

DEVELOPMENT OF LIFE CYCLE COST ANALYSIS SYSTEM FOR THE BUILD-TRANSFER-LEASE PROJECTS

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Abstract

In January 2005, the BTL private investment project was introduced in the Korean construction market as part of the plan to provide high-quality public service and expand the required facilities in a timely manner. Nonetheless, problems such as the low earning rate at the beginning of the business, burden of service compared to the cost of the proposed business, and limitations of the local small and medium-sized companies in relation to their participation in the project arose.

The LCC analysis system for the BTL projects was developed as part of efforts toward efficiently investigating the investment eligibility. Specifically, methods for LCC analysis were selected for each stage of the BTL project in relation to the requests of experts for military residential facilities and public educational facilities. Variables were then extracted to derive an accurate analysis value, LCC for the 5 cost items (initial investment cost, operating expenses, maintenance expenses, energy cost, and disposal cost), analyzed, and system enabling comparative analysis for single and multiple initiatives by year and item, developed. Thus, we have to clearly require the accumulation of data to examine the appropriateness of the results of LCC analysis based on data and results.

Keywords : BTL, LCC, VFM Analysis, Cost Breakdown Structure, Cost Items of LCC

1. Introduction

1.1 Background and purpose of this study

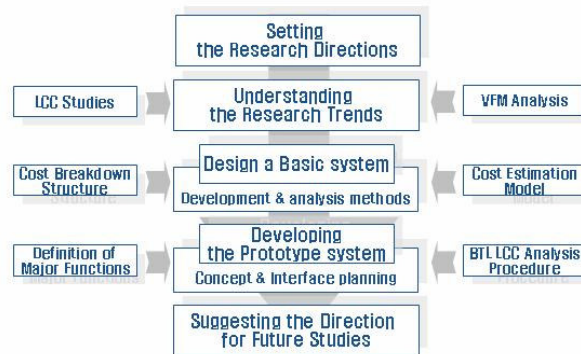
Following the amendment of the Private Investment Act covering SOC facilities in January 2005, the BTL private investment project was introduced in the Korean construction market as part of the plan to provide high-quality public service and expand the required facilities in a timely manner. Such BTL project is patterned after the PFI projects implemented in Japan and England, revitalizing the Korean construction industry by introducing the virtuous circle into the national economy through the allocation of private financial resources and construction of public facilities that are immediately needed by the community. Nonetheless, problems such as the low earning rate at the beginning of the business, burden of service compared to the cost of the proposed business, and limitations of the local small and medium-sized companies in relation to their participation in the project arose. Implementing such construction projects requires analyzing the feasibility of the business, estimating possible risks in the course of using private financial resources, and finding ways of supplying resources considering the characteristics of the BTL project; ditto for surveying in advance the business eligibility of the private investment project compared with the finance investment project.

Therefore, this study proposed a computerized LCC analysis method using information technology to analyze the eligibility of a project through a quantitative VFM survey of the BTL project as well

as attempted to make the operation of the BTL project efficient and to realize a standardized LCC analysis through the proposed system.

1.2 Scope and methodology

This study attempted to develop an LCC analysis system for the major facilities of domestic BTL private investment projects such as the construction of military residential facilities and public education facilities (elementary/middle school, dormitory of national universities). Specifically, the concept of LCC was reviewed including related studies around the world as well as the current status of BTL. To set the direction for this study, the need for LCC analysis was determined from the perspective of investment feasibility. The development methodologies for the proposed system were then established based on the research direction, and cost breakdown system and cost estimation models, suggested. Finally, a prototype was developed by establishing the system concept, flow, definition of functions, and analysis procedure.



“Figure 1 : Flow of this study”

2. Theoretical Considerations

2.1 Domestic and international trends in LCC-related studies

It is realized that LCC analysis systems in domestic and international trends are the limited target and own standard for LCC analysis. Hence, it would be necessary to settle standardization cost breakdown structure, the work process of LCC analysis, expansion of the target. Also, we have to ascertain the credibility of the LCC analysis result after introducing methods of sensitivity and economic estimation.

