• Control over All Functions of Program • Grant License Number • Grant Right of Using Program
CVS Administrator	• iamCVS Purchaser - Assignment of VE Team Leader and Members - Proxy for Leader before Team Leader is Assigned	• Rights of Information Acquisition for Every Task Achieved with iamCVS License • Right to Approve Access to All Items Demanded by VE Team Leader or Members
VE Team Leader	• Assignment of VE Team Members and Achievement of Workshop	• Right to Assign VE Team Members • Right to Achieve VE Workshop with Full Authority for Project
VE Team Member	• Achievement of Project Workshop	• Right to Participate in Project and Submit or Evaluate Opinions

3.2.3 Weighted Comparison Matrix

In order to decide the weighed value for the evaluation of a detailed alternative, an evaluation standard matrix technique is used. It is evaluated by designer, stakeholders and VE team, and then the categories are compared in pairs before weighed value is given. In a box where two different categories cross, comparisons are made and results of important categories are saved. Evaluation categories with high importance are documented and if the

results are not much different, it is written in the form of A/B. Categories with higher importance gain one point, and if the importance is somewhat similar, 0.5 point is given. All the categories in the matrix are added for weighed value calculation to find final weighed value.

3.2.4 Automated FAST Diagram

The module used for making a **FAST** diagram is based on Microsoft Windows and the diagrams are made up of graphs. Deduced results are compatible with ".jpg" format. **FAST** diagrams and its previous stages, function definition and classification, are mutually linked and additional tasks such as function class modification and function addition can be directly achieved on the web.

3.3 Major Functions of *iamCVS*

This system is based on a VE job plan. Achievements at each stage are as described in the following.

3.3.1 Pre-Workshop Phase

To maximize the effects of a VE workshop, it is necessary to share information about the target project among team members and to be able to grasp information about the original idea quickly and minutely by mutual communication. Hence, the web is a proper medium for the original designer, stakeholders and ordering organization to quickly share information.

VE activity is achieved by the team leader, a VE expert, and the VE team, composed of technical experts. In this system, the VE team leader takes responsibility for the whole VE process and the leader and members are users. The main functions at the preparation stage are project management, workshop management, VE team member management, and project and data management. Basic information and data can be uploaded or downloaded through the web for information-sharing.

