INFRASTRUCTURE ASSET MANAGEMENT PRACTICES IN THE U.S., AUSTRALIA, AND KOREA

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ABSTRACT: This paper discusses cases of infrastructure asset management in the U.S., Canada, and Australia and investigates infrastructure management in Korea in order to set the direction for the asset management improvement. The definitions of infrastructure asset management from various entities are introduced and implementation framework and organizational structures are described. The investigation on Korean public asset management practices finds the strong and weak points and defines the requirements and considerations to further improve the current practices. This paper will assist adopting infrastructure asset management in Korea and provide guide for the infrastructure maintenance.

Keywords: Infrastructure Asset Management, Facility Management

1. INTRODUCTION

In the case of developed countries, public facilities, which were built in the 1950s to 1960s after the Second World War, have dilapidated and are increasing their maintenance and management costs, accounting for 40% of the total construction budget. This situation calls for countermeasures, the governments' enhanced accountability for transparent management of collected taxes driven by the people's bolstered awareness of social problems, and the public's increased needs for the governments' public services. Thus, since the 1990s, an asset management system has been increasingly introduced [1].

Asset management aims to strategically plan for the maintenance and management of facilities, maximize the level of service (LOS), establish and implement an optimum plan for repair, reinforcement and remodeling, optimize budgets and expenditures, and devise a long-term asset management plan [2]. The system has yet to be activated in Korea; however, in the U.S., Australia and some other developed nations, researches are being conducted to effectively implement the system from long-term perspectives in order to support optimum maintenance and management activities following a change in the performance of related public facilities. Also, related systems and policies are being developed according to various situations of each nation.

In Korea, in the 1970s to 1980s, driven by a rapid economic development, a vast number of social infrastructure facilities were constructed, and in light of developed nations' examples, within the next ten years, it will be self-evident for the maintenance and management of such facilities to be raised as a key social issue[3]. However, in Korea, the maintenance and management of such public facilities are conducted under the Special Act on Safety Management (Act Nos. 8967 and 2008, "the Special Act"), and this issue is not handled from the perspectives of policy strategies. Thus, the technology and information are lacking to develop the IT system for managing the history of such facilities, as well as related manuals and criteria for proactive maintenance and management, and also efforts to establish/implement plans for maintenance and reinforcement of such facilities are lacking [4]. With an enhanced awareness of the seriousness of these problems, to ensure a systematic and scientific approach to the maintenance and management of public facilities, Korea Infrastructure Safety and Technology Corporation (KISTEC)'s integrated facility information system, or Korea Expressway Corporation's Pavement Management System (PMS) and Bridge Management System (BMS) are being utilized. However, the current level of such systems is nothing but databases to know the status, and has yet to be upgraded in order to support important decision making on methods, timing, etc. [5].

Thus, in this paper, in order to introduce efficient infrastructure asset management systems to Korea, those systems of U.S., Australia, etc. and the most representative related systems of Korea were examined and compared. On this basis, a direction for future development was discussed.

2. INFRASTRUCTURE ASSET MANAGEMENT SYSTEM

2.1 Asset Management Strategy

Where there was less demand for the maintenance and management of facilities, related techniques focused on reactive management. This involved simply investigating into the status of facilities, and repairing and reinforcing them according to the results. As such, since such demand is recently increasing, and awareness for more cost-efficient methods and strategies has been enhanced, the trend has shifted to proactive management. Proactive management is to utilize status investigation and evaluation results and historical data, forecast the degree of future dilapidation of facilities, consider necessary budgets, and establish a long-term plan. Also, according to the types of facilities, management is divided into fix-on-failure management and preventive management. The fix-on-failure management is opted when a facility's faults or collapse does not directly affect safety, and creates small economic losses; this method applies to replacement of street lamps, painting of road signs, etc. In the meantime, the preventive management method must be applied to items such as structural members of bridges which directly affect safety so as to necessitate the repair and replacement of related members of facilities even before their service life ends [6]. It is necessary to conceive methods designed to devise appropriate management strategies, systemize plans for managing facilities, and ensure an optimum effect. Table 1 shows a summary of various strategies for maintenance and management.