Division	BLCC	LCCID	LCC WARE	RELEXLCC	LCCMS
Maker	NIST	BLAST	Isograph	Innovation s/w	LCCKOREA
Target	All type	All/military	All type	Buildings	Apartment
CBS	NIST	Own	Own	Own	Own
LCC model	ASTM	Own	Own	Own	Own
Sensitivity	Able	unable	unable	unable	Able
Type of report	Text	Text/table	Text/table	Text/table	-

“Table 1 : Examples of LCC Analysis System”

2.2 Current status of the BTL project in Korea

The BTL project was introduced in the Korean construction market in 2005; for its 2nd year, 86 projects worth KRW3.8 trillion have been announced, 33 projects, contracted, and 14 projects, started to date. (total project cost at KRW5.69 trillion) Major projects target the construction or

rebuilding of military residential facilities, dormitories of national universities, and elementary/middle school buildings.

The public education facilities project is divided into the construction of dormitories for national universities (National University Facilities Project) and that of elementary/middle school buildings were bundled considering the scale of the project. The “Education Facilities Improvement Project for 2005~2007” expects KRW13.5 trillion worth of projects to be implemented for the next 3 years.

This project is divided into the military apartment and barracks. The precedents in 2005 revealed only 49.3% completion of the planned targets. In 2006, however, the master plan for the facilities project targeting 21 apartments and 39 barracks was announced together with efforts to prevent dumping and improve the evaluation methods for reliable design.

* buildings ** trillion *** Projects

Division	Total	Dormitory	school	Division	Total	Military @	Barrack		
05	Started	18	1	17	05	Scale	-	3.084***	-
	Contracted	19	2	17		Total cost	3.574	3.574	-
	Under nego.	11	7	4	06	Scale	-	6.000***	60*
06	Scale	-	2 **	265**		Total cost	1.32*	5.880	7.298
	Total cost	2.68 *	544	26.216	07	Scale	-	8.916***	188*
07	Scale	-	10**	38 **		09	Total cost	2.59*	8.186
	Total cost	1.88 *	5,427	12,404	Total		4.27*	18.000***	248*

“Table 2 : Current status of public educational facilities & military buildings”

2.3 Investment eligibility (Decision of PFI) survey – VFM(value for money) analysis

When the government pursues a project related to SOC facilities, investment eligibility is determined by carrying out quantitative and qualitative VFM analysis for PSC (Public Sector Comparator) and PFI (Private Finance Initiative) and selecting the best combination of cost and qualitative effect.

2.3.1 Quantitative VFM

To determine project viability, LCC is estimated for the construction and operation stages by the public sector or private sector and converted into present values through risk adjustments.

Items		PSC	BTL
Cost of facilities investment	Project cost	Construction cost	1. survey cost 2. design cost 3. construction cost
		Compensation	4. compensation for land and intrusions
		Incidental cost	5. survey of viability 6. cost of traffic impact evaluation 7. cost of environmental impact evaluation 8. supervision cost 9. variable insurance fees
	Others	10. operating and facilities costs	
Dues & incidental financing		11. financing costs	
Facilities rent		Not applicable	Facilities rent (earning rate reflected, incidental operation income deducted)
Operating expenses		13. operation expenses (labor & general overhead) 14. cost of repair 15. cost of management	
Total		Total cash outlay	States funding(facilities rent + operating expenses)
Total current value		Current values at the time of evaluation applying a 6% nominal discount rate	

“Table 3 : Examples of evaluation items for quantitative VFM analysis”

2.3.2 Qualitative VFM

It carries out imperative comparison of the service quality, estimated effects, and characteristics of the project, i.e., when it would be turned over to the central or local self-government or private

sector. In terms of the risk factors, quantify risks such as the extension of the construction period, increase in construction cost, increase in interest, and termination of contract by applying the social discount rate and earning rate.