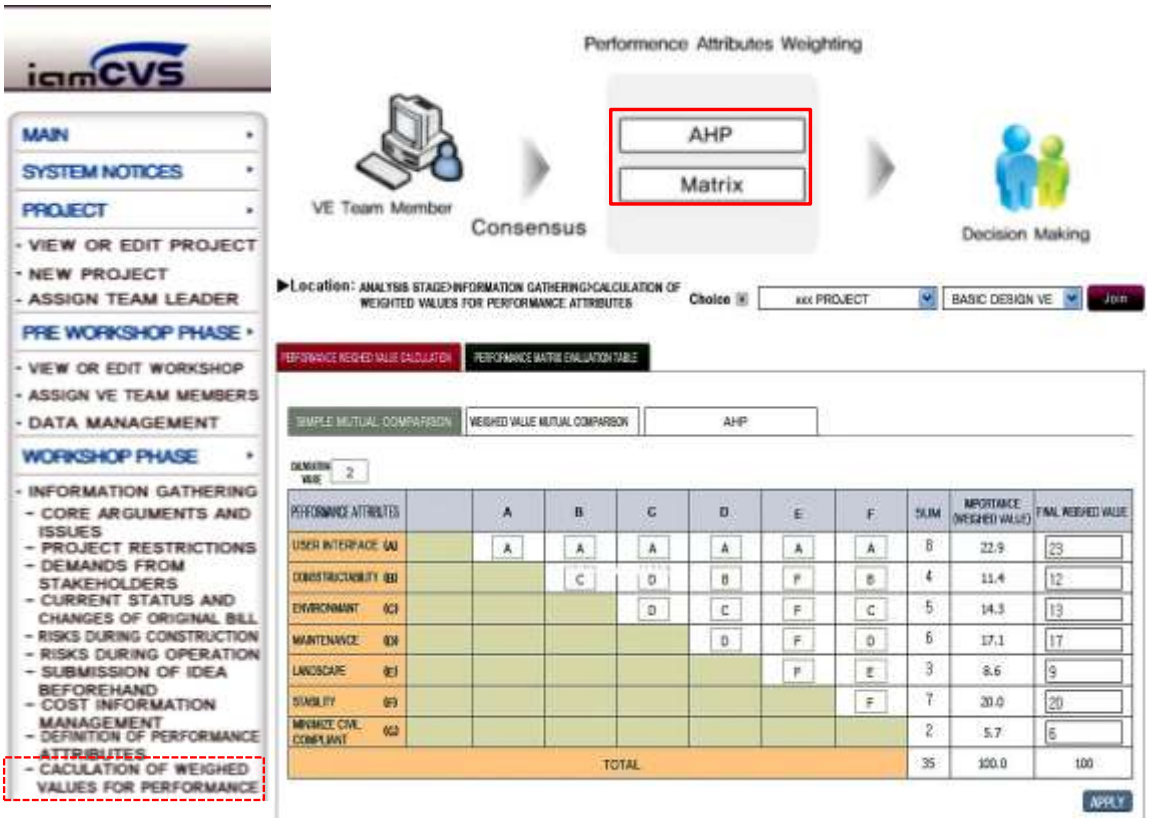
3.3.2 Workshop Phase

Analysis is the core stage of VE activity and is composed of information gathering about the selected target → function analysis → idea creation/submission → idea evaluation → alternative detailing → presentation.

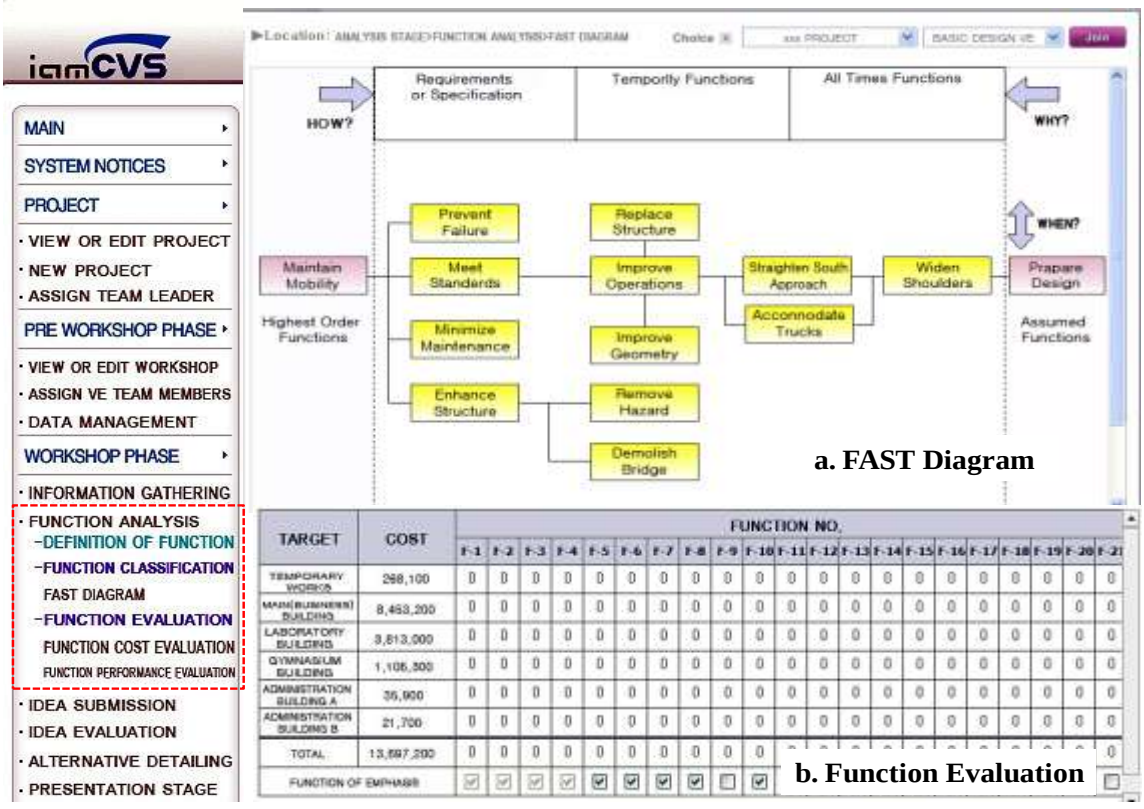
This is the stage where the team leader supervises function analysis, performance evaluation and LCC evaluation. It would be rather difficult to deduce agreement among members if they have different opinions. In such a case, it is very time consuming and minor opinions can shift to become more major opinions, which will produce inaccurate results.