Table 1. Strategies for Maintenance and Management

Method	Strategy	Characteristics
According to types of facilities	Fix-on-failure	Repair and replace after the occurrence of faults Apply to facilities that do not directly affect safety
	Preventive	Before faults occur and the service life ends, repair or Apply to facilities which are crucial for safety
According to methods	Reactive	Respond according to the status of facilities and budgets
	Proactive	Forecast the status of facilities, and budgets, and establish proactive plans

The infrastructure asset management points to a shift from years of a reactive, fix-on-failure management to a proactive preventive management geared towards considering the safety, usefulness and economy of facilities.

The definition of asset management is so diverse that it has over 300 varieties according to institutions, because managers of such facilities have their own diverse points to focus on. A general definition of asset management can be found in International Infrastructure Management Manual (IIMM); "Asset management, in order to retain the service level required of such assets, is to manage the assets the most cost-effectively and keep up the service level of the assets for present and future consumers"[2]. Also, according to British Standards Institute, asset management is defined to mean as a systematic, coordinated activity and work with which tangible assets, and their performance, risk and costs can be optimally managed via an organization's strategic plan from the perspectives of the life cycle of assets. Federal Highway Administration (FHWA), targeting only road assets, offers a narrow, specific definition. FHWA defines asset management as a systemic procedure by which tangible assets are maintained, managed and improved the most cost-efficiently [1]. This economic theory-based engineering principle offers tools for a more systematic and logical approach to decision making. Hence, they see asset management as providing a framework for establishing short-term and long-term plans.

Asset management is not necessarily independent of existing maintenance and management activities, technologies, and skills. It does not apply just to particular facilities, either. This characteristic may enable a development of diverse asset management systems, making it difficult to establish a consistent definition of asset management.

2.2 Core Asset Management

In many countries already adopted infrastructure asset management system, the following cases have preceded before asset management.

1) Due to enhanced growth in economy and population, social infrastructures sharply increased their load and use volume.
2) Thus, it is necessary to preserve, maintain and manage facilities.
3) As time passes, deteriorated facilities with lowered performance are sharply rising.
4) Due to a limited financial support of the government, competition for securing related budgets is harsh between the related agencies.
5) Due to insufficient budgets, it is difficult to implement preservation and maintenance programs and guarantee public safety and convenience.
6) The public's expectation for the quality of safety and environment is increasing.

Thus, asset management may vary according to each nation's economic and cultural situations, maintenance and management systems, financial support systems, and related agencies' supervisory management systems, among other factors. Thus, duties and goals of asset management may vary according to nations, related institutions, facilities and managers of such facilities. Table 2 shows key points of the most representative criteria of this field- IIMM and FHWA's road facility asset management system.

As such, asset management is not necessarily independent of existing maintenance and management activities, technologies or skills. It does not apply only to particular facilities. Asset management is a decision making process designed to gather and analyze the most reliable data on the maintenance and management of facilities through existing activities, utilize diverse

Table 2. Definition and Key Points of Asset Management

Category	IIMM (Australia/New Zealand)	FHWA (U.S.)
Definition	Asset management is to satisfy the service level required through the most cost-effective methods of managing assets for present and future consumers.	A systematic procedure designed to maintain, manage and improve tangible assets the most cost-effectively.
Key factors	Do you take a service life cycle approach? Do you have a long-term cost-efficient management strategy? Do you have a definition of services and performance? Do you predict the effect of demand management and facility investment on growth? Do you manage the risk of facility damage? Do you continue to utilize material resources? Do you continue to develop asset management process?	Respond to the status of facilities and budget situations Draw up proactive plan to predict the status of facilities and budget situations How is the status of current assets? What is the required level of services? Which assets are the most important? What is the best possible strategy for maintenance, management and improvement? What is the best possible strategy for raising long-term funds?

technologies including data management systems, and establish an optimum plan for cost-efficient maintenance and management of infrastructure assets. Also, an internal innovation mechanism must be ensured to keep up such development. In other words, asset management is not so much an individual tool for solving particular problems as a redesign of process and the implementer's organization, and a philosophical paradigm shift.