Evaluation item	Description
Enhancement of service quality	Enhance service quality by SOC.& operating efficiency by PSC
Simplification of contract / management	Provide high quality & management and supervision skills
Diversification of risks	Stable operation based on clear diversification of risks
Estimated effects	Revitalize the financial market and advanced technology
Project characteristics	Decide whether PSC or BTL is appropriated

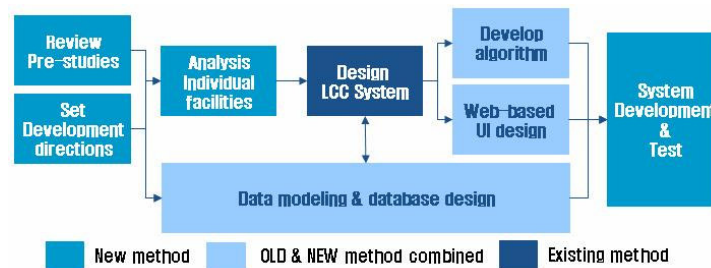
“Table 4 : Examples of evaluation items for qualitative VFM analysis”

2.3.3 Economic VFM

It suggests the result of analyzing economic efficiency in relation to the sunk cost and determine the sunk cost by estimating B/C including the total project cost to compare the (preliminary) feasibility study with the analysis of economic efficiency.

3. Basic Design for Developing the BTL LCC System

In developing the LCC analysis system for the BTL project, analyze the characteristics of individual facilities by reviewing previous studies and examining the current status and perform a close examination of the existing LCC systems to define the work process and an algorithm appropriate for BTL projects. Design the API (application programming interface) and suggest a web strategy.



“Figure 2 : Development strategy of BTL LCC”

3.1 Definition of major system functions

At first, it has to trace the functions for developing the prototype of LCC analysis system. When it divides 5 kinds of functions ; Data input, date analysis, result output, system update, sub-functions. The detail functions of system are follows Table.

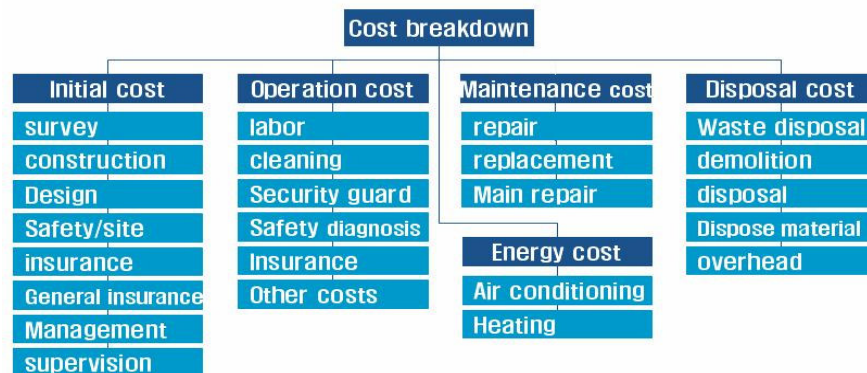
Divisions	Level1	Level2	Level3	Application
○ System functions	Data input	Basic info. input	Material data input	Application
			Cost estimate data input	Application
		Target info. input	Project data input	Application
			Unit(modular) data input	Application
			Facility data input	Application
			Data export to excel	Application
	Data analysis	Analysis condition set up	Analysis items	Application
			Facility types	Application
			Cost variable items	Application
		LCC analysis	Initial cost	Application

			Operation cost	Application
			Maintenance cost	Application
			Energy cost	Application
			Disposal cost	Application
		Inquiry other targets		Application
Result output	LCC result for single			Application
	Maintenance cost for comparative			Application
	Comparative	Classified by items		Application
		Classified by year		Application
	LCC analysis export to excel			To-be
System update	Database update			Application
	System linkage	Supply cost from government		To-be
		Maintenance system		To-be
		C/S to Web		To-be
	GUI(graph user interface)			To-be
Sub-function	System explanation	System manual for user		To-be
		Advise for system usage		To-be
	Function for system manager	DB management		To-be
		System operation methods		To-be
	System simulation (tester)			Application

“Table 5 : Major System Functions”

3.2 Cost breakdown structure

The LCC cost items for BTL are broken down into 5 cost items. In particular, initial investment is divided into the survey cost, construction cost, and general overhead. Similarly, operating expenses and administrative and maintenance expenses are broken down based on the RFP announced in 2006, and energy cost, into air conditioning and heating. Finally, the cost of waste disposal is broken down in terms of the demolition method and remaining values and earnings.



