Study on life cycle costing: a case of building for private high school in Jakarta

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Abstract. There are increasing awareness of life cycle costing (LCC) by the management who has lengthy experience in operation and maintenance of the building. Maintenance of buildings includes replacement, updating, and repair building components in accordance with predetermined standards. This research aim at identifying building maintenance practices of a private high school Building in Jakarta. This instrument of the study was referred to Regulation of Minister of Public Works. Another aim is to identify service life of the building components, and conducts 25 years life cycle cost plan for the school management by adopting model of LCC from ISO 15686 part 5. Research data obtained by distributing questionnaires to the Section of Maintenance 30 persons, and school teachers 68 persons. Result showed that the implementation of the management school provides a score of 4.6 out of 5 scale and considered as a very good maintenance performance for the building. To confirms whether the user perception on the operating and maintenance efforts, a similarly assessment were obtained from direct users who provide a good category. From the results of life cycle costing, the study shows that: for long-term life cycle cost plan, the proportion cost for 1) construction, 2) operational, and 3) replacement and maintenance are 46%, 39% and 15% respectively.

1 Introduction

Indonesia Government concerned to the environment issue since it established Ministry of Supervisory and Environment at the first time at 1983 with Emil Salim as the leader of department in Soeharto presidential era. The first Acts no 23:1997 regarding Environment Management was issued in 1997[1]. Since then many regulatory following the Acts, and the one related to sustainable construction was the Government Regulation no 27:1999 [2] regarding Environment Impact Analysis. To implement the regulations, Ministry of Environment issued types and scales of business that needed to apply the regulation, and provided guidance on how to carry out the environment impact analysis [3]. The efforts for sustainable development in construction industry in Indonesia was shown by the established of Green Building Council of Indonesia (GBCI) since 2008. GBCI working together with the International Finance Corporation, the World Bank Groups issued an initial guide green building assessment [4].

Indonesia as a developing country in the world today is promoting sustainable development in all fields. In implementing directed development, it is expected construction to be able to deliver efficient and effective results and environmentally accepted. This refers to the constructions sustainable concept, where a development can work together between concept of the responsible development, has the spirit of maintenance, and accountability.

Lack of operation and maintenance strategies to maintain building system performance leads to increased operating and maintenance (O&M) cost and less healthy buildings. The first step toward improved practices that take advantage of potential operating savings is to identify the O&M practices routinely performed in buildings. Understanding LCC and service life of building component has two major benefits. First, baseline for service life is the benchmark from which to estimate cost for O&M practices. And second, service life baseline practices can be used as a guide to direct the long terms O&M cost estimate for the assets [4].

In line with the concept of sustainable constructions, costs incurred in the development process is based on the calculation of life cycle cost, which is an integrated process in decision making, planning and control, procurement, operational, security, and the final value assets [5]. The purpose of the life cycle cost is to manage the process repeated from the planning to the destruction or replacement of assets, to manage the lifecycle cost (long-term) of the short-term savings, to ensure the appropriate consistent quality service of the designed building, to improve sustainability and lowers the risk of failure and maximize the potential and advantages of the provision of services, in order to minimize the associated costs throughout the life of the building itself [6].

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In planning life cycle cost, information of the service life of component used such as equipment, and building materials are needed. This is something interesting because whenever service life assessment is only done on a building in overall activities. Determine the service life calculation aims at facilitating the maintenance and replacement of components of the building materials that have overdue the limit of its service life [7]

The objectives of the study were: 1). to assess the level of building maintenance; 2) to identify service life of component of the material a building; and 3). to provide a long-term plan of 25-year life cycle cost a school building in Jakarta. The building is located in the complex of the school at S. Parman Street in Western Jakarta. This school building plans take as long as 1 year. The building is planned to have 5 floors and functioned for offices, class rooms, dancing, laboratory, meeting rooms.

