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DEVELOPMENT OF IDEA HIERARCHY MODEL FOR IDEA GENERATION OF CONSTRUCTION VE

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ABSTRACT: Recently, construction projects are very complicated and diverse such as high-rise buildings and big bridges, etc. These complicated projects call for a system which can effectively generate productive ideas and activities. Value Engineering (V.E.) activity within construction projects is a necessity for systematic design management and to improve construction ability. This need in the construction industry has required a regular implementation of VE into construction projects. For this reason; America, South Korea, and some other nations have adopted VE applications which control the baseline investments of the construction projects. The process of VE activity is a preferred system and a reasonable alternative. In particular, idea generation within these projects is an important stage in the VE job plan. In this study, VE idea patterns are extracted through best practice analysis from VE cases of road construction projects. Next, we suggest an idea hierarchy model to be used in conjunction with VE idea patterns. This model is supported by reasonable idea generation in VE activity of construction projects. Finally, this model could possibly be the outcome of successful VE results.

Keywords: Value Engineering (V.E.); Idea Generation; Idea Patterns; Best Practice; Idea Hierarchy Model

1. INTRODUCTION

Recently construction projects have become very complicated and large scale trends. Accordingly, construction V.E. activities are very important tools in the construction industry. Construction V.E. is a very effective technique for project budget reduction and proficiency improvements. The latter is a main reason for the adaptation of V.E. in construction projects. However, construction projects are complex and diverse so this V.E. application is very difficult. In this study the V.E. job plan process has a scope which is limited to idea generation. I suggest that this process is a very effective accomplishment methodology. This is an idea support system which is case based. This idea tip is provided through case based idea support system development. Research scope is following figure 1. And Research process and method is following the next paragraph; first is the consideration for idea generation methodology in construction V.E. used by literature review. Second is the existing problem analysis used by V.E. expert interview. Third is the idea analysis used by V.E. application case in road projects. Fourth is the idea classification through idea keywords. Fifth is the development of idea hierarchy model.

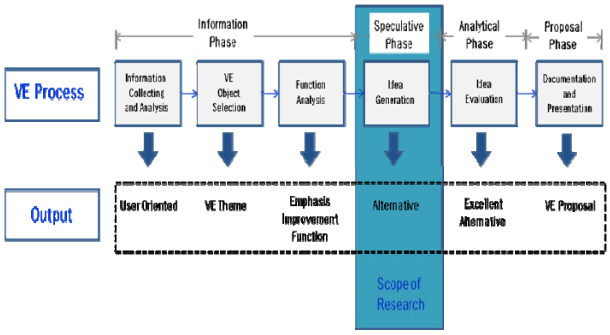


Figure 1. Analysis Scope of Research

Results of this study are idea generation of construction V.E. activity that is controlled by the V.E. participant who ultimately generates the guidelines for the specific project. Accordingly, we predict that the results of this research will support the improvement of the V.E. outcome.

2. IDEA GENERATION OF CONSTRUCTION VE

The process of value engineering follows the job plan. The definition of V.E. is: Value engineering, unnecessary cost within the project as any item that does not provide quality, use, life, appearance, or customer features to the project(Dell' Isola., 1974). The value methodology (VM), a systematic and structured approach, improves projects,

products, and processes(S.A.V.E. International., 2007). Idea generation of V.E. creates an alternative for the core function. Generally, idea generation process is found in figure 2.

Figure 2. General Process of Idea Generation

3. PROBLEM ANANYSIS OF IDEA GENERATION

Idea generation uses the brainstorming method in construction V.E. Brainstorming method has four rules. The four rules are "No criticism", "Free Wheel", "Go for quantity", and "Combine and improve". Therefore, the brainstorming method can possibly have varied ideas. Nevertheless, brainstorming has some problems. Figure 3 can explain the different problems associated with the brainstorming method.

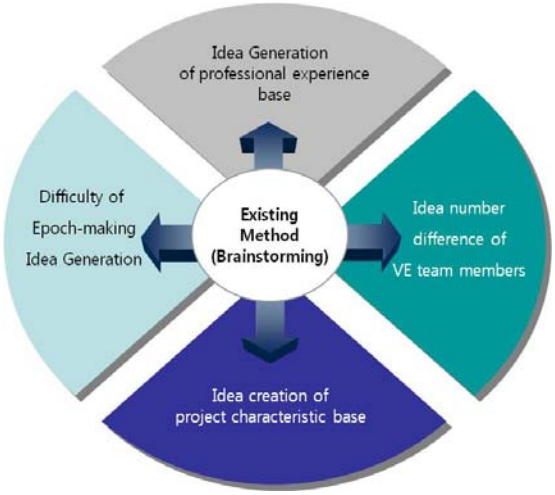


Figure 3. Existing Problem of Brainstorming

Present expert interviews examine problem analysis of idea generation. In order to be considered an expert in the field V.E. activity, the individual must have completed over ten projects as the leader and facilitator of the V.E. project. There are five experts members of these interviews. The result is followed by figure 4.