“Figure 3 : Cost Breakdown Structure”

3.3 Cost estimation model

The proposed system includes cost items such as initial investment, operating and management expenses, administrative and maintenance expenses, energy cost, and cost of waste disposal. Among the 5 cost items, operating and management expenses are broken down based on the RFP announced in 2006 as cited in the cost breakdown system. Below are the cost item and estimation methods.

Level1	Level2	Level3	Estimation method
Operation cost	D. Labor	D1.labor	Num. person* wage *period
	E. Cleaning service	E1.labor	Num. person* wage *period

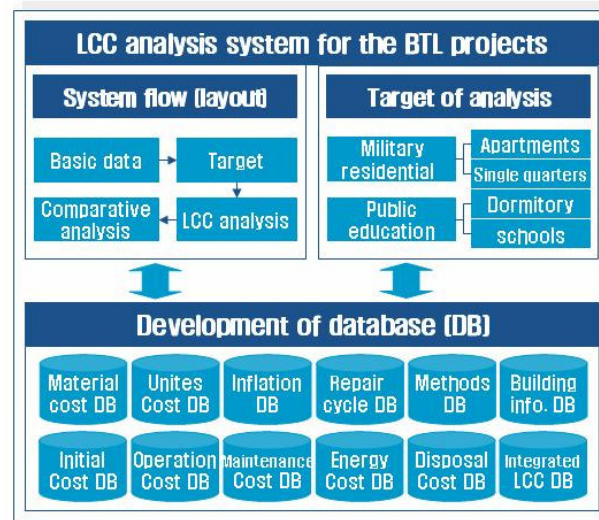
		E2.cleaning equipment	Acquisition / num. of years used
		E3.expendable materials	Volume of use* unit cost *period
F. Security guard service		F1.labor	Num. person* wage *period
		F2.machine	Acquisition / num. of years used
G. Safety diagnosis		G1.periodical inspection	Unit cost * frequency of use(6)
		G2.precise inspection	Unit cost * frequency of use(18)
		G3.other inspection	Unit cost * frequency of use(12)
H. Insurance		H1.all risk	Unit cost * insurance rate * period
		H2.liability	Unit cost * insurance rate * period
I. Others		I1.others	Num. person* wage *period

“Table 6 : Cost Estimation Model”

4. Developing the Prototype of the BTL LCC System

4.1 System concept

As a program independently operating under the Windows Operating System, the LCC analysis system uses Visual Basic, an object-oriented programming language. The system is intuitive; it can also be simplified, containing large amounts of data that can be used for various purposes and allowing the user to prepare and manage easily exclusive data that eliminate repetition as much as possible as well as shared data and to define the relationship between tables to maintain coherence between data as well as various procedures for validity inspection in relation to the data such that only accurate data remain in the database.



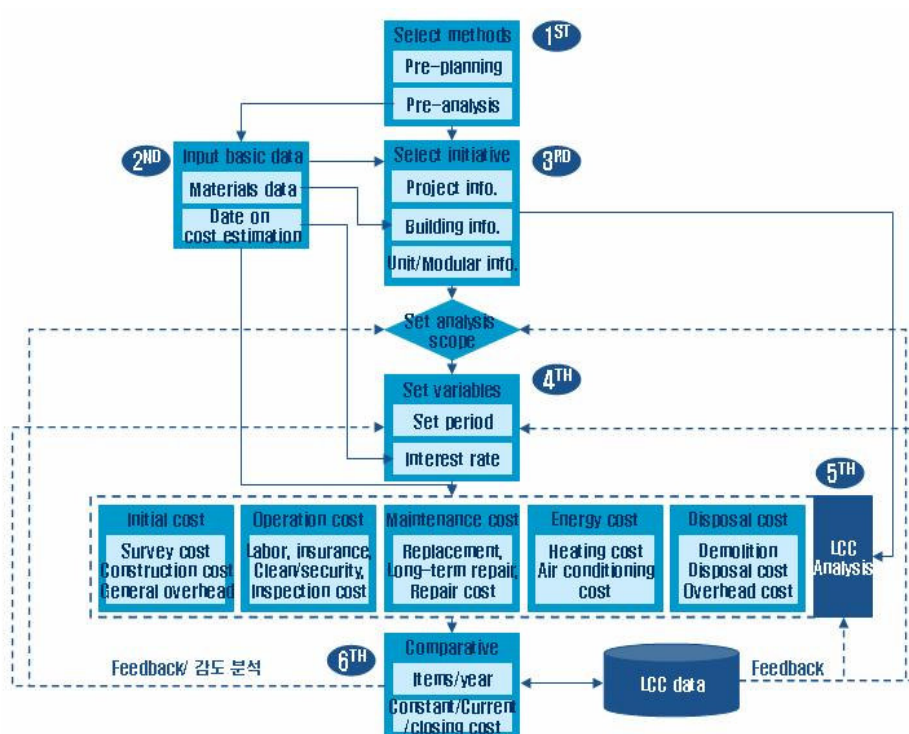
“Figure 4 : Concept of BTL LCC”

