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EVALUATION OF PMS IN KOREA USING PCM METHOD

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ABSTRACT

As the backbone of national transportation, sharing more than 90% of all domestic transportation, roads in Korea have been extended drastically in their lengths since highway construction was triggered in the early 1970s. Among various road components, pavement has a direct impact on the ride comfort of road users. As the road pavement is damaged by vehicle traffic and environmental impact over time, proper maintenance is being carried out to keep the pavement in good condition by investing regular budget. For national highways in Korea, in order to manage road pavement, Pavement Management System(PMS) has been operated by introducing various inspection equipment and analysis system from foreign countries since 1987.

However, although PMS has been operated for 20 years in Korea, there has been nothing for overall evaluation of its effect. If some project lasted for a long time, it needs to improve the system by evaluating it comprehensively and carrying out amelioration, examining whether or not to provide proper data continuously and to be adapted suitably according to circumstance, etc. Through such evaluation, project is advanced and it can be clear to use budget to various participants.

This paper reviewed projects evaluation methods and foreign instances to evaluate the PMS in Korea. As a result of the review, PCM(Project Cycle Management) method was selected. PCM method is a method to evaluate comprehensively certain project using 5 items(relevance, effectiveness, efficiency, impact, and sustainability) and applied to PMS evaluation. In PCM method, Project Design Matrix should be constructed using Objectively Verifiable Indicators. A PDM for the PMS evaluation was constructed and OVIs is going to be complemented. We believe that PCM method is a very useful tool to evaluate comprehensively and enhance gradually the PMS in Korea.

KEYWORDS

Pavement Management System, Project Cycle Management, Project Design Matrix, Objective Verifiable Indicators

1. INTRODUCTION

With the construction of highways in the early 1970s, the expansion of roads in Korea has dramatically increased. The increasing expansion of road management also brought about the increase in the scale and cost of pave management system, calling for the needs for criteria for decision-making processes and efficient use of limited budgets in maintenance.

In light of the foregoing circumstance, road survey equipment and analysis systems have been brought in from overseas and the pavement management system (PMS) has been in operation since 1987 for the pavement management of national highways. The benefits of PMS have been shown in numerous aspects: it has ensured the enhancement of system quality and reliability as well as provided clear evidence for the results of fund inflow for various stakeholders, such as the fund sponsors and supporters.

However, despite the twenty years of operation of the system in national highways, there has been no program to evaluate any potential problems of the system and whether the pavement management has been conducted in a systematic and reasonable manner. It is considered essential to conduct evaluation of the PMS on such areas as whether it is flexibly meeting the changes in the environment and surrounding conditions and whether it is fulfilling the original objectives so that the evaluation may consequently result in improvements in the system.

In light of the foregoing, this paper first surveys PMS evaluation cases and project evaluation methodologies of overseas. In order to establish a more reasonable and systematic pavement management system, this paper intends to provide the foundational platform for PSM evaluation by setting an appropriate evaluation methodology.

2. OVERSEAS PMS EVALUATION CASES

In many countries, pavement management system has been applied to the maintenance of pavement, and researches on the subject of PMS have been actively carried out; however, few cases cite any evaluation on the effectiveness of PMS. Some of the findings on the foreign cases of PSM effectiveness evaluation are as follows:

1) Hudson et al. (2001)

Hudson et al. compared the average rate of deterioration of the road network as a whole in the State of Arizona, USA, for two periods before and after the installation of PMS and concluded that the rate is slower after PMS. Coupled with the finding that the initial condition of new pavements was slightly better in the after period, they concluded that the installation of the PMS extended the life of pavement by 2.0 years in Arizona. This life extension was then converted into monetary value by taking account of the asset value of the whole road network. Also, they attempted to compute the amount of user cost savings accrued from the improvement of road conditions. They attributed these benefits entirely to the introduction of PMS without examining the causal linkages with various outputs of PMS and possible other factors such as pavement budget and traffic volumes.