3. OVERSEAS ASSET MANAGEMENT

In various developed nations, in the 1990's, infrastructure asset management, a key issue, began to be introduced widely to answer the previous mentioned problems such as more infrastructures to manage with limited budget.

3.1 Asset Management in Australia

As Australia experienced an economic crisis in the 1980s, the government, driven by a strong innovation mindset, introduced a new concept of asset management to maintain and manage public facilities in 1986. In 1996, hence, an asset management guideline (first version) was drawn up. Asset management began with roads, and a state asset management council was established. From the 1990s, costs for maintenance and management of facilities were cut by 40%, and user satisfaction increased by 20%, marking a remarkable achievement. In the second half of the 1990s, public agencies led efforts to use established asset management methodologies, thereby developing an integrated asset management system [7]. Also, taking a life cycle approach to facilities, they aimed to develop long-term cost-efficient management strategies, present distinctive service and performance levels, report key asset management factors such as risk management of damage to facilities, and satisfy the most cost-efficient service levels through asset management for present and future customers. These guidelines were written into International Infrastructure Management Manual in 2001, and hence Australia has thus far continued efforts for improvement, leading the global technology of asset management. Its asset management is characterized by the government's strong leadership, a well- developed integrated asset management system, and the world's most cost-efficient management measures, thus satisfying service levels.

In the case of road infrastructure assets, Austroads, a council of Australia's and New Zealand's road traffic agencies, has crafted and implemented guidelines for road infrastructure asset management since 1994[8]. The council consists of Australia's federal government, six state governments, and two quasi-government road traffic agencies, federation of Australia's local governments, and New Zealand's Ministry of Transport. Austroad introduced an integrated asset management concept, and integrated an asset management framework designed to optimize results of decision making on policies and investment plans in order to make clear the needs of road managers, road users, and other related parties. In doing so, it focuses on incorporating all applicable asset management factors into a comprehensive plan framework.

In the case of New South Wales State, Roads and Traffic Authority (RTA) is responsible for managing key roads and bridges of road networks. RTA places the priority of budget execution and asset management on implementing the government policy, gathering data, supporting IT systems, improving safety geared towards minimizing risks, and securing the functional reliability of assets. To that end, in order to monitor road pavement, bridges, recorders, and auxiliary road facilities (signs and sign boards), RTA operates a road asset management system, a traffic asset information management system, a bridge information system, and a maintenance and management contract management system. The road asset management system, a decision-making support system, provides the criteria related to the status and faulty performance of assets, programs proposed by key transportation agencies, and other information useful to road managers. RTA evaluates whether the fixed-amount depreciation method and accounting principles are appropriate in appraising the value of assets, and also utilizes the information from these information systems in determining the priority of asset management.

3.2 Asset Management in the U.S.

The United States announced the Financial Act GASB34 in 1999 to determine the criteria for local governments' accounting and financial reports, requiring state governments and local governments to report their public assets in a bid to manage assets [9]. This Act aims to extend the service period of infrastructure assets, cut costs of maintenance and management, accurately evaluate the status of assets for effective budget planning, effectively use budgets, and ensure a high asset valuation when leasing or selling assets.

To manage road assets, FHWA and AASHTO have implemented guidelines for self-evaluation methods since 2002 to establish an asset management system and to allow each state to conduct asset management [10]. Under these guidelines, each state does not implements an independent asset management program of its own development, but operates its own program which is developed by combining its existing maintenance and management system with asset management factors. In recent years, they analyze asset management results of each state's traffic bureau, make Scan Reports, and strive to define success factors and introduce and disseminate efficient asset management systems [11].

In states like California, their road management department (CalTrans) develops indices reflecting levels of services suitable to their situations and utilizes them as an optimum level of road management criteria. This makes it possible for the department responsible for maintenance and management to compare budget levels versus performance and thus calculate and allot costs of maintenance and management according to scientific and rational procedures. The relations between the input budget level and the performance of public facilities can be defined, therefore enabling an establishment of long-term plans.