2 Literature review

2.1 Building maintenance issues.

According to the Regulation of the Minister of Public Works No. 24 / PRT / M / 2008 [10] concerning Guidance on Maintenance and Maintenance of Building, Building is the activity of maintaining the building of building and facility for building always functional (preventive maintenance). [11], explains the main objectives of the process are: 1) for additional building age; 2) to ensure the transfer of existing and also profit from maximum investment; 3) to ensure the safety of people using the building; and 4) to ensure operational readiness of emergencies. Ervianto [12], conducted a case study on the maintenance of a campus building. The purpose of the research is to find out the program of building maintenance and its facilities that have been running and redefine the building maintenance program that should be done. In his research Ervianto [12] concluded that there is no clear and structured maintenance program, which is only doing activities when there has been instability of the system or facilities attached to the building. In addition, there is no data about the lifespan of any particular facility, such as lamp, faucet, plumbing, telephone. As well as past data about the replacements that have been made. Based on these conclusions, Ervianto [12] suggests to start thinking of a maintenance program structured and periodic for all existing facilities. All facility data in the building is prepared and recorded the date of replacement of all components, so that the age of each component can be detected properly and need to be improved managerial aspects of the maintenance unit, including special executive in facilities that require skill and knowledge enough.

2.2. Building maintenance and maintenance guidance

In this study Regulation of Minister of Public Works Number: 24/PRT/M/2008 regarding Guidance of Maintenance and Maintenance of Building was referred. The observed scope of maintenance was the architectural, mechanical electrical, and plumbing. However, not all building components were observed for maintenance due to limited research resource. The 21 standards of components for maintenance of building available in the guideline was adopted [10].

2.3. Building maintenance management planning

The process of making maintenance planning is based on the general condition, but if there is a specific building then the maintenance program is adjusted to the characteristics of the building itself. Completeness of each component of the building and its facilities should be maintained properly so that at any time throughout the building is enabled to work in accordance with operational requirements. The maintenance period of each part of the building differs from one to another depending on its life cycle. Planning is a process that depends on each other comprehensively. Some of the things that should be of concern in the creation of a maintenance program are: the number of activities that can be separated; the time scale of each activity; sequence of activities; take notes during inspection [12].

2.4. Life Cycle Costing

According to ISO 15686 part 5, life-cycle costing (LCC) is a valuable technique that is used for predicting and assessing the cost performance of constructed assets. LCC is one form of analysis for determining whether a project meets the client's performance requirements. Analyses can necessitate the use of other parts of ISO 15686 and current economic data from clients and the construction industry. It should be possible to use this part of ISO 15686 without extensive reference to other parts, although a number of the terms and techniques described are covered in more detail in the other parts[13]

LCC is a simple idea, in which all costs arising from investment decisions are relevant to the decision. Life cycle cost is suggested as a step forward through a number of stages. All stages in the development cycle will be skipped over the life of the building, and of course in running it all cost. There are some understanding life cycle cost according to some experts, including as the following. 1. According to Ashworth [14], the Life Cycle Cost of a building or structure includes the total related cost from the beginning to the final disassembly stage.

According to Barringer and Weber [7], Life Cycle Cost (LCC) is a conceptual modeling of cost calculation from the initial stage to dismantling an asset from a project as a tool for making decisions on an analysis study and calculating the total cost that exists during the cycle his life. 3. According to Pujawan [15], Life Cycle Cost of an item is the amount of all expenditures associated with the item since it was designed until it is no longer used.

The key use of Life Cycle Costs is when evaluating alternative solutions to specific design issues. Things to review are not just costs but also the cost of maintenance and repair, the long term plan, the appearance, and the things that might affect the value as a result of the available options. Although the appearance aspect is an aesthetic consideration, it is very subjective, but that aspect cannot be ignored in the overall evaluation. Thus, LCC is a combination of estimation and wisdom.

