DEVELOPMENT OF PERFORMANCE MEASURES IN ASSET MANAGERMENT FOR BRIDGE MANAGEMENT IN KOREA

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ABSTRACT: Bridges are exposed to very severe environment and experience, as service life increased, elevated traffic load and traffic flow, in addition to natural disasters. In comparing to other road structures, bridges may cause more significant damage, such as human-involved accidents, to the society in the event of collapse. A certain level of service shall be necessarily secured to assure the minimum safety of users. The cost for manage and preserve bridges will increase gradually and more restrictions will be loaded to efficiently distribute the limited resources, such as monetary budget and human resource etc. In order to enhance performance and serviceability of bridges with the limited resource, asset management technique has been applied into the bridge management system, which capitalizes the road infrastructures including bridges and assess them in accordance with the government finance report. In the application of asset management, there must be a tool for assess the performance of bridges and this study introduces the basic information on the definition and role of performance measures for asset management for bridges. This research suggests future development direction of performance measure for asset management for bridges in Korea.

Keywords: Bridges Management; Asset Management; Assessment of Bridge Performance; Performance Measure

1. INTRODUCTION

The goal of maintenance of bridges and other infrastructures is to minimize the cost preserving condition and to maximize the performance of them as expected from the design. Bridge is one of the most important civil infrastructures and it is usually across river, valley and seawater fronts. Therefore bridges are exposed against most severe environment such as natural disasters including typhoon, earthquake, flood and etc. There have been many of bridge collapse accidents with variety of different reasons all over the world, for example, I-35W Saint Anthony Falls Bridge in US in 2007 and Arkansas River Bridge in 2002. In Korea, there was a big man-made disaster on Han River, the Seong-Su Grand Bridge collapse in 1994 and New Haeng-Ju Grand Bridge in 1992 which collapsed during construction. Majority of these bridge collapse accidents occurred because of jointed reasons of improper maintenance/repair works and insufficient engineering mind and strategy. After these series of the accidents engineers have started to place more effort on maintaining good health and service quality of bridges.

In addition, recently as vehicles become bigger and heavier, bridges experience greater loading conditions. Bridges can also cause more serious effects onto the social life of all users, such as direct physical damage, and economic degradations.

In order to manage bridges in Korea in a more systematic scheme, Bridge Management System (BMS) in Korea had undergone since 1996. The BMS system was merged into Highway Management System (HMS) in 2003 and merged again into the infrastructure management system in Construction Continuous Acquisition and Life-cycle Support (CALS) System in 2005 [1, 2].

In order to maintain good conditions of infrastructures, great amount of cost should be necessary. Direct cost for maintenance of civil infrastructures in Korea in 2001 was about 210 million US dollars [1, 2]. As seen in Figure 1, among the cost about 50% was for road and transportation facilities, and about 25% was for highway bridges, respectively. As number of bridges has dramatically increased since 1970s in Korea the number of deteriorated bridges will also increase with increased amount of maintenance cost.

The national invoice of infrastructure in Korea is about 1,200 billion US dollars and budget investment for the new construction of infrastructure in 2007 was about 57 billion US dollars. Greater than 25% of the investment will be typically needed for the quality maintenance so that about 15 billion US dollar should be spent. In foreign countries, about 1% of national infrastructure invoice is used for the maintenance, that means about 12 billion US dollars may be requested. However, in Korea only about 1/3 of the amount, which is about only 8% of budget for new construction investment, is spent for the purposes of infrastructure maintenance. This amount of budget distribution is far shorter than the amount for a good quality maintenance of infrastructures in Korea as corresponding to the Special Law for Infrastructure Safety Management. Table 1 addresses the maintenance

cost for different types of civil infrastructures in the city of Seoul. As indicated in Table 1, the maintenance cost increases rapidly and the cost for bridges takes greatest portion of the cost.

