A STUDY ON THE IMPORTANCE-BASED CALCULATION OF RIVER FACILITY MAINTENANCE CYCLE

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KEY WORDS: GIS, SOC, LLC, Disaster Management

ABSTRACT: The basic river plan, implemented by MOLIT, is established through the surveying of the general situations, as well as through the hydrological investigation, the investigation of river characteristics, and the investigation of river project history and damage situation, among other things, which are later reviewed. The investigation results are reviewed for their validity every 5 years, and if necessary, they are changed and applied, but the plan is insufficient to respond to the flooding damage occurring every year, and measures are needed to improve the method.
To improve the planning method, this study used the information on river facilities in calculating the facility maintenance cycle quantitatively. Through flooding damage simulation, the damage amount by region was calculated, and based on the results, the region that requires the maintenance of facilities with the first priority was selected. Of the information on facilities in the river areas in the selected region, the importance was determined by factor and item, and it was quantitatively evaluated. The weight, derived by experts on facilities, was applied to the evaluation results so as to derive the quantitative value, which was reflected in the class of importance of facilities. In addition, the life cycle cost of facilities was quantitatively calculated, and the results were reflected in the classification of importance so as to calculate the maintenance cycle of facilities. By referring to the calculated maintenance cycle of river facilities, the economic division of the limited facility management budget was achieved. Further, the durability of facilities could be predicted, making it possible to promptly acquire the facility management information compared to the actual surveying which requires much more time. These results can be used as a reference for planning the maintenance of the river facilities to ensure the economic management of facilities and the reduction of human and material damages.

1. INTRODUCTION

Abnormal climate phenomena frequently occur all over the world due to increased average temperatures and global warming, thereby increasing property and life damage. Flooding damage caused by heavy rain and damage caused by typhoons occurring every year are on the increase. In particular, damage due to the collapse of SOC infrastructures such as dams and embanks brings on fatal results, indicating that safety management is crucial. Domestic SOC infrastructures, however, were constructed mainly in the 1990s, becoming 30 years or older in large amounts, and the consequent infrastructure dilapidation is fast occurring. As such, there is a need to integrate the management of facilities through the life-cycle approach instead of the current follow-up safety management. Notably, river facilities such as embankments and weirs cause enormous damage when they crash due to overflow, erosion, and penetration, making the management of river facilities all the more important. To ensure the maintenance of river facilities, the relevant agencies each establish safety and maintenance plans by facility and conduct safety inspection and diagnosis. The regulation provides that, based on such inspection results, the facility maintenance priority must be determined along with response measures, but given the continuously decreasing maintenance budget, a maintenance system is required to secure the safety of facilities with the limited budget and yet maximize the effects. Therefore, this study used the river facility information in calculating the maintenance cycle required for facility management, and the calculated cycle is deemed to be used effectively as a reference data for the officials responsible for the prevention of disasters and for the reduction of damage to make decisions.

2. DISCUSSIONS

In order to calculate an economic maintenance cycle of river facilities, this study determines the priority of maintenance based on the importance, Wando-gun, and amount of damages. Scores were calculated in terms of the damage rate due to disasters and catastrophes, the importance of buildings, and the grade of damages. Further, the

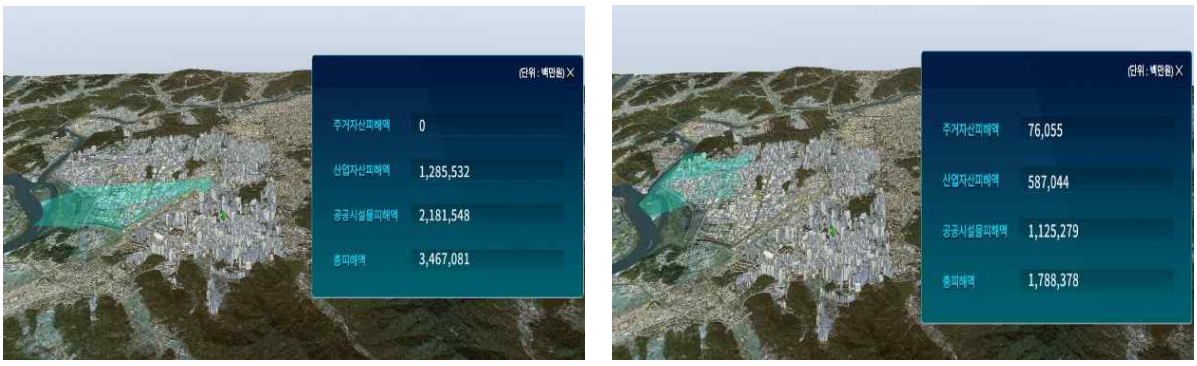
cost required for the construction and maintenance of buildings was simply calculated and reflected in this priority of maintenance so as to prioritize the cost-efficiency of maintenance.

2.1 Development of Maintenance Priority Calculation Method based on the Damages and Importance of Facilities

This study selected the area near Gangjeong Boryeong Weir in Dalseo-gu, Daegu as the target research area, used the HQ-owned DRiMSS(Disaster Risk Management Support System) in simulating the flooding damage occurrences and calculating the amount of damages, and thus determined the priority of embankment and weir maintenance. Scores of 1-5 points were allocated to facilities concerned according to the importance and risk levels of facilities, and the damages levels were determined according to the amount of damages and scores of 1-5 points were allocated accordingly. The importance of buildings in the target area was classified according to the presented standards. Seongseo embankment and Daemyeong embankment in the target area were selected as the two embankments, and the simulation indicated that Seongseo embankment suffered KRW 1.7884 trillion in damages, while Daemyeong embankment suffered KRW 3.4671 trillion in damages, so the facilities in the Daemyeong basin were selected.