3. Methodology

This research is a quantitative research using descriptive statistics method. As Sekaran, [16] argued that descriptive statistics method was to the search for facts with appropriate interpretation. Descriptive research studies problems in the community as well as certain situations, including on relationships, activities, attitudes, views and processes that are underway and the effects of a phenomenon.

The location of the research is a building in BPK Penabur 2 Jakarta. Preparation of the study began in September 2016. Questionnaires began to be distributed to respondents as well as in October 2016. Data analysis, discussion and conclusion were made during October-December 2016.

The data were collected by using questionnaires. List of questions a very important tool, and its statement should be easily understood regarding a particular aspect. Questionnaires in this study were closed questionnaire, i.e. the respondent was only given the opportunity to choose an answer which has been provided [17]. In this research used structural questionnaire. Secondary data of cost regarding LCC were obtained from the Office of the Maintenance for the school.

Life cycle cost is the cost during the life of the plan buildings, which can be formulated as below: LCC = Initial Cost + Usage Fee + Maintenance and Replacement Cost. Where, the initial cost is the cost of planning and implementation of buildings, costs use is the cost incurred during the building is in operation, and maintenance and replacement costs are fees for maintenance and reimbursement building components during the life of the building plan.

4. Results and discussion

4.1 Respondents and the description of the School Sites

Total respondents participated in this study was categorized as direct user category are 68 people, consisting of 40 students from middle school and 28 teachers and staff of BPK Penabur 2 Jakarta. From the total 68 respondents between students and teachers/staaf consists of 35 male respondents and 33 female respondents. As common knowledge, the school since the last two decades had produced many talents students who won many Olympic medals in mathematics, physics, and others in International level.

Building BPK 2 Penabur Jakarta is located on Jl. Pembangunan III. IA, RT.7 / RW.1, Northern Petojo, Gambir, Central of Municipality of Special Region for the Capital of Jakarta. The boundaries of this building are as follows: Northern part adjacent to Jalan Pembangunan I, Southern part nearby PT. Bima Angkasa Putra, Eastern part neighbors with populated housing area, and Western boundary with Jalan Pembangunan III. The complex of the school building served 3 levels of schools, namely kinder garden, elementary level, and Intermediate level.

This building consists of 5 floors. First floor 1 consists of classes, playing rooms for Kindergarten, Waiting for pickers, Pantry, Canteen, Kitchen, Parking for motor cycle, administration room, Lobby, rooms for teachers, Multimedia rooms, Emergency room, meeting rooms, Cooperation Unit Room, panel room, and Toilet. The second floor consists of rooms for Head of school for elementary, Teacher rooms, Living room, Deputies of head of school, Drawing room, Studio, Library, Computer, Warehouse, Counseling Guidance room, Meeting, Dance, Music, Toilet, and Panel rooms. The 3rd floor consists of Pantry, Class rooms, Computers, Praying room, Audio & Music, Warehouse, Board for student room, Culinary art room, Home Industry, Laboratories, Language, Head of School for Intermediate, Administration room, teacher rooms, picket room, Dancing room, Library, Toilet, Panel rooms. The fourth floor consists of Pantry, Junior Class rooms, Social Activity room, Counseling Guidance room, Library, Teacher rooms, Meeting room, Warehouse, Toilet, Laboratory for physics, chemical, and mathematics, Computer, and Panel rooms. The 5th floor consists of Warehouse, Outdoor Class, Lab Biology laboratory, Physics laboratory, Toilet, Auditorium, Waiting rooms, Operator room, Field Sports, and Panel rooms.

Table 1. Description of statistics obtained from respondents of maintenance office of the school.

