THE DEVELOPMENT OF BUILDING MAINTENANCE SYSTEM (PBMS) FOR MONITORING REPAIRS & REPLACEMENT HISTORY IN PUBLIC FACILITY

Chun-Kyong Lee[1]*, Tae-Gab Jung[2], and Tae- Keun Park[3]

[1] *Technical Institute, LCCKOREA. CO., Ltd., Seoul, Korea*
[2] *Section of Water Technology , K-WATER, Daejeon, Korea*
[3] *Department of Architecture Engineering, Mokwon University, Daejeon, Korea*
** Corresponding author (bri1305@gmail.com)*

ABSTRACT: In Korea Water Resources Corporation (K-Water) has seen four problems rising in four aspects of property management of approximately 1,200 buildings scattered through put to country. To solve these, ground data for repair and replacement works to be conducted for prevention and will be prepared and building maintenance system (hereinafter referred to as PBMS) intended to record related repair and replacement work histories and calculate LCC of the related these items will be developed. To sum up, PBMS are expected to maximize efficiency in four aspects including establishing maintenance work plans for prevention, monitoring historical work, predicting future work to be occurred through the results of analysis of repair and replacement histories and LCC.

***Keywords**: Maintenance System, Priority Determination, Repair & Replacement, Public Facilities*

1. INTRODUCTION

With frequent replacement and repair requests, K-Water Public Corporation (K-Water hereinafter), dotted through more than 1,300 buildings of the country, need to establish a long-term maintenance plan and secure the appropriate budget. In addition, for a systematic approach to preventive maintenance and follow-up activities to cope with architectural deterioration, it is urgent to secure ground data by creating a database with relevant data and implementing a utilization system thereof.

There are the following inherent issues to consider in terms of the property management by K- Water. First, there are frequent repair and replacement requests because of degradation; second, maintenance tasks are conducted through an approach of post maintenance within a limited budget; third, there is no standard of judgment for maintenance; fourth, there is no database for repair and replacement activates; and finally fifth, there is no plan connecting existing repair and replacement results and preventive maintenance activities.

In order to solve such issues, this paper aims to develop an building maintenance system (PBMS hereinafter) that enables the prediction of future repair and replacement activities through the use of a DB with the ground data of performance profile and the LCC calculation of repair and replacement items, to conduct repair and replacement tasks through an approach aiming for preventive maintenance.

In addition, PBMS, the result of this study, would be the result of basic study for the development of a facility status assessment module that eventually allows the determination of repair and replacement priority through the use of repair and replacement profile and LCC analysis.

This study focuses on the office buildings and machinery buildings of K-water having pure architectural function (excluding water resource processing facilities such as dams) as a target Test-bed. Considering the need to target public facilities dotted around the country, developing a web-based system, to promote user convenience and enable real-time data sharing, would be appropriate.

2. THEORETICAL CONSIDERATIONS

2.1 Current Maintenance Status

K-Water, the target of Test-bed in this study, has more than 1,300 buildings throughout 7 areas and 64 sites, and the gross area of these buildings is 638,888m^2 excluding facilities such as dams. Moreover, 6 billion won, 9 billion won, and 10 billion won of new investment are planned for 2007, 2008, and 2009, respectively. While it has lots of buildings of significant scale, its manpower for performing facility maintenance is 17 personnel on the headquarters construction team and 3 personnel (belonging to construction development in corresponding regional head offices) allocated to 5 of the 7 regional head offices.

Considering that the K-Water has a significant in formational system, the information stage for the maintenance area seems to be initial stage of setup.

2.2 The Facility Breakdown Structure

The facility breakdown structure is the basic data of PBMS, and is comprised to enable the user to set management target facilities, and to input essential facility information on that basis. The facilities of K-Water can be classified into 4 classes, as follow:

- Class1 - Headquarters and 8 regional head offices
- Class2 - department/management unit group based on specific location
- Class3 - site unit (headquarters is classified by usage purpose, while regional head offices are by classified operation department/management unit)
- Class4 - building for facilitation activities (building/ rooms are classified by functionality)

2.3 The Repair and replacement Breakdown Structure

The repair and replacement items in K-Water are classified into 4 levels. The first level is divided into architecture (including civil engineering, electricity and communication, and machinery, in compliance with the standards of long-term repair planning in the Korean Building Act, but with consideration of the characteristics of K-Water.