This research conducted in Arizona attempted to prove the effectiveness of the cost expended on establishment and operation of PMS by comparing the cost of PMS establishment and operation with the benefits arising from the improved road condition. This research methodology was limited to evaluating the cost-effectiveness of PMS.

2) Falls et al. [2]

Falls et al. reported the results of case studies that are related to the quantification of costs and benefits of PMS using longitudinal (i.e., historical) data. Case studies from the State of Alberta, Canada, the average network pavement condition in terms of

Pavement Quality Index (PQI) was reported to have improved by 7.9% between two five-year periods before and after the installation of PMS, which was attributed to the PMS by noting that rehabilitation funds remained constant in these years. This improvement was converted to the savings in agency costs and user costs in a similar manner to the Arizona study. The approach adopted in this case study is almost the same as that of the Arizona study, and therefore the same observation can be made regarding its validity and applicability. Additionally, there is no mention about traffic volumes or ESAL's in this study.

This research also aimed at evaluating the effectiveness of the cost of PMS establishment and operation in a quantitative measure.

(3) Smadi (2004)

Smadi conducted a before-and-after analysis in a unique manner. His analysis is based on an understanding of the role of PMS that it is a tool to help decision makers make more cost effective decisions and not all the recommendations from the PMS are implemented. Following this, he computed the "implementation gap" that is the difference in average network conditions in terms of PCI between that predicted to be achieved by applying the best strategy recommended by the PMS and that resulted from the actual maintenance program. Given the known average PCI value of the network at the beginning of a selected five-year period after the start of PMS and the amount of maintenance budget during this period, the PCI value at the end of this period under the ideal scenario was computed using the PMS. Also, with the known actual maintenance program during this period, the "actual" PCI value at the end of the analysis period was predicted using the deterioration prediction models of PMS. The implementation gap was then computed as the difference in these PCI values at the end of the analysis period. Similar calculation of the gap was done for another five-year period before PMS, with known initial PCI value at the beginning of the period and the actual maintenance program during the period including the expenditures. This gap represents the maximum potential benefit of PMS for this period. He presented the difference of these two gaps as the benefit of PMS recognizing that this maximum cannot be achieved given the aforementioned role of the PMS. He further translated the gain of PMS in terms of PCI value into a monetary value. The major inputs of this analysis are network condition data at the beginning of two five-year periods and actual maintenance programs including their expenditures for the two periods. This analysis did not use the data on actual network conditions for both periods. Rather, it predicted "actual" network conditions using the aforementioned input data and the PMS, which were said to be in good agreement with the actual conditions.

This paper tried to translate the difference on the road surface condition in PMS establishment and implementation into cost figure and thereby demonstrate the effectiveness of PMS. This paper, however, is limited to the effectiveness and fails to discuss other points such as grasping the current condition of road surfaces and future predictions.

Pavement Management System refers to a system which involves comprehensive systemization of pavement management in order to ensure serviceability of pavement. This entails surveys on deterioration on pavement, deterioration prediction, analysis of economical efficiency and optimization of benefits and minimization of costs. The researches conducted in other countries on the evaluation of PMS have been limited to cost-effectiveness based on the deterioration rates of pre- and post-PMS and to rationality analysis of the cost required for establishing and operation PMS. As the need for having PMS in place seems obvious, an evaluation method that is more comprehensive and covers beyond economic feasibility is now necessary.

3. SELECTING EVALUATION METHODOLOGY

Little efforts have been made both in Korea and internationally to evaluate the effectiveness of PMS. Those existing studies on PMS effectiveness rarely encompass evaluation in comprehensive aspects. As an effort to meet multi-faceted needs regarding pavement management of road authorities, it is essential to create a platform capable to handle the

PMS operation on a comprehensive basis in order to be able to conduct a meaningful evaluation of PMS. By doing so, it would be possible to bring about qualitative enhancement in PMS and further enhance transparency of the project by ensuring the inflow of funds to show its results, along with the qualitative enhancement of other projects. Therefore, it is concluded that it would be reasonable to implement an evaluation methodology which considers multi aspects of a project for PMS evaluation, and a decision has been made to utilize the Project Cycle Management (PCM) developed by the Foundation for Advanced Studies on International Development (FASID) [1, 3, 4].

