ROADWAY PERFORMANCE EVALUATION USING FUNCTION ANALYSIS METHOD OF VALUE ENGINEERING

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ABSTRACT: Infrastructure is provided to the user through long-term project period and large-scale working expenses. Existing facilities are getting old as time goes by. Accordingly, proper maintenance is required and generally more maintenance cost than initial invested cost is needed during life cycle. Therefore, a specific plan that just increases the value of facilities is required by evaluating performance of facilities and inputting minimum maintenance cost. Value engineering that increases the value of object by systemically analyzing Life Cycle Costs and function is actively promoted at the design phase of construction. These efforts can increase the performance of facilities at the maintenance phase of infrastructure. This study is to search how to evaluate the performance of Roadway by utilizing function analysis, as a core part of VE in the maintenance phase. In order to this a new evaluation criteria were proposed by adding an evaluation items to the existing criteria through the research of old documents, status of roadway maintenance and function analysis of VE. The results of this study may promote the effective performance evaluation to determine a resolution of roadway congestion in future. A succeeding study using the proposed evaluation criteria will be required..

Keywords: Roadway, Performance Evaluation, Maintenance, Function Analysis, Value Engineering(VE)

1. INTRODUCTION

A lot of cost and long-term period are required for social infrastructure to be provided to users. Also, appropriate maintenance management is needed for ageing facilities.

Generally, 80%~85% of total input cost is used for the activities of maintenance. Therefore, the performance of facilities should be precisely assessed at the maintenance phase and the plan to raise value is necessary to devise with the minimum cost.

Recently, value engineering (VE) which is a technique to improve the value of facilities by analyzing life cycle cost and function has been served at the design phase of construction. Based on the outcome, the purpose of this study is to search how to evaluate the performance of facilities with VE in the maintenance phase.

Roadway is a typical of infrastructures. If VE experts and other fields' professionals analyze the function of roadway together and the result is applied to the maintenance, the roadway can be efficiently maintained.

The roadway maintenance cost has increased every year and some economic losses cannot be avoided if the cost is not properly used. Adding evaluation items through function analysis of VE into the existing roadway performance evaluation criteria will lead to the efficient maintenance management that improves the value of facilities with the minimum cost.

The objective of this study is to suggest criteria for performance evaluation in terms of roadway facilities improvement using the function analysis method of VE.

2. MATHODOLOGY

This study proposes performance evaluation criteria for roadway facilities improvement in the view of roadway maintenance. The method is as follows.

1) Consider theory of Roadway Maintenance Management and VE
2) Study and Analyze the existing VE and Roadway Maintenance references
3) Understand the current situation of the existing Roadway Maintenance
4) Review evaluation criteria for Roadway facilities improvement
5) Derive evaluation items using the function analysis of VE and analyze
6) Modify evaluation criteria for Roadway facilities improvement.

3. BACKGROUND OF CASE STUDIES

3.1 Roadway Maintenance Management

Roadway maintenance management is to conserve its function as well as driver's comfort and safety by means of regular repair and maintenance, and avoid impeding facilities use in case of disaster or accident.

The roadway maintenance management consists of two activities such as maintenance and management. Maintenance activities include an emergent recovery and facilities improvement such as road extension and layout modification. The procedure of roadway facilities improvement is as follows.