4.2 Procedure for BTL LCC analysis

The diagram below outlines the procedure for BTL LCC analysis.

- (1) Selecting the Analysis Method - This stage involves selecting analysis methods such as approximate LCC analysis for the pre-planning stage and detailed LCC analysis for the bidding of business proposals, selection of preferred bidder, and evaluation stage from among the many stages of the BTL project.
- (2) Entering Basic Data - Basic data required for LCC analysis are entered to develop a basic database. Such data consist of materials data including the unit cost and cost of itemized units and data on cost estimation including the interest and repair rate.

- (3) Selecting the Initiatives - This stage involves selecting the project to be analyzed and entering basic information as well as general building and unit (modular) information.
- (4) Setting the Analysis Scope and Variables - Boundaries are set for the number of LCC analysis items and initiatives; ditto for the variables including the interest rate and inflation as independent variables with the biggest impact on the LCC analysis.
- (5) LCC Analysis - This stage involves estimating the values for the 5 cost items, i.e., initial investment, operating and management expenses, administrative and maintenance expenses, energy cost, and cost of waste disposal, and performing an LCC analysis for a single initiative. Values are also integrated for each item and converted into the current price, closing price, and constant price.
- (6) Comparative Analysis - A comparative analysis of LCC values is carried out by item and by year to come up with a sensitive analysis in relation to the changes in values for a single initiative or to select the best initiative from among multiple initiatives.



“Figure 5 : Procedure of BTL LCC”

4.3 Layout of BTL LCC

4.3.1 Function of data input

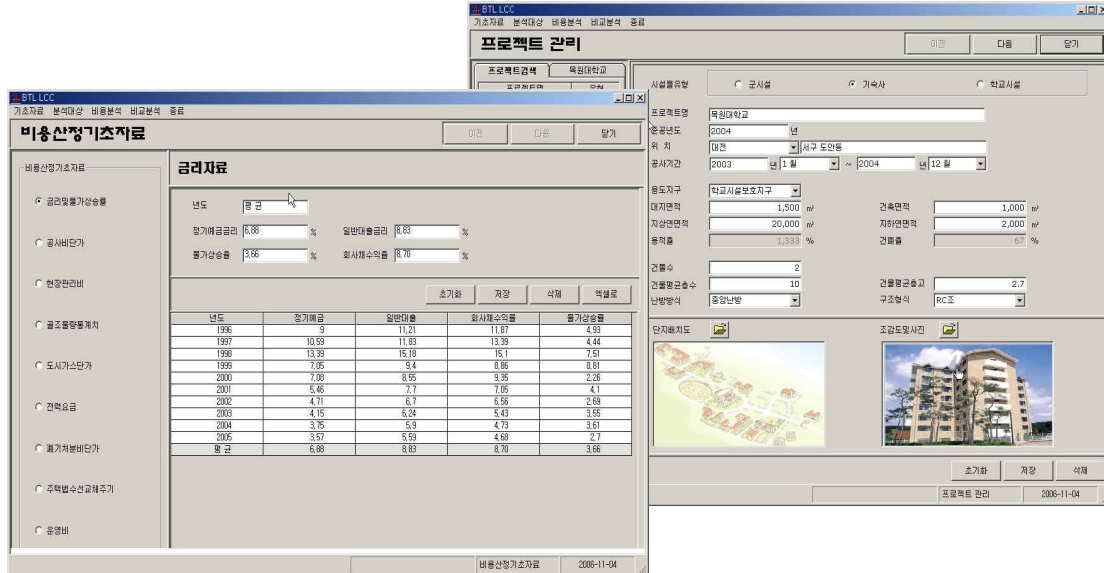
(1) Basic data input – basic data for cost estimation

There are materials information and basic data for cost estimation for the LCC analysis. The Basic data for cost estimation have the following particulars : Interest and inflation, construction cost, cost of construction management, statistics on volume of steel frames, cost of city gas, power cost, cost of waste disposal, repair and replacement cycle(Housing Act.), operating expenses.