No	Maintenance Activities	Mean	Std. Dev	Performance
1.	Cleaning of floor surfaces	4,00	0	Good
2.	Carpet surface cleaning	4,50	0,94	Very Good
3.	Cleaning of glass and windows	4,03	0,18	Good
4.	Cleaning the plywood ceiling	4,97	0,18	Very Good
5.	Gypsum ceiling maintenance	2,30	0,83	Less Good
6.	Cleaning of the jamb	4,90	0,55	Very Good
7.	Finishing back wooden frame	4,03	0,18	Good
8.	Giving lubricant on lock, latch, and hinge	4,77	0,43	Very Good
9.	Maintenance of folding door	4,60	0,81	Very Good
10.	Cleaning of curtains or curtains	4,93	0,25	Very Good
11.	Air conditioning maintenance	5,00	0	Very Good
12.	Cleaning of wood plywood	4,93	0,25	Very Good

13.	Cleaning of floor surfaces	5,00	0	Very Good
14.	Carpet surface cleaning	5,00	0	Very Good
15.	Cleaning of glass and windows	5,00	0	Very Good
16.	Cleaning the plywood ceiling	4,27	0,45	Good
17.	Gypsum ceiling maintenance	5,00	0	Very Good
18.	Pinching of upright water gutter from PVC or iron pipe	4,57	0,81	Very Good
19.	Pinching the outer wall of the building	4,23	1,30	Good
20.	Cleaning ceramic wall in bathroom / WC	4,10	0,31	Good
21.	Cleaning sanitary fixtures	4,07	0,25	Good
22.	Check the tap water	4,80	0,41	Very Good
23.	Check the water filter (floor drain) on the bathroom floor / WC	4,73	0,25	Very Good
24.	Use of disinfectant to kill bacteria on the floor or wall of the bathroom / WC	5,00	0	Very Good
25.	Trash materials	4,77	0,43	Very Good
26.	Restrictions on smoking area	5,00	0	Very Good
Total mean score		**4,56**		**Very Good**

4.2 Assessment of performance of building maintenance.

Table 1 shows the result of all respondents regarding the performance of the building. From 26 maintenance activities, only gypsum ceiling was less performed. Thus the study confirmed that the school building was well maintained. This study was also had comparable results with the previous finding as shown in [12, 18, 19]

4.3 Analysis of service life and results

The questionnaire were distributed directly to the respondent supported by interview to know service life of component of building material used in building in the school. From the interview results obtained data service life and description of building materials used in school building. Table 2 shows the data of service life and description of building component and material used for the school building.

Table 2. Service life and description of building component/materials

Groups	Building Components	Service Life (year)	Brand Component/Material
Roof Structure	Steel roof structure	40	Steel
	Roof tile (*zincalume*)	35	*Zinclume*
	Gutter	15	Fiber
Wall, Door & Window	Paint for wall	10	Dulux & Catylac
	Paint for aluminum	12	Catylac
	Paint for wooden	12	Catylac
	Paint for roof tile	15	Catylac
	Aluminum window and window	20	Alexindo
	Wooden frame	20	Jati wood
	Wooden shutters for door and window	20	Jati wood
	Glass for door & window	20	Glass 5 mm
Floor	Ceramic	30	Roman
Ceiling	Gypsum	15	Local
	GRC	20	Kalsiboard
	Paint for ceiling	15	Catylac
Sanitary	Sink	8	Toto
	Stainless steel sink	12	Toto
	Water Crane	3	Toto
	Urinal	15	Toto
	Water Closed	15	Toto
	Hand shower	5	Toto
	Floor drain	8	Toto
	Pipe PVC	35	Waving
Accessories	Slot for door & window	10	Aluminum
	Handle for door and window	18	Aluminum
	Hinge for door and window	15	Aluminum
MEP	Lamp T8	7	Philips
	Ordinary Lamp	5	Philips
	Wall type stop-contact	20	Scheneider
	Single switch	18	Scheneider
	Double switch	18	Scheneider
	Fitting	15	Scheneider
	AC	10	LG
	Lift	35	Hyundai
	Fire alarm	30	Siemens
	Tele-phone	15	Telkom
	CCTV	30	Sonny

4.4 Life Cycle Cost Analysis

4.4.1 Development costs

The value of construction costs is based on information from the management of the building based on development data of Rp.5.000.000/ m² and fees 10% of development cost. Then the total cost of development is (9.984 x Rp.5.000.000) + (10% x (9.984 x Rp.5.000.000)) = Rp.54.912.000.000.