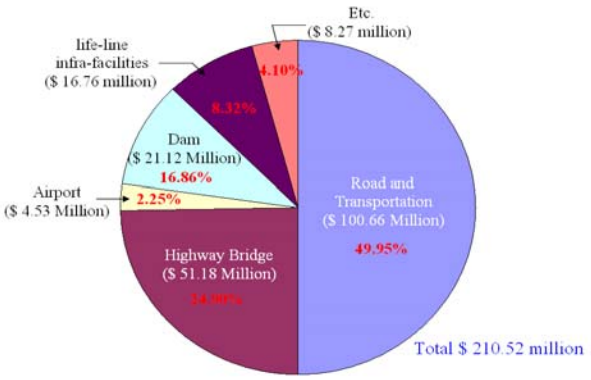

Figure 1. Direct Maintenance Cost for Civil Infrastructures in Korea

Table 1. Maintenance Costs for Different Structure Types in Seoul Korea during 1996-2000 (million US dollars)

Year	1996	1997	1998	1999	2000	Sum (%)
Bridges	19.3	27.7	46.1	28.4	19.0	140.4 (87.5)
Tunnels	0.1	0.9	0.5	1.1	1.7	4.3 (2.6)
Safety Systems	0.4	6.3	3.4	2.9	0.2	13.3 (8.3)
Others	0.5	0.5	1.2	0.3	0.3	2.6 (1.6)

Therefore, with the limited budget resource, more effective maintenance system and decision making tools for the budget distribution based on engineering database is necessary. In other countries, monetary values are given to civil infrastructures and they are registered into the national accounting book. In USA, Statement 34 in Government Accounting Standards Boards (GASB) requested to consider infrastructures as a national asset and manage them accordingly. Currently Korea Institute of Construction and Technology (KICT) and other institutes are involved in developing the asset management system for bridges and other infrastructures. This research deals specifically a methodology for measuring performance of bridges in Korea, which takes most important role in the asset management for bridges.

2. ASSET MANAGEMENT FOR BRIDGES IN KOREA

The cost for management and preservation of bridges will increase gradually and more restrictions will be loaded to efficiently distribute the limited resources, such as monetary budget and human resource etc. Therefore, asset management technology has been introduced for the purpose of effective budget and human resource distribution.

Asset management is a strategic framework for improving resource allocation and utilization decisions, which reflects a comprehensive view of system management and performance. The primary important principles of asset management, from which performance measure criteria are derived, are as follows [2] and Figure 2 shows basic procedures of asset management technology:

• **Policy-Driven:** Decisions for resource allocation and utilization should be based on a well-defined and explicitly stated set of policy goals and objectives, which typically are tied to economic, community, and environmental goals.

• **Performance-Based:** Objectives for policy are translated into system performance measures that are used for both day-to-day and strategic management.

• **Analysis of Options and Tradeoffs:** Resource allocation decisions within and across different assets, programs, and types of investments are based on understanding how different allocations will affect the achievement of policy objectives and what the best options to consider are. The limitations posed by realistic funding constraints also must be reflected in the range of options and tradeoffs considered.

• **Decisions Based on Quality Information:** The advantages of different options with respect to an agency's policy goals are evaluated using credible and current data.

• **Monitoring to Provide Clear Accountability and Feedback:** Results from performance are routinely monitored and reported for both impacts and effectiveness. Feedback on actual performance can influence agency's goals and objectives, as well as future resource allocation and use decisions.

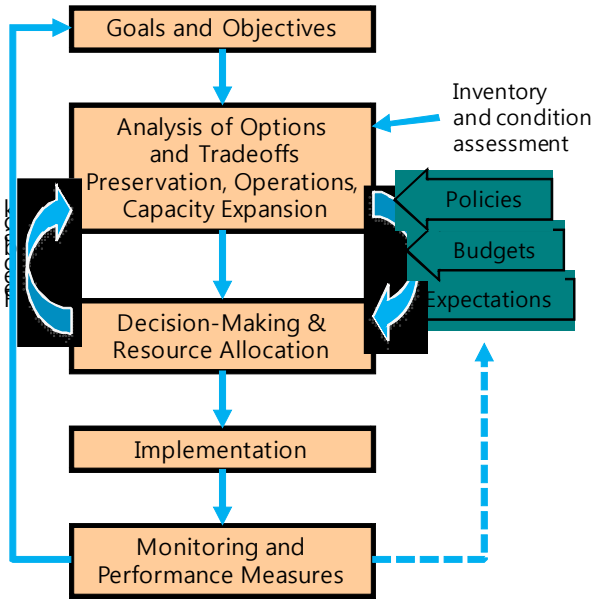

Figure 2. Basic Procedures of Asset Management for Bridges

In Korea these principles, however, are not familiar yet and the introduction of asset management system for civil infrastructures is currently being studied. Asset management techniques in other countries such as Canada, New Zealand, and Japan are based on the similar principal foundations and their applications are also based on the indistinguishable goals [3].