At the information phase, contents of collected data about the original idea are mainly focused on for analysis. Here, the information phase can be added to analysis stage, so efficiency of the workshop can become smoother by obtaining information about related concerns, such as necessity of additional data, after reviewing the original design or analyzing the original idea.

Weighed value for performance evaluation can be computed by putting team members' diverse opinions together with the team leader sharing the result to discuss with the members.



<Fig. 5> Determination of Importance Factor Using iamCVS



<Fig. 6> Function Analysis Using *iamCVS*

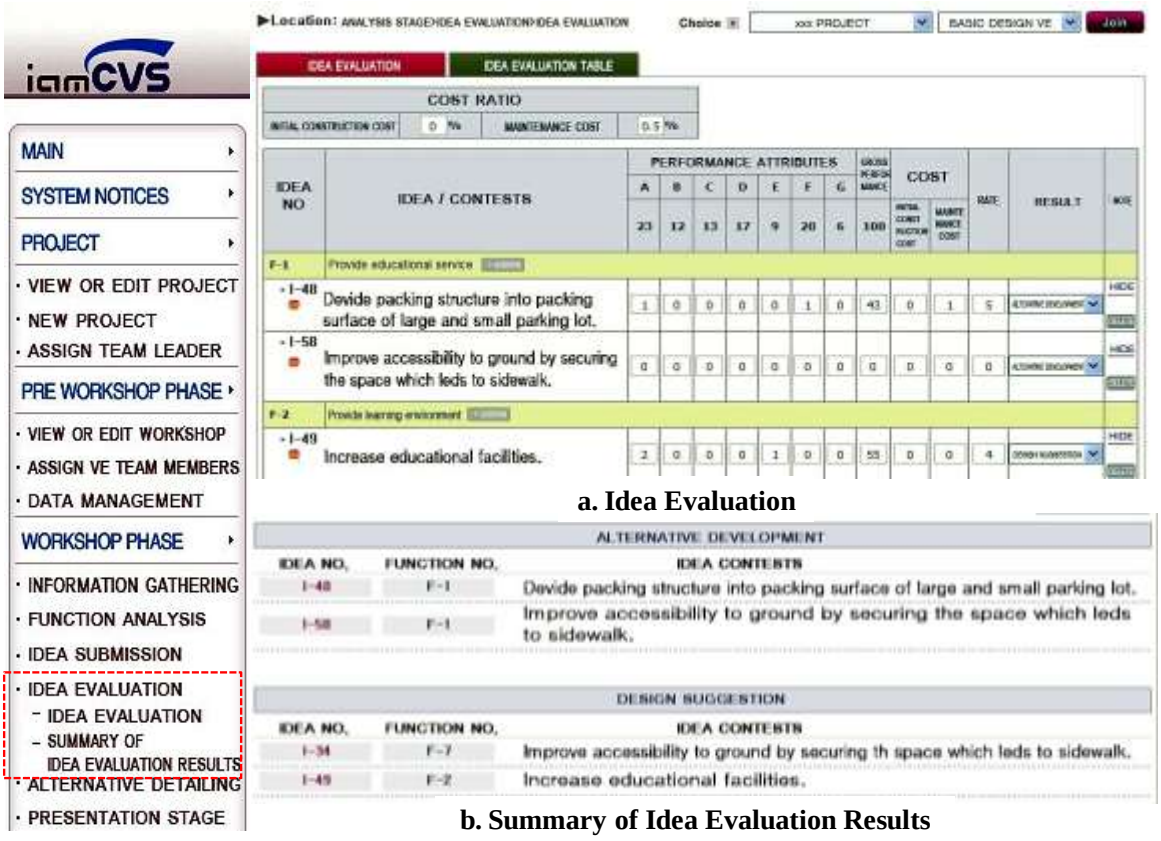
This repeated discussion will prevent time loss and boost active opinion sharing. <**Fig. 5**> shows how to achieve the property-attribute-evaluation stage, where the team leader and members define multi-level performance evaluation items and then compute the weighed value of performance evaluation by using the matrix method made with performance attribute evaluation criteria.