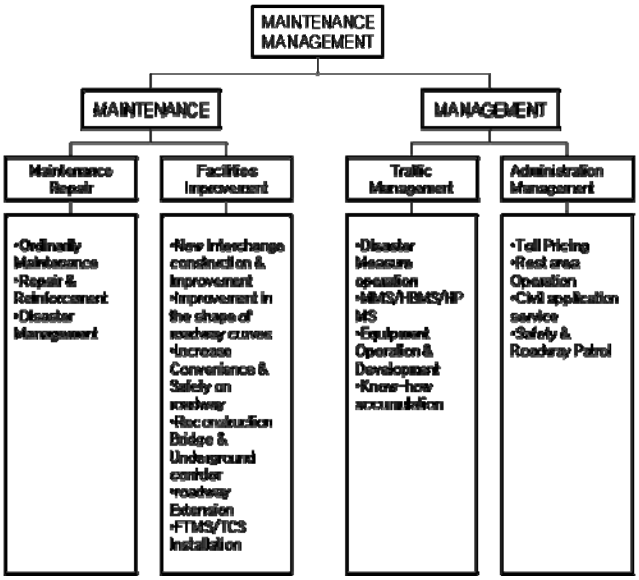

Figure1. Maintenance management chart

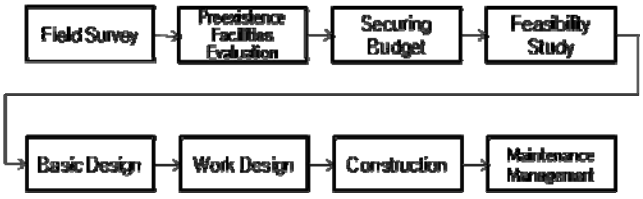

Figure2. Facilities improvement procedure

3.2 Function analysis of VE

Value engineering is a systematic method to improve the value of goods or products and services by using an examination of function.

The function analysis is at the core of VE and is a basis for creating ideas. In addition, priority function required for improvement shall be listed as the result of the function analysis. In general, the analysis of the function is divided into three parts: Identify Functions, Classify Functions, and Function evaluation.

It is noted that the function analysis is significant in the VE as follows.

With the analysis, decision makers are able to determine why building, system and configuration are designed and how the design is planned.

Therefore, the function analysis should be carried out and it is the criterion for the minimum performance level to be selected. Users' need and desire is incorporated into the analysis.