The repair and replacement cycle for classified each items is a source data utilized in LCC analysis, and PBMS own criteria is setup by comparing the repair and replacement cycle of K-Water with that of educational facilities, army bases, residential facilities, and the Building Act.

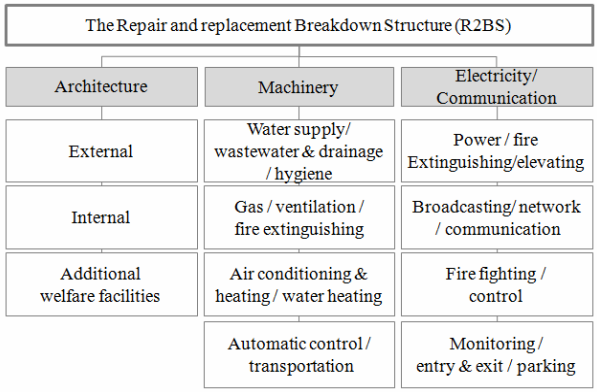

Fig. 1 Repair & replacement Breakdown Structure Tree

2.4 The Cost Breakdown Structure and Variables

In PBMS, the cost is divided into actual spending cost and future estimated cost, the former comprising repair and replacement cost, facility management cost, and energy cost, and the latter comprising initial investment cost, repair and replacement cost, and energy cost.

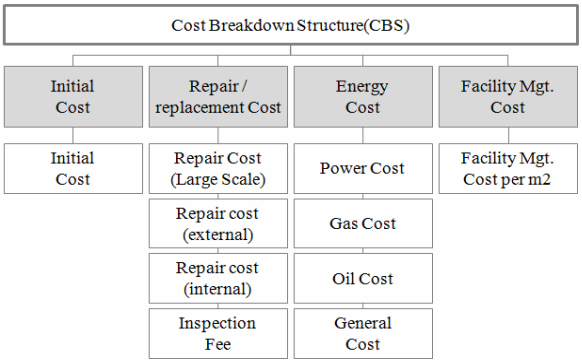

Fig. 2 The cost breakdown structure (CBS)

Variables for the respective items are as follows:

- Facility Information
  1) Cost Variable: Cost, Activity, Cost item
  2) Energy variable: Usage volume, Unit price
- Life Cycle Cost
  1) Summary LCC Variable: Base Point, Cost & Ratio
  2) Detailed LCC variable: Date & Period, Rate

3. THE BASIC DESIGN OF MAINTENANCE SYSTEM

3.1 System Overview

The PBMS is comprised of the following 4 modules. For this study, only VIS and LCC are developed.

- FIS - Facility Information System
- LCCS - Life Cycle Cost System
- FCAS - Facility Condition Analysis System
- EMSS - Estimate Management Support System

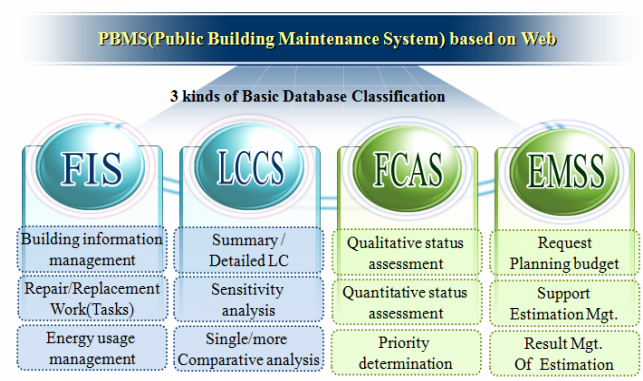

Fig. 2 Main Structure of PBMS

There are the distinctions from other maintenance system which has same tasks and purpose, as follow:

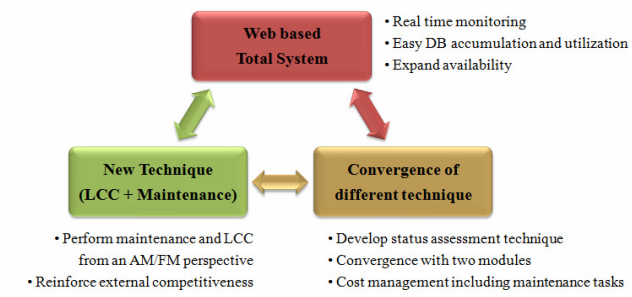

Fig. 3 Distinction from other maintenance system

3.2 Main structure and function

In the paper, the following structure is developed as a result of the 1st phase PBMS. As it is to be developed as a web-based system, web contents are to compose Home, and Admin is added for system management to allow setting facility classification and repair and replacement classification.