This system uses simple mutual comparison, the most conventional and simplest matrix method, but weighed mutual comparison and the AHP method will be added soon.

As shown in <**Fig. 6**>, ***iamCVS*** realizes the **FAST** diagram on target function through evaluation of function-cost and function-performance on the web. The **FAST** diagram assigns each classified function at its position and makes linking easy, so even beginners can easily understand and utilize it.

In the next stage of idea submission and evaluation, most time is spent on putting team members' ideas together and arranging them. Idea submission is the stage where deduced ideas are roughly evaluated in terms of cost and performance to find a proper idea for value improvement. Here, each team member suggests ideas and a team leader puts them together to share and deduce alternatives found by the evaluation method saved in the system.

Here, each idea can be hidden or deleted, so the idea evaluation is more effective. As shown in <**Fig. 7**>, idea evaluation is made up of simple performance and cost. The ideas confirmed as potential alternatives are explained in the alternative detailing stage.



a. Idea Evaluation

b. Summary of Idea Evaluation Results

<Fig. 7> Idea Evaluation

For each developed alternative, life cycle cost (LCC) and performance are automatically analyzed through conversion to current value and final value. Technicians who are not familiar with the LCC analysis can also use this function to analyze alternatives more accurately. Alternatives can be shared with team members after being developed and properties, including outline, performance, LCC and value analysis, can be downloaded. By virtue of these functions, output, revision and supplementation of data can be made even after the workshop without restrictions of time or space, so VE suggestions can be made more efficiently. All the developed results of alternatives can be downloaded in excel format for other uses.

The ***iamCVS***, has a groundbreaking function of combining alternatives from analyzed alternatives. A variety of combination can be made with developed alternatives. Users can select and omit alternatives to automatically deduct results. This system has no limit to the number of synthetic alternatives that can be selected, and also allows for synthetic alternatives to be removed at the users' discretion. This function could be very convenient due to very fast reporting.

Performance index, performance improvement ratio, relative LCC, saving ratio, value index, value type, and analysis result of the analyzed alternatives are displayed as well. Resultant values are expressed in graphs for visual representation.

At the presentation stage, the decision maker (approved by the ordering office or the person in charge of VE affairs) in charge of ordering organization and the design team of the project suggest alternatives and try to convince decision makers. The presentation should be simple, real and accurate. Results of the alternative detailing stage are depicted in presentation form so contents, performance, life cycle cost and value of original ideas and alternatives can be checked.

3.3.3 Post Workshop Phase

Results can be revised, supplemented or examined on the web after the workshop without restrictions of time or space, so the VE suggestion form can be filled out. This allows the ordering organization, designers and VE team members alike to decide on alternative developments, construction suggestions, dismissals and ex post facto examinations so that they can make decisions on achieving alternatives without physically gathering together. In addition, this system has suggestion management and report management functions so project information and results stored during the workshop last for a while, and so the CVS administrator can access them at any time.