The Transportation Bureau of Florida conducts asset management as it monitors the mobility of human beings and goods, improves economic prosperity, defines a safe transportation system to preserve environments and communities, and places first priority on safety, preservation and volume. In order to maintain and manage facilities, infrastructures are divided into five categories, such as roads, roadsides, transportation services, drainage canals, and grass and pipeline network, and the Maintenance Rating Program (MRP) is utilized. In the case of transportation, the bureau appropriately utilizes the existing bridge management program – PONTIS – according to the state's characteristics and needs. As a trend of spending maintenance and management costs, the bureau is gradually shifting from the existing maintenance and management contract method to a road facility asset management contract method. In 2008, asset management contract ratio was set at 40%, and great efforts towards asset management were made.

4. ASSET MANAGEMENT STATUS KOREA

In Korea as well, following the collapse of Seongsu Bridge in October 1994, the Special Act on Safe Management of Facilities ("the special act") was enacted. Targeting road facilities, railroad facilities, harbor facilities, dams, buildings, river facilities, waterworks and sewage/wastes-related facilities, retaining walls, cut slopes, and key infrastructure facilities, the special act aims to conduct regular safety inspection and appropriate maintenance and management so as to prevent calamities and disasters, to increase the usefulness of facilities, therefore securing the public's safety, and boosting the people's welfare.

Under the special act, the asset management procedure consists of the flow under Figure 1; measurement of the status and performance of facilities, decision making, operation and management.

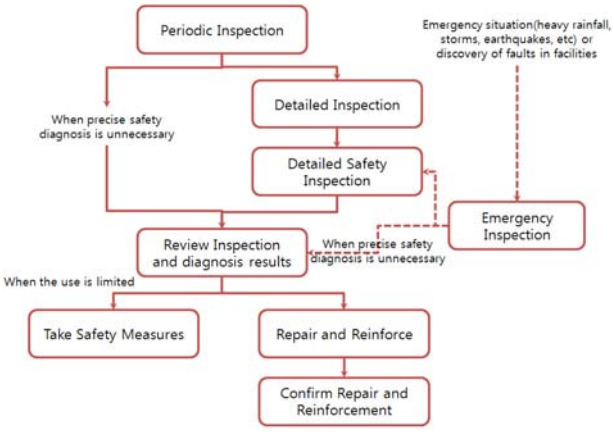

Figure 1. Maintenance and management procedure under the Specical Act on Safety Management

A step is missing during which long-term asset management strategy is established by considering policies and goals. Also, the five steps from E through to A evaluate the status of facilities, roughly grade them to evaluate whether they are good or bad, and conduct inspection and action, but this procedure does not consider the services and performance of facilities. Also, the steps do not reflect a life cycle approach, asset management factors such as appraisal of the value of facilities and budgets, therefore indicating a need to improve the criteria.

In the meantime, Korea Expressway Corporation (KEC), which is responsible for managing Korea's expressways, maintains road facilities for preserving road functions, convenience and safety, as well as recovers damaged facilities, improves dilapidated facilities, and adds facilities, thus extending the service life of facilities. Since the 1990s, KEC has developed and operated a range of maintenance and management information systems to effectively manage a total road length of 3,132km under the strategy of ensuring a scientific maintenance and management system. Of them, the Pavement Management System (PMS) has increasingly been applied to fields since 1997. PMS develops databases on road status by road line, design and construction factors, traffic volume, maintenance and repair results, pavement status, etc. But, problems such as investigation into the status of road facilities using a naked eye, failure to properly consider budgets reflecting the status of facilities, and securing and development of