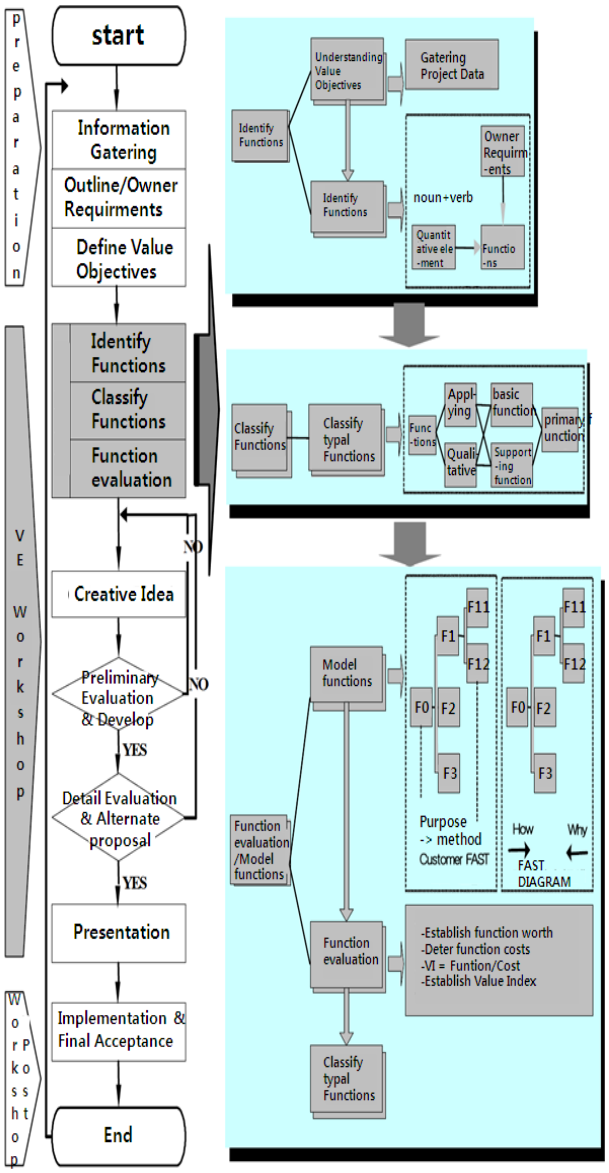

Figure3. Function Analysis in VE

3.3 Consider preceded study

As pre-study related to Roadway Maintenance Management, in 2002, Jo Byung Wan developed economic and efficient pavement roadway maintenance system as the result of diagnosing pavement conditions precisely and analyzing it. Byun Chang Hum studied in 2002 how roadway and its facilities in Seoul improve and maintain. In 2008, Lee Sang Woo investigated the current road and railway conditions, analyzed case studies of other countries, and studied infrastructure management system.

As pre-study related to function analysis of VE, Choi Chang Hoon, Kim Soo Yung suggested the Identify Function method by converse conception method. In 2005, Lee Min Jae suggested the improvement plan of

Seoul tollgate according to Caltrans's design VE method. In addition, Park Ji Young, Min Kyung Seok proposed the design plan taking into account logistics center's function in 2007.

Pre-study of VE function analysis are actively promoted at the design phase, but it is few yet in the maintenance phase.

4. ROADWAY PERFORMANCE EVALUATION CRIRERIA BASED ON VE FUNCTION ANALYSIS

4.1 Existing roadway performance evaluation criteria

Roadway performance evaluation is defined as a process to provide the roadway service performance with objective information by measuring the level of satisfaction compared to the roadway performance measurement and user's expectations for the roadway service performance. Roadway service performance hereby is divided into quantitative part that shows driving performance such as density and the volume of traffic versus capacity (V/C) and qualitative part that shows the level of user's satisfaction such as driving environment performance, safety and roadway information.

In fact, any detailed method and procedure to evaluate the roadway performance is not yet organized In the maintenance phase. This study researched and analyzed the regulations and references in relation to the roadway design standard and structure facilities to derive the roadway performance evaluation items generally applied to maintenance and management. To understand the more detailed actual conditions, opinion about the performance evaluation items applying to the roadway maintenance was also studied and analyzed. The existing roadway performance evaluation criteria are as below.

Table1. Existing performance evaluation criteria of roadway

Class	Category	Evaluation Items
1.Roadway Status	1.1 Facilities Standards	1.1.1 Fitness of existing Roadway Standards
		1.1.2 Underground Laying the investigation
	1.2 Facilities Safety Evaluation	1.2.1 Facilities Old age
	1.3Roadway Condition	1.3.1 Fine view of Roadway
		1.3.2 Road area Natural situations
2. Traffic Flow	2.1Traffic Stream	2.1.1 Traffic stream in standard Section
		2.1.2 Traffic stream in Weaving Section
		2.1.3 Traffic stream in Ramp
		2.1.4 Traffic stream in Tollgate
3.Transportation Safety	3.1 Traffic Accident	3.1.1 Traffic accident rate
	3.2 Safe Driving	3.1.2 Satisfaction index of Safe Driving
4.Convenience	4.1 Driving Convenience	4.1.1 Roadway Driving convenience
		4.1.2 Rest area Status
5. Traffic Information	5.1 Traffic Information	5.1.1 ITS Operation
		5.1.2 VMS installation
	5.2 Signal Operation	5.2.1 Signal lamp Installation
6.Society economy	6.1 Community Economy	6.1.1 Population and vehicle increment
	6.2 Local Development	6.1.2 Local development policy establishment
7.Maintenance	7.1 Maintenance	7.1.1 The fine view of roadway
		7.1.2 Efficient maintenance

4.2 Derive the additional items through the roadway VE case study

To derive a performance evaluation item available for the roadway facility improvement in the maintenance phase, analyzed the recently performed roadway VE case study such as improvement in the shape of roadway curve and Interchange(IC).