(2) Subject of analysis – project management

This page enables entering project-related information for each facilities type. Enter basic information of the project, area, and flower space index, building information, and structure

format. Search for the required data using the project search tool on the lower left side. The application of related laws and guidelines for the facilities type is differentiated. On the other hand, the structure format includes the modular construction method to be applied to the BTL project in the future. A comparative analysis with structure formats may be performed in the future.

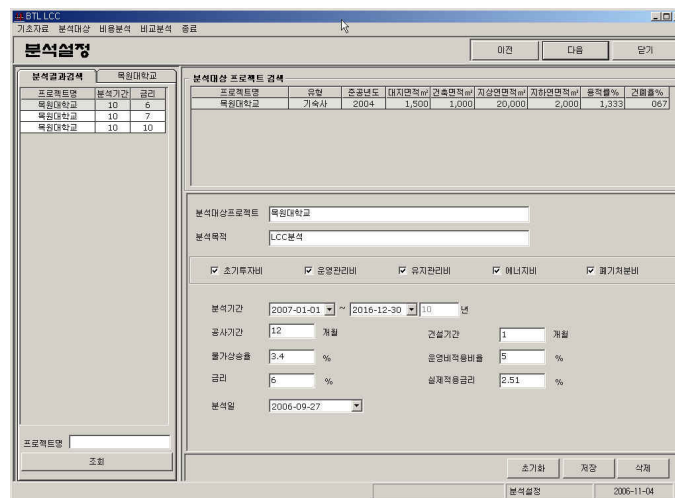


“Figure 6 : Basic data page for cost estimation / Page for project management”

4.3.2 Data Analysis

(1) Analysis setting

Search for a project and select a subject of analysis on the left. Set variables such as the LCC cost items, analysis period, and interest. Appropriate initiatives may be selected, and precise variables, set, since the particulars of the project are displayed in the search. The changes in the variables in this page are also taken into account in the sensitivity analysis between single and multiple initiatives in the future.



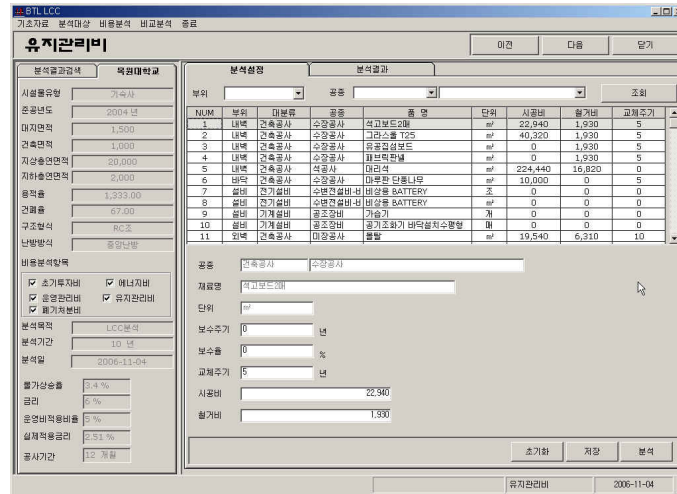
“Figure 7 : Page for Analysis setting”

(2) LCC Analysis – 5 kinds of cost items

As part of operating expenses, administrative and maintenance expenses occurring during the designated operating period are appropriated in connection with the basic data and variables for analysis setting.