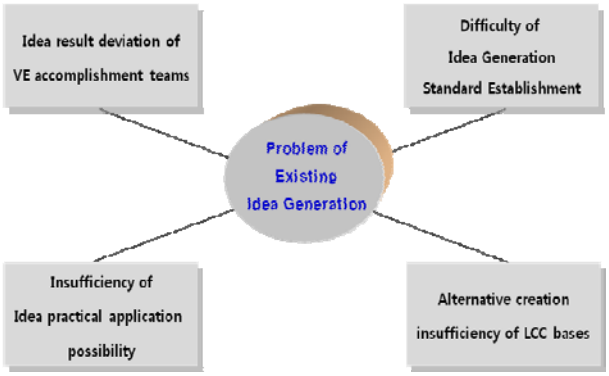


Figure 4. Existing Problem of Idea Generation

4. CASE ANALYSIS

4.1 Description of Case Projects

All of the case analysis projects are road construction projects because road projects are usually very similar in scope and often repeated. Accordingly, the profit outcome of these road projects is generally very beneficial and is good reference for V.E. activity.

All the case projects follow the job-plan. In turn the job plan offers the user a six phase process which clearly lays out the system most effective for each individual case project. The first phase is the information phase where the team identifies current tasks and goals of the project. Next is the function analysis phase. In this phase the team uses a system of a active verb/measurable noun rule. This rule helps the team to consider functions that could be changed, eliminated, or revised. Following this is the creative phase where the team utilizes imaginative techniques which offer them alternative methods to perform the given function. Fourth is the evaluation phase in which the team adheres to a given process where they choose the most effective option for value improvement. In the Developmental phase the team improves the chosen ideas in preparation for the proposal. Finally, the last and sixth phase is the presentation phase where the team will make the final presentation to the owner.

Table 1. Description of Case Projects

Division	Project Title	Description
A	Industrial complex Road Project	1. Connecting road : L=2.44Km, B=18.6m 2. Level road : L=0.96Km, B=20m→55~60m
B	Industrial Complex Road Project	Road length: L=1.27m (Bridge 700m/ 4 Section)

C	Belt way project	1. Length : L=2.345Km B=23.0m(Main line: V=60Km/hr, Connecting road: V=40km/hr) 2. Bridge : Long-span bridge(270m) 1 Section 3.Intersection: at-grade intersection(2)
D	Industrial Complex Road Project	1. Width 1) A Section : B=20.0m~35.0m(4 lane) 2) B Section : B=20.0m(4 lane) 2. Length 1) A section : L=3.68km 2) B section : L=0.58km 3. Bridge : 170.0m/1 Section 4. Intersection : 5

The last adaptation of the V.E. proposal is divided into V.E. proposal numbers and five different V.E. types. There are two types; cost reduction, and improving proficiency. Nearly all of the types are cost reduction types. There are many proposal ideas in road and construction parts.

Table 2. VE Outcome of Case Projects

Division	Idea Number	Cost Reduction	VE Type
		Ratio (%)	
A	14	(-)44.65%	Cost Reduction Type (B) - 7 Item Function Rise Type(C) - 7 Item
B	7	(-)12.54%	Cost Reduction Type (A) - 6 Item Function Rise Type(D) - 1 Item
C	22	(-)14.02%	Cost Reduction Type (A) - 5 Item Cost Reduction Type (B) - 1 Item Function Rise Type(D) - 6 Item
D	22	(-)0.58%	Cost Reduction Type (B) - 8 Item Function Rise Type(D) - 14 Item

VE Type	A	B	C	D	E
Function	Increase	Sameness	Increase	Increase	Reduction
Cost	Reduction	Reduction	Sameness	Increase	Reduction

4.2 Idea Analysis

Every part is divided into adoption numbers and cost reduction ratio. Idea key words come from idea core contents. And every idea has application parts and effectiveness categories.