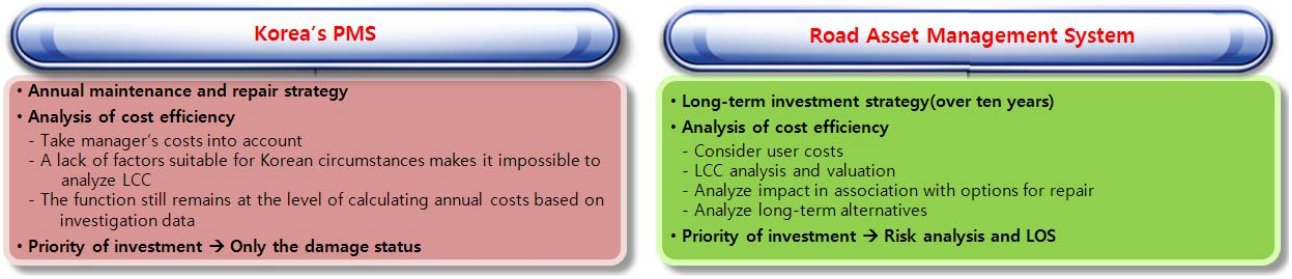

Figure 2. Road asset management system versus Korea's PMS status

data by depending on manpower, should be addressed. Also, in order to continuously facilitate the functions of the maintenance and management system, it is imperative to develop inspection equipment suitable for Korean situations and cost-efficiency analysis models. Figure 2 shows a comparison of road asset management systems of Korea and developed nations, pointing out certain limitations [12].

The Highway Bridge Management System (HBMS) was developed in 1999 to respond to a sharp increase in bridges on expressways, and afterwards, various data on bridges such as books on bridges, and repair and inspection results were computerized. Thus, KEC manages the status of bridges by five levels of member status, but the data have yet to be further accumulated and the HBMS is still being improved.

5. DEVELOPMENT OF ASSET MANAGEMENT FRAMEWORK

As we examined researches on and trends of developed nations' asset management systems, asset management varies according to such nations' social and cultural situations, and policies and supervision procedures. Thus, asset management cannot be defined uniformly, but when using the basic components of the system, it is possible to develop an appropriate asset management system.

Australia embraces a life cycle approach, a cost-efficient management strategy, a definition of LOS and performance monitoring, risk management with regard to asset damage, and sustainable use of material resources. Thus, Australia implements a system shown in Figure 3 of undergoing the process of strategy, listing, LOS, decision making, appraisal of value, and operation and management, placing first priority on reduced disasters, enhanced safety, and bolstered functional reliability and managing assets using a range of this information. The USA seeks to define the status of assets, and to answer key questions about the required LOS, the optimum O&M strategy, and the strategy of raising long-term funds. As shown in Figure 4, the USA defines the status of asset management system as a process of strategy, appraisal of value, decision making, operation and management, monitoring of status and performance, and raising of funds. FHWA is responsible for ensuring mobility, economic prosperity, environmental conservation and safe transportation systems – albeit slightly varying according to states – and for managing assets including auxiliary facilities in the vicinity of roads. To maintain and manage the existing PONTIS, etc., FHWA is striving to develop road systems designed for sharing the existing management system's data and databases, and a bridge performance management program under a long-term project. As such, it endeavors to develop a dilapidation prediction model.