4.4.2 Operational costs

Components of operational costs consists of 3 parts, namely:
1. Cleaning Cost
a. Employees
The number of employees who handle cleaning as many as 30 people, consisting of 5 coordinators and 25 members. With salary for coordinator Rp.2.550.000 per month, and salary for employee Rp.2.100.000 per month. Then the total cost incurred during one month for the employee is Rp.65.250.000.
b. Material
The materials used for cleaning are floor cleaners, glass cleaners, table cleaners, and dish cleaners in lump sum. Costs incurred for materials refer to information obtained from the building management of Rp.3.000.000/month.
c. Tools
The tools used for cleaning consists of vacuum cleaner 5 pieces, 20 broom swabs, 15 mop broom, 20 glass cleaners, 30 cleaners and 8 dishwashing sponge. Costs incurred for materials refers to the information obtained from the building management of Rp.25.000.000 on the initial purchase. Referring to building management information for maintenance and replacement of tool set Rp.1.000.000/month in lump sum. The cost of the cleaning group is shown in Table 3.

Table 3. Cost incurred of cleaning group per month.

No	Group	Cost Item	Qty	Unit	Unit Cost (Rp)	Total (Rp)
1	Clean-ing					
1.1		Labour	5	Man-month	2,550,000	12,750,000
		Labour	25	Man-month	2,100,000	52,500,000
1.2		Mat'l		Lump sum	3.000.000	3.000.000
1.3		Tool		Lump sum	1.000.000	1.000.000
	Total					69.250.000

2. Cost of Utilities
The utilities cost consists of electricity, telephone, generator, internet, and Stated Water Supplier. For details of cost calculation can be seen below:
a. For the calculation of electricity cost using tariff of Stated Electricity Supplier (PLN) that is Rp.1.467,28/kWh assuming monthly electricity usage 16.000 kWh. Then the total cost incurred is 16.000 x Rp.1.467 = Rp.23.476.480
b. The calculation of telephone expenses is based on average building management experience of Rp.900.000/month.
c. For the calculation of generator costs using non-subsidized diesel fuel price Rp.7.200, assuming the use of diesel fuel 300 liters / month. Then the total cost incurred is 300 x Rp.7.500 = Rp.2.160.000.
d. For calculation of internet cost using monthly package speedy gold that is Rp.5.000.000/ month.
e. For the calculation of PAM cost is based on PDAM price of Jakarta class 2F for educational institution Rp.8.150/m³ with the assumption of water requirement that is 500 m³ / month. Then the total cost incurred is 500 x Rp.8.150 = Rp.4.075.000.
Table 4 shows the cost spent for the utilities group based on the information provided from the building maintenance officers during the interview.

Table 4. Cost incurred on utilities group per month.

No	Group	Item	Qty	Unit	Unit cost (Rp)	Total(Rp)
2	Utilities					
2.1		Electricity	16000	kWh/month	1.467,28	23.476.480
2.2		Phone bill	1	month	900.000	900.000
2.3		Generator	300	liter /month	7200	2.160.000
2.4		Internet	1	month	5.000.000	5.000.000
2.5		Water bill	500	m3/month	8.150	4.075.000
					TOTAL	35.611.480

3. Cost of administration
The cost of the admin section in building management consists of managers, electronics teams, sanitation teams, equipment teams, personnel. For detailed calculation of bias cost seen below:

Tabel 5. Cost incurred for administration group.