Table 3. Idea Analysis Result of Case Projects

Division	Field	Idea Analysis		Idea Keyword	Application Part	Effectiveness
		Adoption Number	Cost Reduction Ratio (%)			
"A" project	Structure	1(Adoption) / 5(Total)	Sameness	Simplification	Span length	Cost reduction
				Size reduction	Pier	Cost reduction Time reduction
				Addition space	Parking space	Increase of space utilization
				Height reduction	Sound proof facility	Cost reduction
				Pattern unification	Bridge type	Cost reduction
	Road & Construction	2(Adoption) / 6(Total)	(-) 83.89%	Width expansion	Lane width	Safety Increase
				Change of Moving line	Passage	Accessibility Increase
				Composition diversification	Level road	Increase of space utilization
				Simplification	Foundation	Cost reduction Time reduction
				Addition of composition	Over bridge	Landscape increase
				Change of composition	Underpass	Cost reduction , Utilization Increase
	Soil	1(Adoption) / 3(Total)	(-) 30%	Eco-friendly method	Retaining wall	Landscape increase
				Functional method	Sound proof wall	Safety Increase
				Change of foundation depth	Foundation	Increase of space utilization
"B" Project	Structure	1(Adoption) / 2(Total)	(-) 5.02%	Thickness adjustment	Diaphragm	Safety increase

	Road & Construction	4(Adoption) / 7(Total)	(+) 0.01%	Change of Material	Sound proof wall	Cost reduction Time reduction
				Change of pouring method	Gutter	Safety Increase Cost reduction
				System addition and method elimination	Foundation	Functionality increase Cost reduction
	Soil	2(Adoption) / 4(Total)	(-) 2.53%	Eco-friendly method	Tree-planting	Eco-friendly increase
				Change of system	Earth reinforcement	Cost reduction
"C" Project	Structure	4(Adoption) / 7(Total)	(-) 8.97%	Length adjustment	Bridge	Cost reduction
				Method change	Bridge	Safety increase
				System(Form) change	Bridge	Safety increase
				System addition	Road & bridge	Safety increase
	Road & Construction	6(Adoption) / 9(Total)	(-) 0.002%	System unification	Road interface	Functionality increase
				Size adjustment	left section of road	Functionality increase
				Material change	Sidewalk	Cost reduction
	Soil	2(Adoption) / 6(Total)	(-) 9.66%	Supplementation of exist method	Foundation	Cost reduction
				Eco-friendly method	Slope	Eco-friendly increase
"D" Project	Structure	2(Adoption) / 8(Total)	(+) 0.01%	Location adjustment	Expansion joint	Safety increase
				Material adjustment	Culvert	Safety increase
	Road & Construction	3(Adoption) / 9(Total)	(-) 0.23%	Size adjustment and System change	Earth reinforcement and Gutter	Cost reduction Functionality increase
				System addition	Culvert	Safety increase
				Safety system	Steep slope section of bridge	Safety increase
	Soil	1(Adoption) / 5(Total)	(+) 0.01%	Location adjustment	Gutter	Functionality increase

5. DEVELOPMENT OF IDEA SUPPORT SYSTEM

5.1 Idea Grouping

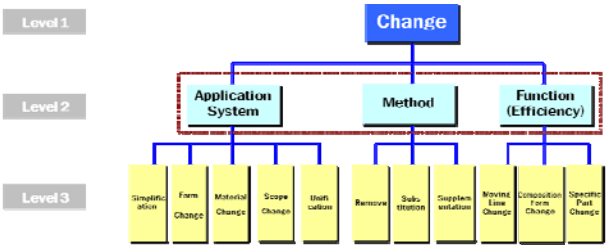
The results of idea key words and application parts are repetitive throughout the process of idea grouping. The aim of the same idea key word grouping has a result of change, diversity, addition, and adjustment.

Figure 5. Idea grouping

5.2 Idea Hierarchy Model

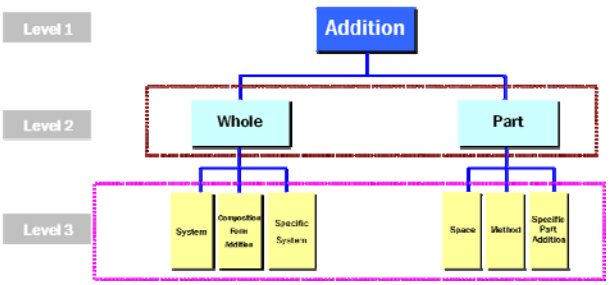
1) Change

The change of idea key words is classified by the number eleven. The results of idea hierarchy models have three categories and eleven items. The following figure will show an idea hierarchy model for change.