As a result of analysis focused on each function analysis phase among total seven VE case studies, VE experts per project and experts at every disciplines defined total two hundred and eleven functions made up of noun and verb in accordance with SAVE International VE Job Plan and arranged basic functions and supporting functions by distinctly clarifying the multi-relationship between the defined functions through Function Analysis System Technique (FAST). Defined main-functions were evaluated by using Force Decision (FD) method & Improved Weight Decision Method (IWDM) and total fifty priority improvable target functions were selected.

This study derived thirty functions from selected fifty priority improvable target functions excluding twenty functions that are overlapped with the existing roadway performance evaluation items.

These thirty priority improvable target functions were arranged dividing into noun and verb parts to analyze the relationship per function. The below table categorizes them into the following types: environment, popular enmity, contiguity capacity to derive additional applicable evaluation items to the roadway facilities improvement performance evaluation.

Table2. Function Analysis in VE case study

VE case	Identify Functions	Basic function	Priority improvable Target functions	Derived function
A	44	20	9	7
B	47	21	7	4
C	30	13	9	6
D	25	17	8	3
E	21	11	5	2
F	25	16	9	8
G	14	8	3	3
Total	211	106	50	30

Table3. Additional performance evaluation of roadway facilities improvement

Class	Category	Evaluation Items
1.Environment	1.1 Noise Occurrence	1.1.1 Drive noise occurrence
		1.1.2 Soundproof facility installation
	1.2 Vibration Occurrence	1.2.1 Vibration occurrence
	1.3 Ecology Environment	1.3.1 Forest damage
		1.3.2 River pollution
		1.3.3 Animal protection
	1.4 Environment Administration	1.4.1 Environmental improvement countermeasure
2.Popular enmity	2.1 Prospect Right	2.1.1 Adjoining land Prospect right conflict
	2.2 Traffic Congestion level	2.2.1 Popular enmity occurrence for traffic congestion
	2.3 Popular Enmity	2.3.1 Popular enmity occurrence for different reasons
3.Contiguity capacity	3.1 Local area Accessibility	3.1.1 Building area accessibility convenience
		3.1.2 Accessibility to adjoining amusement facility

4.3 Performance evaluation criteria for Roadway facilities improvement

Applicable performance evaluation criteria to the roadway facilities improvement in the maintenance phase were arranged integrating the existing roadway performance evaluation seven classes and three performance evaluation classes derived through the roadway function analysis in VE case study. These ten evaluation classes verified the effectiveness as a performance evaluation item of the roadway facility improvement through the 2nd interview with staffs in charge who selected the existing roadway performance evaluation items and finalized ten-class, twenty-category and thirty-two items as the roadway facilities improvement performance evaluation criteria.

Table4. Advanced performance Evaluation Criteria of Roadway

Class	Category	Evaluation Items	Specific evaluation list	Check	
				Roadway Extension	Improvement in the shape of roadway curves
1.Roadway Status	1.1Facility Standards	1.1.1 Fitness of Existing Roadway Standards	Roadway Width/curves Length/Vertical Sloop/Turning Lane	◎	◎
		1.1.2 Underground Laying the investigation	Interference of Electric /GAS/Water Supply Pipe	◎	◎
	1.2Facility Safety Evaluation	1.2.1 Facility Old age	Road surface Status/ Structure Safety/ topographical survey		◎