No	Group	Item	Qty	Unit	Unit cost (Rp)	Sum (Rp)
3	Adminis tration					
3.1		Manager	1	Man-month	6.000.000	6.000.000
3.2		Deputy	1	Man-month	4.750.000	4.750.000
3.3		Team electric	3	Man-month	3,500,000	10,500,000
3.4		Team sanitary	3	Man-month	3,500,000	10,500,000
3.5		Supporting	3	Man-month	3,500,000	10,500,000
3.6		Supervisor	4	Man-month	1,800,000	7,200,000
					TOTAL	49.450.000

a. For the calculation of manager salary Rp.6.000.000/month, with the amount of 1 person.

b. For the compensation of the deputy manager salary Rp.4.750.000/month, with the amount of 1 person.
c. For the electrical team calculation consists of 3 person with salary per person Rp.3.500.000/ month. Then the total cost incurred per month to pay the electrical team is 3 x Rp.3.500.000 = Rp.10.500.000.

d. For sanitation team calculation consist of 3 people with salary per person Rp.3.500.000/ month. Then the total cost incurred per month to pay the electrical team is 3 x Rp.3.500.000 = Rp.10.500.000.

e. For the calculation of team equipment consists of 3 people with salary per person Rp.3.500.000/month. Then the total cost incurred per month to pay the electrical team is 3 x Rp.3.500.000= Rp.10.500.000.

f. For personnel calculation consist of 4 people with salary per person Rp.1.800.000/month. Then the total cost incurred per month to pay the electrical team is 4 x Rp.1.800.000 = Rp.7.200.000. SeeTable 5.

For the calculation of the group that make the operational cost with total cost per month that is Rp.154.311.480 used as percentage, hence get the percentage of cleaning 45%, utilities 23%, and admin 32%. The pie chart of the group that makes up the operational costs is shown in Figure 1.

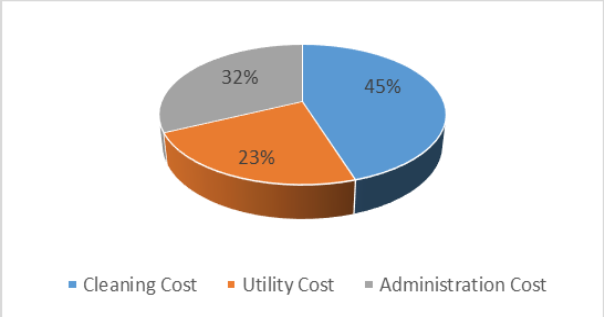

Fig 1. Proportional of three elements of operational cost.

4.4.3 Maintenance and Replacement Costs

The cost of maintenance and replacement with a 25 years plan consists of the cost of roof structure, wall, floor, ceiling, sanitation, ME, and accessories. For details of cost calculation can be seen below:
1. Group roof structure consists of the following components. Structure steel frame with service life 40 years. The school building was built in 2009 with the LCC of 25 year plan then there is no maintenance and replacement on steel frame structure. Zincalume tile with 35 year service life. The 25 year LCC plan there is no replacement and but still possible the maintenance by painting. Gutter with service life of 15 years. The total cost was estimated as Rp. 343.000.000.
2. The wall group consists of the following components. Paint wall with 10 year service life for exterior and 15 years for interior. The interior area is 16,520 m² and the replacement cost is Rp.105.000/m² (cost including material and wage), then the cost incurred in the 15th year is 16,520 x Rp.105.000 = Rp.1.734.600.000. While for exterior area is 4,142 m² and replacement cost Rp.200.000/m² (cost including material and wage), hence expense in year 10, and year 20 that is 4,142 x Rp.200.000 = Rp.828.400.000. Total of LCC for 25 years was estimated as Rp. 4.624.800.000.

3. Floor group consists of Ceramics with 30 year service life. With a floor area that uses ceramics that is 9.975 m², then with the age of 25 years plan there is no replacement and but still possible the maintenance on the tile floor.

4. The ceiling group consists of the following components.
Gypsum or ceiling with service life 15 years. With the plafond area using gypsum is 7.680 m² and replacement cost was estimated Rp 1.485.820.000.

5. Sanitation group LCC for 25 years was estimated Rp. 590.070.000 with the components sink, water tap, urinal, WC squat, hand shower, etc.