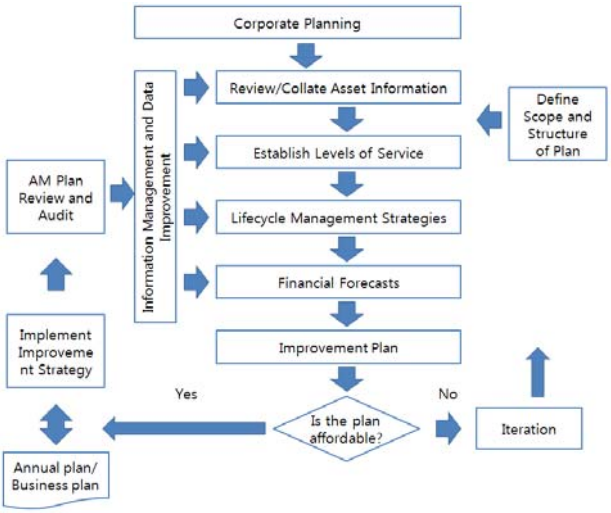

Figure 3. Australia's AM framework

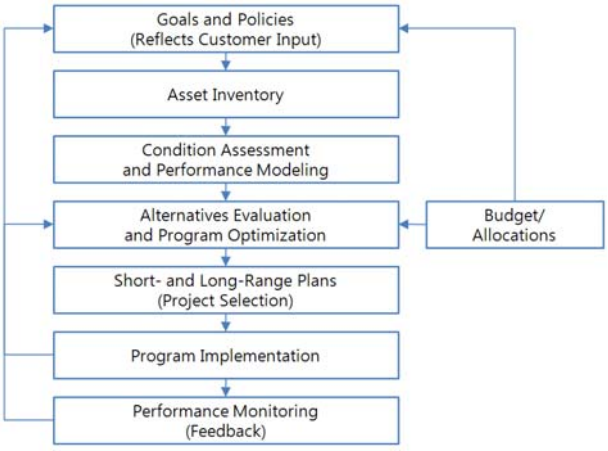

Figure 4. USA's AM framework

6. CONCLUSIONS

Requirements for the introduction of an asset management system to Korea are outlined as follows on the basis of an analysis of the domestic status, and developed nations' examples, and the asset management framework.

First, it is imperative to work out measures to evaluate the status of facilities and develop performance indices at the stage of defining the level of service. Due to a lack of appropriate methods of and guidelines on evaluating the status of public assets, it is necessary to work out management guidelines for the safety and usefulness of building structures. The existing status evaluation method designed to simply indicate good or bad class offers limited usefulness to the extent that it can only replace the existing items; thus it is more reasonable to evaluate an effective remaining service life. Also, due to absence of tools for supporting crucial decision making, it is necessary to evaluate cost efficiency of maintenance and management in association with years served, facilitate decision making in line with total life cycle costs, and standardize the determination and revision of long-term repair and reinforcement items and cycles. It is necessary to define the common service life of facilities in order to analyze a life cycle. This calls for a model equipped with functions of life cycle cost analysis, prediction of deterioration, and establishment of alternatives to repair and reinforcement methods. This calls for research to quantify the effects of repair and reinforcement, estimate costs in line with measures for maintenance and management, establish strategy for optimum maintenance and management, and estimate the future demand for maintenance and management.

Furthermore, it is imperative for the government and its related agencies to work out guidelines on facility asset management, and to pave the way for the introduction of asset management system in terms of policy.

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REFERENCES

[1] FHWA, “Asset Management Primer, Office of Asset Management”, *U. S. DOT*. 1999.

[2] INGENIUM, IPWEA, “International Infrastructure Management Manual-Version 3.0”, ISBN No:0-473-10685-X. 2006.

[3] Gong Jeong-sik, Park Gyeong-hun, and Yim Jong-gwon, “[Construction Technologies and Management Trends] Civil Engineering-On Maintenance and Management Technology Trends and Direction for Development,” *Korea Institute of Construction Engineering and Management Journal*, pp.22-31, 2007.

[4] Yi Myeong-gyu, Jin Nam-hui, and Jeong Sang-hwa (2006) “A Study on Necessity for Maintenance and Management of Road Facilities on the Basis of Asset Management Techniques,” *2006 Korean Society of Civil Engineers’ Regular Forum*, pp. 2338-2341.

[5] Chae Myung-jin, Lee Giu, Kim Jung-ryeol, and Cho Moon-young, “Development Measures for Asset Management through Analysis of Domestic and Overseas Examples of Social Infrastructure Asset Management,” *Korea Institute of Construction Engineering and Management Journal*, Vol. 10, No. 2, pp. 55-64, March 2009.

[6] Jeong Hyeong-seok, Chae Myung-jin, and Jin Gyeong-ho (2008) “Management of Infrastructure Assets,” Construction Management (Korea Institute of Construction Engineering and Management Journal), v.9, n.3, *Korea Institute of Construction Engineering and Management*, pp. 17~20.

[7] FHWA, "Transportation Asset Management in Australia, Canada, England and New Zealand", 2005.

[8] Austroads Inc. "Integrated Asset Management Guidelines for Road Networks", *Sydney NSW Australia*, 2002

[9] U.S.A. Governmental Accounting Standards Board Statement No. 34 1999.

[10] AASHTO "Transportation Asset Management Guide", *NCHRP Project* 20-24(11). 2002

[11] FHWA, "Best Practices in Transportation Asset Management", *U.S. Domestic Scan Program*, 2007.

[12] CERIK, Integrated Road Management System, Five Development Steps (final), May 2003.