3. PERFORMACE MEASUREMENT FOR BRIDGES

Performance measurement can be used as a tool for monitoring the progress toward to a result or goal. Simultaneously, performance measurement may provide good information to quality decision makings. Transportation Research Board (TRB) in US defined the performance measures as indicators of work performed and results achieved [4]. The performance measures can help forecast and track the impacts of budget distribution and decisions made, maintenance, and operations improvements. In addition, it also help monitor the condition of system assets and gauge the management and service delivery. Since asset management for infrastructures including bridges requires a performance-based system, it is important to determine how to collect and measure the performance and how to utilize the obtained data in the decision making procedures and analysis of the effects. Implementation of these procedures is key criteria for successful asset management. Performance measure takes important roles for each basic procedure of asset management, shown in Figure 2. TRP Report 551 defines its role as follows [4]: For policy objectives, as the practical expression of policy objectives that reflect customer expectations and realistic funding targets; For analysis of options and tradeoffs, as a guidance to procedures and criteria used at key decision points in the management functions. For example, performance targets provide a consistent framework for evaluating options in planning, defining, and valuing prioritization criteria in programming; guiding tradeoff analyses in resource allocation; and influencing priorities in delivery of projects and services. It also serve as the basis for system monitoring to obtain indications of system performance resulting from system preservation, transportation system management and operation, and capacity expansion investments. For feedback, it helps as signals of change through feedback to policy formulation.

4. QUATIFICATION AND EMBODIMENT OF PERFORMANCE MEASURE FOR BRIDGES IN KOREA

There must be a variety of performance measures for transportation infrastructures and different performance measures take their own responsibility for basic principles of asset management. Such primary categories of performance measure are defined within preservation of assets, mobility and accessibility, operations and maintenance, safety, environmental impacts, economic development, social impacts, security and etc [4, 5]. Each country where utilize the asset management system for effective infrastructure management may have different types of performance measure and customize them incorporating their own situations. In Korea, the performance measure should be customized reflecting the transportation circumstances. There has not been a developed set of performance measure in Korea yet but most important issue may include average daily traffic, conditions states, structural capacity, functional capacity, exposure conditions, and deterioration rate with respect to different types of bridges. As explained in the introduction in this research paper, there is greatly sufficient amount of available information on bridge and other infrastructures regarding current condition, repair/rehabilitation history, maintenance cost and other invoice data that are obtained through BMS, HMS, and Construction CALS etc. This information may be more specifically categorized and quantified in a form of digitized database. Then the data can be applied as a performance measure to help develop a level of service of target bridges, an analysis procedure for tradeoffs, and determine future cost for maintenance.

5. CONCLUSIONS

Bridges may require more intense monitoring and maintenance among all civil infrastructures because of their exposed conditions and roles as an infrastructure. In addition, as service life increased, elevated traffic load and traffic flow may also hinder keep safe and healthy conditions. Therefore, a certain level of service shall be necessarily secured to assure the minimum safety of users. The cost for management and preservation of bridges will increase gradually and more restrictions will be loaded to efficiently distribute the limited resources, such as monetary budget and human resource etc. As asset management technology is introduced for effective resource allocation and maintaining balanced performance along the networks, the importance of performance measure was highlighted in the research herein. The research also suggests future development direction of performance measure for asset management for bridges in Korea. There are sufficient available information on bridges regarding current condition, repair/rehabilitation history, maintenance cost and other invoice data that are obtained through infrastructure management systems in Korea so far. This information can be successfully utilized in the development of appropriate performance measures to help develop a level of service of target bridges and an analysis procedure for tradeoffs, and to help determine future cost for maintenance in Korea.

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