A. Analysis Setting: Enter and manage the variables required for administrative and maintenance expenses.

B. Analysis Result: An analysis of administrative and maintenance expenses per part and building is performed.

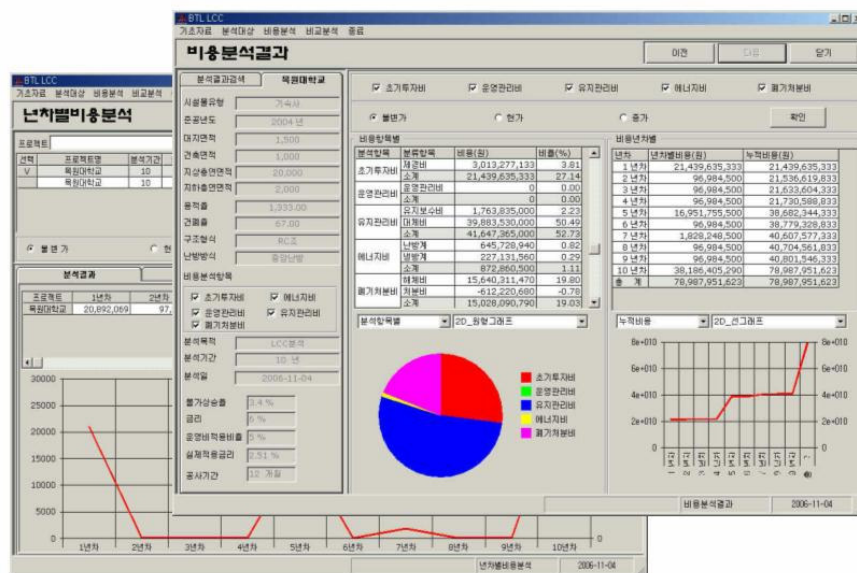


“Figure 8 : Page for Setting the analysis of maintenance expenses”

4.3.3 Result Output

(1) LCC analysis result

The variables for analysis setting as entered for analysis and values for each cost item are appropriated and displayed. Basic information and settings related to the subject of cost analysis on the left are also shown, with the results plotted in graphs including the pie chart for purposes of visual comparison. Finally, values for the single initiative are stored and recorded in the database.



“Figure 9 : Page for LCC analysis result for single/comparative initiative”

(2) Comparative analysis by items or year

In the comparative analysis between initiatives, comparative analyses of LCC values by year and by item may be performed. In particular, the comparative analysis by year enables searching the project on top and selecting the initiative and comes up with a comparative analysis of the values of LCC analysis between initiatives by converting the values into the current price, closing price, and constant price. Similar to the results of LCC analysis, the result is represented in graphic form including pie chart. Considering the characteristics of the BTL project, the page is designed to provide a detailed analysis of operating expenses as well as a comparative analysis based on the changes in variables for sensitive analysis.

5. Conclusion

The LCC analysis system for the BTL program was developed as part of efforts toward efficiently investigating the investment eligibility of PFI compared to PSC. Specifically, the proposed system (BTL LCC) was developed to help both the client and the bidder carry out standardized and quantitative VFM analysis and select the optimum initiative and appropriate methods for LCC analysis for each stage of the BTL project, thereby promoting the use of actual operation-oriented LCC analysis.

Specifically, methods for LCC analysis (pre-planning stage, stage of detailed analysis) were selected for each stage of the BTL project in relation to the requests of experts for military residential facilities and public education facilities. Variables were then extracted to derive an accurate analysis value, LCC for the 5 cost items (initial investment, operating and management expenses, administrative and maintenance expenses, energy cost, and cost of waste disposal), analyzed, and system enabling comparative analysis for single and multiple initiatives by year and item, developed. In particular, operating and management expenses and administrative and maintenance expenses were determined based on the price section of RFP (2006).

Nonetheless, maximizing the functionality of this system is difficult considering the changeable work process and cost items owing to the short history of BTL programs in Korea and lack of visual references and databases; thus clearly requiring the accumulation of data to examine the appropriateness of the results of LCC analysis based on definite base data and results.

Some of the directions for system design for the proposed LCC analysis system include maximizing the appropriateness of values of LCC analysis through feedback and developing an integrated system for economic efficiency evaluation including state funding issues. Therefore, a standardized LCC and a method for state funding estimation considering the changeability should be suggested, and the appropriate legislation on database development should be realized. The evaluation method shall be standardized for economic efficiency as well. Developing and introducing a maintenance and management system appropriate for the BTL project -- whose operation and management shall commence by 2007 -- are also essential in its successful execution.

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