- Admin module - a basic system DB is composed, which includes facility classification, repair and re-placement classification, and unit price proposed in prior study, and the development of such DB is made for management.
- Facility information management module - Basic information management is the module used to manage actually performed repair and replacement and energy, along with basic facility information, which is developed to allow profile search and utilization through accumulated data.
- Life cycle cost module - the estimation module of life cycle cost is the LCC analysis, where summary LCC analysis for facility and detailed and combined analysis for repair and replacement items are available, on which basis it is developed to allow comparative analysis with single and combination type LCC analysis results.

3.3 Procedure of The maintenance system

In the paper, the following structure is developed as a result o analysis results. The facilities of K-Water can be classified into 4 classes, as follow:

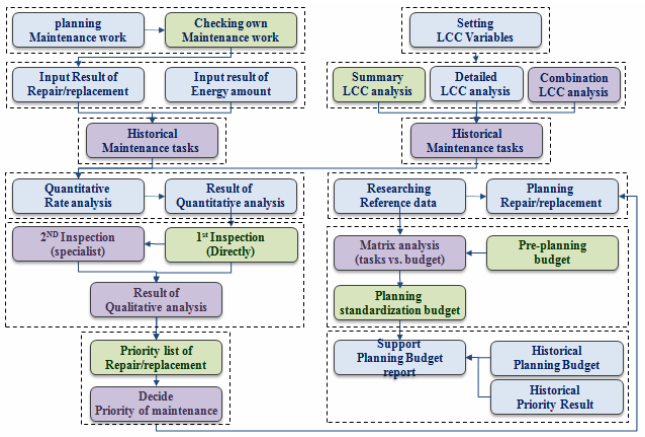

Fig. 4 Procedure of PBMS

4. IMPLEMENT THE PROTOTYPE OF THE MAINTENANCE SYSTEM

4.1 The main screen of system

To create a credible and viable mixed-use development site, By taking into account that the target includes numerous facilities that are scattered throughout the country, a map

of the nation is utilized to interlink the list of facilities in corresponding regions with basic information, and the menu is structured in three layers.

4.2 Admin-Facility classification-Facility information

Using the tree structure scheme on the left side of the screen, the settings can be derived by finding the facility from this tree structure. By aggregating basic information items for the facility in more detail, the information required for maintenance can be obtained with the basic information alone. In addition, file uploading function is attached to collect data regarding registration, licenses and certification matters, etc.

4.3 Admin-repair and replacement classification

The repair and replacement items in architecture, machinery, electricity and communication for each facility can be selected from more than 30,000 listed items, and managed. A scheme is prepared to select and manage these items from a tree diagram.

Fig. 5 Classification of repair & replacement

4.4 VIS-energy management

The screen is for the input of monthly usage volumes for electricity, gas, and oil, and for the management unit price. It is designed to be utilized for the calculation of energy usage volume per facility and its energy ratio. Moreover, with this first-level integrating and managing each unit can be prepared.

4.5 VIS-repair and replacement maintenance

The screen is for the input of the detailed contents regarding replace and replacement activities actually conducted, and is composed in a manner that allows the user to input and edit detailed items by dividing them into activity and cost information.

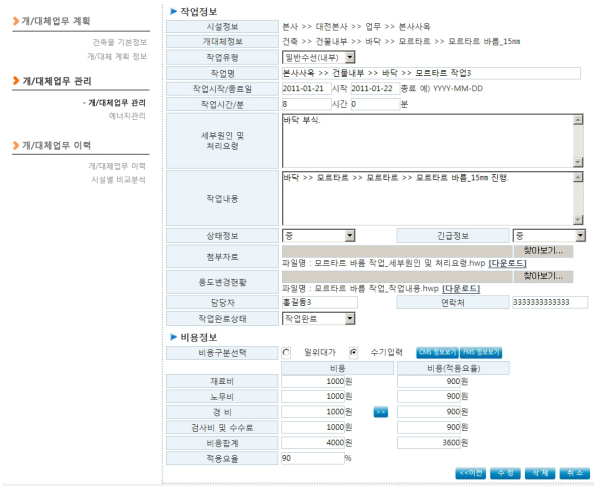

Fig. 6 Input/edit of repair and replacement task result

4.6 VIS-profile results of repair and replacement tasks

The screen is used to search the profile of the estimated cost for a certain repair and replacement activity by task facility, period, cost items, and specific maintenance activity.