4. SYSTEM BENEFITS

The VE job plan achieved off-line through the VE workshop may also be accessed on-line through ***iamCVS***, so that any issues that may have come up during the workshop can be fixed. A comparison between the existing VE workshop and the ***iamCVS*** for the environment at each phase is presented in <**Table 2**>. As mentioned previously, all the activities can be achieved on-line using the Internet Network, facilitating a more efficient use of both time and space.

iamCVS reduces input time and increases efficiency as compared with the conventional

approach. Information collection, usage of information and other activities in the pre-workshop phase take a sufficient amount of time in concerns with mailing or e-mailing to assign team members or make blueprint etc. On the other hand, ***iamCVS*** helps handling all the procedures within the program and therefore saves time and makes your work more efficient. Also, at the analysis stage, the system can be used instead of excel or visio separately so all the activities can be covered quickly and easily. In the achievement stage, time to prepare and edit reports is also saved because it can be done directly within the system. The ordering organization can continue their management role through using this system indefinitely.

<Table 2> Comparison of Existing VE Workshop and *iamCVS*

VE Stages	Work	Conventional approach	『iamCVS』
Pre-Workshop	Using Information	• Collect/Use Information • Build up Team members	• Just find out and Use it
	Collect Information	• Collect design Materials	• Upload material and Download
		• Collect question by papers and e-mail	• Collect questions form online
	Share Information	• E-mail materials to all participants	• download materials from website
Workshop	Information	• Make lots mistakes of performance calculation (using Excel)	• Very low probability of mistake
	Function	• Waste time of drawing of FAST Using Post-it and Visio Program	• Quick drawing of FAST Diagram • Quick education of functions
	Speculation	• Waste time in collecting generated idea by Team Members and Participants	• Quick collection of ideas
	Evaluation	• Do not stimulate team dynamics very well	• Stimulate team dynamics • Make consensus Quickly
	Development	• Lots of calculation time of value calculation	• Easy and exact calculation of value
Post-Workshop	Implementation	• Waste time to make reports	• Automatically reporting • Follow up value Alternatives • Making value strategies easily
	Follow-up	• Waste time to change reports	• Automatically making special report format for Government officials

iamCVS can receive DB from similar previous projects to reduce the amount of time spent on collecting information, as it reinforces active opinion sharing and idea creation. At the performance and function evaluation stages, commenting and evaluations can be made directly on the web, so team activity is maximized and results are calculated immediately. This allows team members to check and revise these results in real time thus engaging team members more actively than when off-line.

5. CONCLUSION

This system is a web-based support system for decision making and VE, ***iamCVS***, have been developed to help efficiently achieve VE within the internet environment. An improved value measurement method using quantitative evaluation to efficiently deduce agreement among team members was suggested and applied to performance analysis. We developed ***iamFAST*** which can immediately apply and realize results of function definition and classification to save time when achieving **FAST**, as well as solving difficulties with the application of opinions amongst team members. It does not simply show the results of each analysis stage, but enables the application of mutual linkages between input and output values and feed-back. It can also play a role as an objective analysis frame in diverse areas through function evaluation for unit project and improvement. ***iamCVS*** lets beginners easily handle complicated function analyses through the standardization of overall VE procedures. It is envisaged to raise industrial competency in many fields and induce cost reduction and innovation in business.

6. FUTURE DEVELOPMENT

The authors feel that it is very difficult to develop perfect system realizing VE activities. This system will be continuously developed considering a variety of user-oriented functions. The system will have more powerful graphic user interface environment in near future. Various and flexible tools should be considered so that more CVSs and value practitioners can be interested in it

REFERENCES

Caltrans (2003), *Value Analysis Report Guide & Value Analysis Team Guide*.

Jong-Kwon Lim, Heung-Min Park, Sung-Hun Kim (2008), ”Multi-Level Performance Measurement for Value Engineering of Large Scale Construction Projects”, Technical Presentation, *48th Annual Conference*, *Discovering ‘Value Added” Strategies*, June9-12, 2008, Silver Legacy Resort, Reno, Nevada USA.

SAVE International (2007), *Value Methodology Standard*.