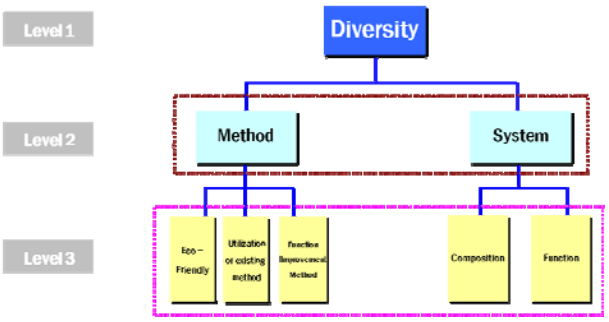
2) Addition

The addition of idea key words is classified by the number six. The results of idea hierarchy models have two categories and six items.



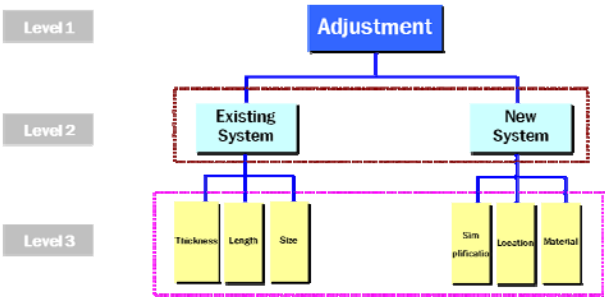
3) Diversity

The diversity of idea key words is classified by the number five. The results of idea hierarchy models have two categories and five items.



4) Adjustment

The adjustment of idea key words is classified by the number six. The results of idea hierarchy models have two categories and six items.



5.3 Testing of Idea Hierarchy Model

This model is just a model so we need to test the effectiveness of the idea hierarchy model. The selection of the case projects following the V.E. proposal contents are classified by the idea hierarchy structure. The description of the case project is seen in the following table 4.

Table 4. VE Outcome of Testing Project

Field	VE Proposal		Adoption Result	
	Proposal Number	Cost Reduction Ratio (%)	Adoption Number	Cost Reduction Ratio (%)
Structure	8	-15.70	3	-6.45
Road & Construction	6	+0.61	4	+0.61
Soil	15	-2.37	13	-1.48
Total	29	-17.46	20	-7.32

Every field of the case project extracts the idea keyword from the idea contents. The idea keyword of the case project has adapted from the idea hierarchy model. All of the divisions have a result of inclusion. The only category that has a not applicable result is the soil category. The result has a suitability of 75% for idea hierarchy model. This is significant because within this model are the results of all divisions and mostly the results were applicable to new projects. So, the idea hierarchy model is very effective for idea generation in construction V.E.

Table 5. Testing Result of Case Project

Division	**Idea Number**	**Cost Reduction Ratio (%)**	**Proposal Idea**	**Application of Idea Hierarchy Model**			
				Idea Grouping (Level I)	Idea Category (Level II)	Item (Level III)	**Result**
Structure	3	(-)15.70	Thickness Adjustment	Adjustment	Existing system	Thickness	inclusion
			System Addition	Addition	Part	Addition of specific section	inclusion
			System Form Change	Change	Application system	Form change	inclusion
Road & Construction	4	(+)0.61	Method Change	Change	Method	Change	inclusion
			Adjustment of location and space	Adjustment	Existing system	Size	inclusion
			System change	Change	Function(Efficiency)	Composition change	inclusion
			Thickness adjustment	Adjustment	New system	-	Part inclusion
Soil	13	(-)2.37	Material change	Change	Application system	Material change	inclusion
			System change	Addition	Part	Addition of specific section	inclusion
			Economics of material procurement	-	-	-	N/A

			Estimate adjustment	-	-	-	N/A
			Supplementation of exist method	Change	Change	Supplementation	inclusion
			System change	Change	Application system	Scope change	inclusion
			Composition change	Change	Function(Efficiency)	Composition change	inclusion
			Composition diversity	Diversity	System	Composition	inclusion
			Material change	Change	Application system	Material change	inclusion
			Height(Size) adjustment	Adjustment	Existing system	Size	inclusion
			Quantity optimization	-	-	-	N/A
			Optimal design of specific section	-	-	-	N/A
			Addition of system	Addition	Whole	System	inclusion

6. CONCLUSIONS

Recently construction projects have become very complicated and large scale trends. Construction V.E. is a very effective technique for project budget reduction and proficiency improvements. Finally, we would like to conclude by stressing the significance and role of idea generation in construction V.E. Idea generation is an essential and preferred system in V.E. We can now implement successful idea patterns with the use of best practice analysis by considering cases of road construction projects. So the development of the idea hierarchy model from best practice analysis will become a standard technique in idea generation due to the successful testing of the model. Finally, the model discussed throughout this study could possibly develop a tradition of successful V.E. results.

ACKNOWLEDGEMENT

This work was supported by the Second stage of Brain Korea 21 Project in Division for Ubiquitous-Applied Construction of Port Logistics Infrastructure.

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