4.7 VIS-facility comparative analysis

Fig. 7 View result of repair & replacement tasks

For a comparative analysis of three facilities, the estimated cost of repair and replacement can be compared by facility, repair and replacement item, and period. A visual

comparative analysis function with bar-graph and pie chart is available for the result value of the estimated cost.

4.8 LCCS-Setting Price variable

For LCC analysis, Setting price variable including inflation rate, net discount rate, deposit interest, is established in advance. The screen is for calculating net discount rate of certain year range and monitoring whole price variable per year.

Fig. 8 Price variable list and calculation per year

4.9 LCCS- LCC analysis

In PBMS, the step of LCC analysis is more important than other step and each tab of costs can be calculated by a certain method.

Fig. 9 Repair & replacement cost of Detailed LCC

There are 3 kind way of LCC as following;

- Summary LCC - whole LCC by ratio
- Detailed LCC - comparing each item
- Combination LCC - a lot of items for facility

The screen is for the input of the detailed LCC analysis contents regarding setting repair and replacement item and whole information ahead of time.

4.10 LCCS-Comparative analysis for single facility

The screen, a comparative analysis for single facility, is used to search the profile of the estimated LC costs (facility management, repair and replacement, energy) for a certain item of specific maintenance activity.

4.11 LCCS-facility comparative analysis

For a comparative LCC analysis of three facilities, the estimated cost of repair and replacement per year can be compared by Durable years of facility, Net discount, so on. A visual comparative analysis function with bar-graph is available for the result value of the estimated cost by year (60 years in figure).

Fig. 10 Comparative analysis result – by cost item

Fig. 11 Comparative analysis result – by year

Fig. 12 Combined comparative analysis result

5. THE PLANS FOR EFFICIENT USE AND RIPPLE EFFECTS

After developing the PBMS, it will be providing a lot of efficient use and ripple effects determining priority of maintenance in public buildings.

- Providing efficient newly data for maintenance
  1) Storing and managing DB by automatic System
  2) Collecting Repair and replacement historic data
  3) Predicting the Result by whole data
- Planning LCCosting and long-term repair & replacement
  1) Extracting Priority by historical maintenance data
  2) Planning Preventive maintenance
  3) Supporting works for compiling budget a year

6. CONCLUSIONS

The maintenance system of public facilities developed to determine repair & replacement priority based on a DB that uses background data related to the cost of these promotion according to the deterioration and aging of approximately 1,200 buildings owned by K-Water can be expected to have effectiveness from four perspectives. From a physical perspective, it prevents deterioration and induces a life cycle for various buildings dotted around the country; from an economic perspective, it reduces maintenance cost through the estimation of future expected cost; from a social perspective, it improves the reliability of repair & replacement activities through the maintenance system; and from a welfare perspective, it will provide a more pleasurable working space for users. Eventually, it is conceived that reliability between maintenance entities in preventive maintenance for facilities that is the national property would be derived, through the promotion of reasonable repair & replacement activities.

ACKNOWLEDGEMENT

This research was supported by a grant (Developing CFM system for office and general facility of K-water) from R&D Program funded by Korea Water Resources Corporation (K-Water) & Prevention of Disaster with Information Technology RIC in Mokwon University

REFERENCES

[1] Halim A. Boussabaine et al, “Whole Life Cycle Costing; Risk and Risk Responses”, 2004.

[2] R. S. Means, “Facilities Maintenance and Repair Cost Data”, 2006.

[3] K-water (Korea Water Resource Corporation), “A Development of Computed Aided Facility Maintenance System (CFM)”, *Final Report of First year*, 2010.

[4] Chun Kyong Lee et al, “A Basic Study on the Development of the Maintenance System based on Maintenance Expense”, *AIK*, 2010.