6. Group accessories consist of the following components: slot and hinge for doors and windows, with a total LCC was estimated as 134.472.000

7. The MEP group consists of the components, such as T8 type lamp with 7 year service life; normal lamp with 24 watt tornado or threaded type, with 5 year service life; stop contact with service life 20 years; double switch with 18 year service life; TL fittings with service life 15 years; etc. The total LCC for 25 years was estimated 5.636.184.000.

Table 6. Summary of cost for maintenance and replacement at the service of 25 years

Group	Components of building	Cost over 25 years (Rp)
Roof Structure	Frame, purlins, roof, gutters	343.000.000
Wall	Interior, exterior, painting, windows and doors	4.624.820.000
Floor	Granit and tile	-
Ceiling	Gypsum, GRC, painting	1.485.916.500
Sanitary	Sink, basin, water faucet, urinal, squat toilet, seat toilet, hand shower, floor drain, plumbing.	590.070.000
Accessory	Doors and windows slots, hinges, handles.	134.472.000
Mechanical & Electrical	Lamps, stop contact, sucker, fitting, AC, lift, fire alarm, telephone, CCTV, water heater.	5.636.184.000
	Total (Rp)	12.814.462.500

Table 6 and Figure 2 shows the summary of LCC for 25 years for maintenance and replacement cost of the building, and the proportion the groups components of the building respectively. Roof structure = 2.70%; wall = 36.10%; ceiling = 11.60%; sanitary = 4.60%; accessory = 1.80% and mechanical and electrical (ME) =43.20%. Since service life for the floor is longer than 25 years, then the replacement cost would not appear in the LCC plan.

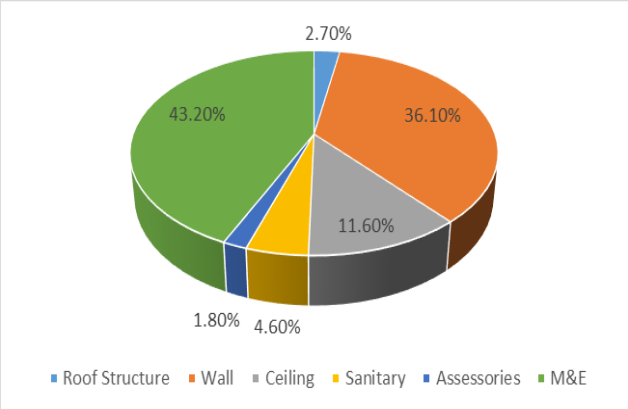

Fig. 2 Proportional of Maintenance and Replacement Cost for six Major Groups of Component.

4.4 Overall LCC of the building

Total cost of life cycle cost planning at the school building consisted of: development cost Rp.54.912.000.000 (46%), operational cost Rp.46.293.444.000 (39%), maintenance and replacement cost Rp.12.814.462.500 (15%), Total cost of life cycle cost plan for 25 years would be Rp.114.019.906.500. Figure 3 shows the proportion of these costs.

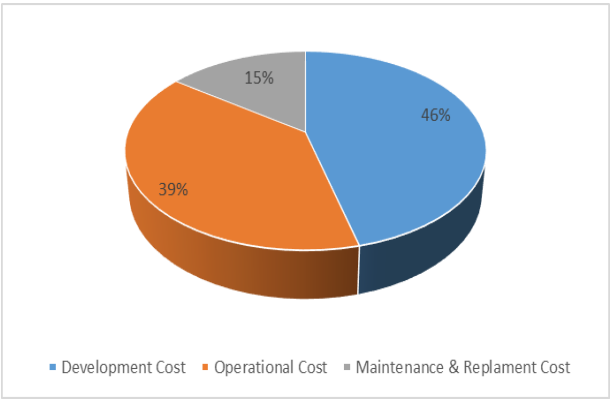

Fig. 3. Proportional LCC of Development, Operational, and Maintenance & Replacement Cost Over 25 years Period.