Table 1. Importance criteria table

	Priority 1 (Rainwater pump plant) (unit: point)		Priority 2 (Roads)		Priority 3 (Convenience facilities)	
River facilities (Embankments, weirs)	5	Securing of rainwater pump plant	5	Two or more lanes	5	3 or more
	4		4	2 lane roads	4	3
	3		3	Walking+bicycle	3	2
	2		2	Walking	2	1
	1	Securing of rainwater pump plant	1	Nil	1	0



(a) Damages in the scenario of collapse of Seongseo embankment

(b) Damages in the scenario of collapse of Daemyeong embankment

Figure 1. Amount of flood damage by region

Further, the importance was determined after giving considerations to the user scope, number of users, and citizens' common convenience facilities, among other factors, holding advisory meetings of experts by category so as to derive the items of importance, and allocating scores of 1-5 points according to priority. Then, weighting was applied to individual items so according to priority, priority 1 got 15 points; priority 10 points; and priority 3 got 5 points.

By adding the weighting of 1.0/0.8/0.6 derived by experts to the calculated score of importance, 107~150 points were determined as class 1; 63~107 points as class 2; and 18~63 points as class 3. For instance, if the facility importance for category 2 facility, Terminal A, is evaluated, the 1st stage evaluation assesses the category 2 facility

as class 2. The 2nd stage evaluation gives a total of 115 points to the facility of a tunnel. If the scores of 1/2/3 priority importance items are 5/3/2, respectively, the scores multiplied by the weighting each are 15*5=75/10*3=30/5*2=10, respectively, and the total score is 115 points. If the 1st stage evaluated class 2's weighting 0/8 is applied to the total score of 115 points for importance items, it will become 92 points, and it will have the final facility importance of class 2. Likewise, hospitals, schools, police stations, Welfare Center 119 Safety Center and the like were calculated as a high 120 points or more, while parking facilities and parks were calculated as a low 42 points or lower.

Table 2. Weight by facility importance

Score by item	Priority of items of importance			Total score
	Priority 1 (15 points)	Priority 2 (10 points)	Priority 3 (5 points)	
5	15×5=75	10×5=50	5×5=25	150
4	15×4=60	10×4=40	5×4=20	120
3	15×3=45	10×3=30	5×3=15	90
2	15×2=30	10×2=20	5×2=10	60
1	15×1=15	10×1=10	5×1=5	30

Table 3. Determining the priority facilities

Category	Dongsan Medical Center	Sindang Elementary School	Paho Elementary School	Waryong High School
Importance	5	4	4	4
Damages	5	3	3	2
Risk	1	4	2	2
Total	11	11	9	8

2.2 Calculation of Facility Maintenance Cost Using LCC Data

To segment the maintenance priority, the maintenance cost was calculated and reflected in the priority. Based on the construction unit cost, available data among the initial investment cost, maintenance cost, operating cost, and waste disposal cost was selected and the cost was calculated. The calculation method is shown in Expression 1 below. X means the service life, and to prevent calculation errors, calculation goes like X=(service life/5)-5.

$$Planned\,facility\,cost = 0.924X^{-0.2739}$$

$$Operating administrative\,cost = 29.954X^{-0.0739}$$

$$Maintenance\,cost = 13.091X^{-0.1612}$$

$$Disposal\,cost = 0.9163X^{-0.233}$$

Using the above Expression, the cost consumption vs. the construction cost can be calculated, and this was classified as shown in the Table 4 and the maintenance priority by cost was determined.

Table 4. Estimation of maintenance cost based on unit cost

Category	Dongsan Medical Center	Sindang Elementary School	Paho Elementary School	Waryong High School
Planned service life	50 years	50 years	50 years	50 years
Service life	0 year	24 years	19 years	18 years
Planned facility cost	177 million	29.5 million	32.45 million	23.6 million
Operating administrative cost	10 billion	1.7 billion	1.8 billion	1.3 billion
Maintenance cost	5.1 billion	848.5 million	933.35 million	678.8 million
Disposal cost	189 million	31.5 million	34.7 million	25.2 million
Construction cost	30 billion	5 billion	5.5 billion	4 billion
Priority of maintenance	1st place	3rd place	2nd place	4th place

According to the service life, the planned facility cost, operating administrative cost, maintenance cost and disposal cost were calculated, and these were reflected in the facility damages- and importance-based maintenance priority.

3. CONCLUSION

In this study, in addition to the facility damages and importance-based priority, the facility maintenance cost was calculated using LCC data, and thus the facility maintenance priority was segmented. The segmented facility maintenance priority is expected to ensure an economic maintenance of facilities. Further, if the rough facility maintenance cost calculation method is improved, a more accurate facility maintenance priority can be determined.

ACKNOWEDGEMENT: This research was supported by a grant(19AWMP-B121100-04) from the Water Management Research Program funded by Ministry of Land, Infrastructure and Transport of Korean government.

References

Ji-Eun Kim, Hyun-Sang Choi, Tae-Yook Gang, 2014, Derivation of System Requirements and Implementation of System Framework for BIM-based Urban Facility Maintenance System, The Journal of the Korea Contents Association, 14(4), 397-406.

Yoon-Shin Bae, Sangyum Lee, Wan-Taeg Kwon, Jong-Myung Jeon, 2014, A Study on the Database for Analyzing Life Cycle Cost of Road Facilities in Seoul, Korean Society of Hazard Mitigation, 14(3), 99-105.

Tae-Hui Kim, Bon-Hak Gu, Ok-Gyu Kim, Tae-Keun Park, Hyun-Soo Lee, 2008, The Development of Life Cycle Cost Evaluation Index for Public Facilities, Korean journal of construction engineering and management, 9(6), 216-224.