Project Cycle Management (PCM) is based around a project cycle to ensure that all aspects of projects are considered in its operation and management. It incorporates Project Design Matrix (PDM) in order to manage a project cycle of planning, implementation, and evaluation effectively and consistently. PDM is a logically designed matrix that defines the logical correlation of project purpose, output, and indices to verify such output, activities and input involved in a project management.

The first step of PCM is about analyzing problems that entail the introduction of a project. In the second step, an objective tree is created with a focus on providing descriptive solutions for problems collected at the problem tree. The prepared objective tree functions as a guidebook for designing the project. The third stage is about post-evaluation of the project in which it is verified whether the PDM prepared in an optimal condition at the beginning accurately reflects the current project structure, and upon discovering any incongruities, the PDM is modified according to such discovery. Finally, following the preparation of the PDM for evaluation, an evaluation is conducted based on five evaluation criteria of OECD/DAC which serve as a comprehensive basis for post-evaluations for complex and multi-dimensional projects such as PMS; the five criteria include relevance, effectiveness, efficiency, impact, and sustainability. In other words, the project evaluation method based on PCM means a systematic evaluation method integrating PDM and the five evaluation criteria.

4. PROJECT DESIGN MATRIX(PDM)

A project evaluation based on PCM analyzes problems and objectives, and produces a project design matrix in order to evaluate the entire project with the PDM and five criteria, and provide suggestions for improvements.

4.1. Analysis of Problems

The central problem that road authorities were faced with in managing the national road network of Korea before the introduction of PMS was the lack of a rational mechanism with which to estimate objectively the needs for maintenance and repair (M&R) of roads at national and regional levels. Coupled with insufficient national general budget, this led to insufficient budget allocation for road maintenance in relative to, for example, new construction of roads. Since information regarding the true needs for M&R of different road classes and regions was not available, the allocation of the distributed maintenance budget, which is already insufficient, over these budgeting items was biased at the least and often exacerbated the shortage of budget.

4.2. Analysis of Objectives

To alleviate the aforementioned problems, the introduction/development of PMS in Korea was conceived in around 1987. The core objective of the PMS was deemed to establish a mechanism with which to estimate the M&R needs of roads at national and regional levels. A mechanism for justifying budget request for M&R and rationalizing the allocation and use of the distributed M&R budget was called for. With such a mechanism in place conditions of the national road network was deemed to be improved and accountability increased.

Crucial to the development of such a mechanism was the availability of objective information on M&R needs of road network as a whole and their distribution over different road classes and regions. This in turn entails systematic condition survey of road network and the development of computerized road databank as well as installation of PMS software. The whole process must be initiated with the development of human resource and IT infrastructure and fitting of survey equipments.

Narrative Summary	Objectively Verifyable Indicators	Means of Verification	Important Assumptions
Overall Goal Improve road condition by appropriate maintenance /Increase accountability	**1a**.Overall road network condition **1b**. Satisfaction of taxpayers		
Project Purpose Rationalize maintenance budget allocation /Rationalize use of maintenance budget /Increase road maintenance budget	**2a**. Money saved by use of PMS **2b.** Cost effectiveness of maintenance works **2c.** Budget for road maintenance		Efficiencies of maintenance works implementation and contracting have not deteriorated.
Outputs Conduct systematic road condition survey /Devop road databank /Develop objective information of road maintenance needs	**3a**. Road length surveyed each year **3b.** Data stored in road databank and updated each year **3c**. Proper usage of a PMS software for strategy, program and project level analyses		National budget reasonably sufficient /Interference of politicians not excessive
Activities Develop institutional structure / Develop human resource /Develop IT infrastructure /Install PMS software /Install survey instruments	**Inputs** **4a. Initial costs:**Establishment of an institutional structure for implementing PMS /Assigning staff to develop and operate PMS /Budget for developing IT infrastructure, purchasing softwares and survey equipments and staff training **4b. Running costs:**Staff salary /Maintenance costs of survey equipments, IT infrastructure and PMS softawres /Costs of outsoureing		Trained staff continue to work in PMS /Commitment of MOTC management remains sufficient **Preconditions** Budget and technical assistance for developing PMS secured.