Class	Category	Evaluation Items	Specific evaluation list	Check	
				Roadway Extension	Improvement in the shape of roadway curves
1.Roadway Status	1.3Roadwaty condition	1.3.1 Fine view of Roadway	Clean Well-Lighted Status of Roadway	◎	
		1.3.2 Road area Natural situations	Weather conditions		◎
2.Traffic Flow	2.1Traffic stream	2.1.1 Traffic stream in standard Section	Traffic density/Average running Speed/V/C / ADT	◎	◎
		2.1.2 Traffic stream in Weaving Section	Average running Speed	◎	◎
		2.1.3 Traffic stream in Ramp	Flow rate	◎	◎
		2.1.4 Traffic stream in Tollgate	Approach Delay Time/ Delay rate	◎	◎
3.Transportation Safety	3.1Traffic accident	3.1.1 Traffic accident rate	Traffic accident survey	◎	◎
	3.2Safe Driving	3.1.2 Satisfaction index of Safe Driving	Visual field for Driving/safe distance/ Pedestrian traffic	◎	◎
4.Convenience	4.1Driving convenience	4.1.1Roadway Driving convenience	feasibility of Guide Sign		◎
		4.1.2 Rest area Status	Accessibility/utilization of Rest area		◎
5.Traffic Information	5.1Traffic Information	5.1.1 ITS Operation	Traffic information Accuracy/CCTV	◎	◎
		5.1.2 VMS installation	VMS status	◎	◎
	5.2Signal Operation	5.2.1 Signal lamp Installation	Delay rate in Signal section / Visual rate/ Signalized intersection	◎	◎
6.Society economy	6.1Community economy	6.1.1 Population and vehicle increment	Population and industrial population, Industry, Utilization status of land, Number of vehicle possession, Factory distribution	◎	◎
	6.2local development	6.1.2 Local development policy establishment	City planning, Traffic and local development policy establishment	◎	◎
7.Maintenance	7.1Maintenance	7.1.1 The fine view of roadway	Obstacles of the road, Cleanness of the roadway, Maintenance	◎	◎
		7.1.2 Efficient maintenance	Manual or person for maintenance, equipment possession status, archive administration	◎	
8.environment	8.1 Noise occurrence	8.1.1 Drive noise occurrence	Noise level (expectation) evaluation	◎	
		8.1.2 Soundproof facility installation	Soundproof facility(expectation) evaluation	◎	◎
	8.2Vibration occurrence	8.2.1 Vibration occurrence	Vibration (expectation) evaluation	◎	◎
	8.3Ecology environment	8.3.1 Forest damage	Contiguity forest damage level	◎	◎
		8.3.2 River pollution	Contiguity river pollution level		◎
		8.3.3 Animal protection	Eco-bridge, Road Kill status	◎	◎
	8.4Environment administration	8.4.1 Environmental improvement countermeasure	Environment preference policy adoption level and practice	◎	◎
9.popular enmity	9.1 Prospect right	9.1.1 Adjoining land Prospect right conflict	Disturbance of roadway adjoining resident, Obstruction aspects for the beauty of the city	◎	◎
	9.2Traffic congestion level	9.2.1 Popular enmity occurrence for traffic congestion	popular enmity occurrence for traffic congestion	◎	◎
	9.3 Popular enmity	9.3.1 Popular enmity occurrence for different reasons	Occurrence and handling cases, Cause, Problem related facility status	◎	◎
10.Contiguity capacity	10.1Local area accessibility	10.1.1 Building area accessibility convenience	Distance between the city center and the center of local area, distance covered	◎	◎
		10.1.2 Accessibility to adjoining amusement facility	Distance from adjoining amusement park	◎	◎

5. CONCLUSIONS

Performance evaluation criteria for the roadway facilities improvement in the maintenance phase was derived from the existing literature and expert's verification. The existing performance evaluation criteria was arranged dividing into the following seven classes: Roadway Status, Traffic Flow, Transportation Safety, Convenience, Traffic Information, Society economy, Maintenance and this also derived additional performance evaluation item by utilizing function analysis method, a core part of VE, to improve the value of facilities investing a minimum maintenance expenses. Items additional derived categorize as below; Environment, Popular enmity, Contiguity capacity.

Ten-class, twenty-category and thirty two items derived by utilizing VE presented in clause 4.3 will be used as a performance evaluation criteria for the existing roadway facilities in case that the roadway facilities is improved in the maintenance phase. This study derived the roadway facilities improvement evaluation item by analyzing seven roadway VE case studies that was recently performed. Performance evaluation item is expected to be more active in the event that more roadway VE case study in relation to the roadway facilities improvement in the future are researched and analyzed and this result actually presents the various applicability of VE in the maintenance phase.

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