4.5 Discussion on depreciation

Depreciation is a decrease in physical property over time for its service life. Depreciation is a non-cash cost that affects income tax. Deprecated properties must meet the following conditions: 1) should be used in business or maintained to generate income; 2) must have a certain useful life, and should be longer than a year; 3) the property was decay/destruction, obsolescence, or decreases the value of its original value.

Depreciation is an important component in technical economic analysis, since it can be used to determine the value of an asset over time, can be used to allocate depreciation (accounting depreciation) value of the asset. Since the building would be handed over and be operated by the building management of the school building, the calculation of depreciation value of the building was ignored [18,19,20].

4.6 Comparison with other school buildings

Table 7 shows the comparison of LCC cost of three studies. Private schools tends to have larger operational cost. While that from state university had larger maintenance and replacement.

Table 7. Comparison of LCC studies

No *	Location	Development Cost	Operational Cost	Maintenance& Replacement Cost
1	Private University at Yogyakarta [21]	43%	46%	11%
2	State University at Yogyakarta [22]	41%	11%	47%
3	Private High School at Jakarta	46%	39%	15%

5 Conclusion and recommendation

Results of analysis and the discussion regarding maintenance with the school building officer, it can be concluded as follows. Applying the Minister of Public Works Regulation number 24/PRT/M/2008 on Guidelines for Maintenance and Maintenance of Buildings, the officer of the maintenance department of the building obtained a total score of 4.6 out of 5 scale, implying that the implementation of the construction of school is well done by the maintenance of the building since it is classified as very good. But the users only score 3 as only good classification of maintenance performance of the school building. This implying that there is a gap between the users' need and the building maintenance officers.

Based on the results of analysis and the discussion regarding of life cycle costing plan of the school building, it can be concluded as follows.

1. There are three groups that compile the plan of life cycle cost analysis of the school building, namely initial development cost, operational cost, and maintenance and replacement cost.
2. In the development cost group costing Rp.77.845.625.000 (91%), in the operational cost group costs Rp.3.712.621.500 (4%), the maintenance and reimbursement cost group costs Rp.4.405. 091.000 (5%).
3. In the operational group, the largest cost is on the item admin Rp.52.150.000 (35%), followed by utilities cost Rp.25.854.860 (17%), and cleaning costs Rp.70.500.000 (48%).
4. In the largest maintenance and reimbursement cost group went to ME = Rp.2.102.226.000 (47.7%), sanitation Rp.200.186.200 (4.5%), wall Rp.1.008.062.200 (22.9%), ceiling Rp.1.006.128.000 (22.8%), accessories Rp.71.060.000 (1.6%), for floor no replacement and maintenance due to service life more than 25 year, and for roof Rp.17.429.500 (0.5%).

Based on the experience gained during the study, five suggestion are provided. 1) As to find out the gap

provided by building maintenance officers and the user, the building maintenance officers should pay more attention to the maintenance of buildings ranging from the smallest to large components and facilities in order to provide comfort for users of the building, i.e. maintenance of gypsum ceiling has to be carried out with accordance to the standard of Regulation of Minister of Public Works Number: 24/PRT/M/2008. 2) In this study the life cycle costing plan that using service life obtained from in building management officers are not recorded data. All data were at the top of the head of the officer. Therefore, the top management school should start with the policies to record g service life related to the use of materials and quality of materials so it can determine more reasonable service period of the component of the building. This can also be a consideration for better of the future in planning life cycle costing. 3) The cost incurred in each group of the LCC plan can be adjusted to the financial condition of the school, if the management desires for savings on some group of building components. 4) For the future studies in service life of the building components, it cannot solely rely on the manufactures that produced on the building component. Factors methods form ISO 15686 part 1 on service life predicting and methodology can be adopted. 5) For future study, perhaps the LCC 25 five years would be more appropriate to extend to whole life cycle costing.

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