Figure 1. Project Design Matrix(PDM) for Evaluation

4.3. Constructing PDM

PDM summarizes a project in terms of five project elements: Inputs, Activities, Outputs, Project Purpose and Overall Goal.

It has, as an integral part of the matrix, Important Assumptions and Preconditions that are necessary to be fulfilled in order for the project to make progress toward achieving its purpose and goal. This structure is very powerful in clearly showing the logical relationships between the five project elements of a project. It can also serve as a checklist for identifying Objectively Verifiable Indicators (OVIs) and Means of Verification that measures the extent of the achievement of each project element. Examination of OVIs should constitute the basis for objective and rigorous monitoring and evaluation.

PDM should have been constructed at the design phase of a project in order to manage the project in its entirety. However, in such cases like Korean PMS, it is useful to construct a PDM in retrospect as a framework for ex-post evaluation.

In constructing PDM for evaluation of PMS in Korea, it is crucial to create OVIs which serves as a verification tool for measuring the attainability of the five criteria by the project. The current version of OVIs is showed as Fig. 1, and it will be

continually updated throughout the evaluation of PMS as needed. Furthermore, it is expected that a comprehensive evaluation of PMS be conducted through the five criteria of relevance, effectiveness, efficiency, impact, and sustainability used in the PCM evaluation.

5. CONCLUSIONS

During the past twenty years, PMS has been in operation in Korea, no evaluation has been conducted on the effectiveness of the system in operation in such areas as whether any potential problems exist in the system and whether the pavement management is conducted in a systematic and reasonable way. It is thus deemed necessary to conduct evaluations on the system whether it is flexible enough in responding to various changes in the surrounding environment and whether it is fulfilling the original objective so that any issues may brought up for improvement in the system.

In light of such need, this paper has surveyed PMS evaluation cases in the international context and conducted research on evaluation methodology for the purpose of undertaking evaluations on the PMS in Korea. In most cases, the PMS evaluations conducted overseas were limited to the cost analysis of pre and post PMS. The need for the implementation of PMS is no longer contested, and thus an evaluation method that covers beyond economic feasibility is called for. Thus, it is intended in this paper to conduct an evaluation of PMS via a Project Cycle Management which allows considering all aspects of a project.

Project Cycle Management (PCM) is based around a project cycle to ensure that all aspects of projects are considered in its operation and management. It incorporates Project Design Matrix (PDM) in order to manage a project cycle of planning, implementation, and evaluation effectively and consistently. PDM is a logically designed matrix that defines the logical correlation of project purpose, output, and indices to verify such output, activities and input involved in a project management. The PCM entails evaluation of projects through analysis of problems, objective tree and PDM, and five evaluation criteria of OECD/DAC.

The PDM for PMS evaluation has been completed. In writing the PDM, it is also crucial to create OVIs which serves as a verification tool for measuring the attainability of overall goal, project purpose which are identified by analysis of problems and objective tree. The OVIs will be continually updated, and a comprehensive evaluation of PMS will likely be conducted using the five evaluation criteria of relevance, effectiveness, efficiency, impact, and sustainability by integrating PDM and the five evaluation criteria. The PCM is expected to serve an important role in a comprehensive evaluation of PMS in Korea and thereby contribute to the continuous improvement of the PMS.

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