



LIFE CYCLE COST ANALYSIS OF BUILDING MAINTENANCE

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ABSTRACT

Building maintenance is an activity to maintain the reliability of the building so that it remains functional following the Regulation of the Minister of Public Works No. 24 / PRT / M / 2008 concerning Building Maintenance Guidelines; building maintenance includes architectural, structural, and mechanical maintenance. This problem must be considered during building construction to realize the use of structures that fulfil requirements for efficiency, environmental harmony, safety, health, comfort, and convenience. With regular maintenance, the building can achieve its design life with a minor frequency of damage and repair. The cost of building maintenance will increase yearly according to the inflation increase in each region. This study aims to analyze the maintenance costs of the Sports Center building using the LCC (Life Cycle Cost) method with architectural aspects (walls, ceilings, and floors) within the next 20 years. Life cycle costs (LCCs) are costs required by a building over the life of its plan. This approach assesses the total cost of an asset over its life cycle, including initial capital costs, maintenance costs, operating costs, and the residual value of an asset at the end of its life. The study's findings demonstrate how to create a model for predicting maintenance costs. According to this, the Sports Center building must spend IDR 1.445.082.148,15 on maintenance over the next 20 years. The following includes IDR 280.180.770,42 for ceiling maintenance, IDR 338.260.528,79 for walls, and IDR 826.640.848,94 for flooring.

Keywords: *Construction Building Maintenance, Life Cycle Cost, Maintenance Costs*

JIPTEK: Jurnal Ilmiah Pendidikan Teknik dan Kejuruan
Vol 16 Issue 2 2023

Received:25/11/22 Revised:17/05/23 Accepted: 18/05/23
Online:14/06/23

DOI: <https://doi.org/10.20961/jiptek.v16i2.67729>

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INTRODUCTION

The building has various functions according to the needs of its owners. Building upkeep occurs to preserve this feature so the structure is always fit. The need for regular maintenance to care for the building to reach a predetermined age of the building. With regular maintenance, frequency of replacement and repair will be carried out more and more frequently during the life of the

building plan, resulting in high maintenance costs. Hence the cost of the entire project cycle will also be high.

One method that can be used to analyze the economic value of a building by considering operational costs throughout the life of the building is the Life Cycle Cost (LCC) method. This method has been known since the mid-1970s and has now been applied by large corporations and government-sponsored projects in several countries. This method is also helpful in making decisions based on economic value, considering the location, engineering and

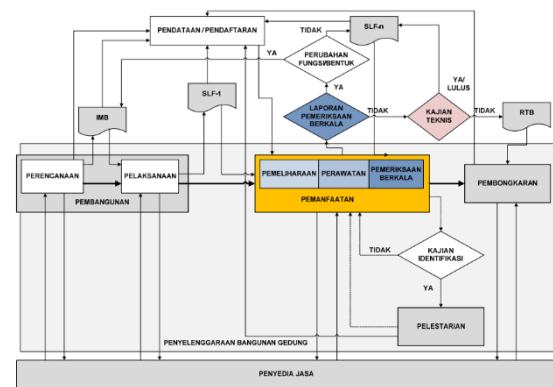
planning of architecture, construction, arrangement, and operation to disposal followed by replacement of components or systems during a life span.

Building Maintenance

Building maintenance seeks to make it possible to utilize structures that are efficient, in tune with the environment, safe, healthy, comfortable, and convenient. It is required to do routine building maintenance following applicable criteria in order to realize this. Building maintenance is an activity to maintain the dependability of the building and its infrastructure and facilities so that the building is always livable, according to the Indonesian Minister of Public Works Regulation Number 24/PRT/M/2008 concerning the Guidelines for Building Maintenance and Maintenance (Rakyat, 2008).

The Hall of the Training Education Center is a unique training place for human resources to support service performance. The Hall of the Training Education Center consists of several buildings, a Sports Center, mosques, libraries, punctuality buildings, mechanical labs and others. To support the function, it is necessary for buildings the implementation of routine maintenance as a form of maintenance of the feasibility of the building according to the age of the planned building. The discrepancy in the implementation of maintenance and the non-maintenance of buildings in this building caused some buildings to undergo repairs often. The Sports Center building underwent wall repairs in 2020 with a new building age of 4 years. Maintenance activities were carried out, but

there was no list of periodic inspections and no building maintenance. Based on preliminary surveys, there are several visible damages, namely fine cracks in some of the building walls, peeling paint, and ceilings. For the period of use to be by the plan, it is necessary to periodically maintain the building against damage to building components to maintain the comfort level of building users (Nanda, Ratnaningsih, &



Nurtanto, 2020).

Figure 1. Building Implementation Process
Source: (Rakyat, 2010)

From Figure 1, it can be seen that at the stage of building utilization, utilization implementation of Maintenance, Maintenance and periodic inspection of the building. Based on the Government Regulation of the Republic of Indonesia Number 36 of 2005, which was amended into Government Regulation of the Republic of Indonesia Number 27 of 2018. Certificate of Eligibility for Building Functions, as referred to, is valid for 20 (twenty) years. Therefore, the maintenance cost for the 20 years from which the building was erected will be calculated.

Life Cycle Cost

Life Cycle Cost (LCC) is the concept of modelling the calculation of costs from the initial stage to the dismantling of assets from a project as a tool for making decisions about analytical studies and calculations of total costs that exist during its life cycle. LCC can be defined as the method for assessing the economic value of decisions of a design project. LCC is from cradle-to-grave costs. Life cycle costing for buildings is usually taken as a total cost. This total cost includes annual operating, maintenance and disposal costs (Levander, Schade, & Stehn, 2009). The technique can help make decisions about building investment projects (Schneiderova-Heralova, 2018). LCC integrates several mathematical calculations that help to identify future costs (Flanagan et al., 2005; Manewa, Siriwardena, & Wijekoon, 2021). According to Ashworth (1994) (in Kamagi, Tjakra, & Malingkas, 2013), various factors are considered essential and related to Life Cycle Cost. Such factors are building age (biological age, functional age, and economic era), component age, interest, taxation, design methods, and quality in construction.

Life Cycle Cost is a way that at least theoretically has the potential to evaluate construction work and is one of the successful techniques for identifying the total cost of ownership of construction assets (Manewa, Siriwardena, & Wijekoon, 2021).

RESEARCH METHOD

The Life Cycle Cost method is used only on building elements of walls, floors, and ceilings. Based on the Indonesian Government

Regulation No. 36 year 2005 (Pemerintah, 2005), the approximate life of the plan used is 20 years. The research was conducted at the Sports Center in Bandung City, West Java. The following are the stages for which the calculation is used:

- Determine the initial cost of construction of each work.
- Calculates the cost of maintenance with the influence of inflation using the open rate, with the formula:

$$F = P (F/P, i\%, N) \quad (1)$$

(Source: Pujawan, 2009)

Where: F = Future Worth

P = Present Value

i% = Effective interest rate period

N = Number of drying periods

- Create an actual Lifecycle Costs table.

RESULTS AND DISCUSSION

Data processing process:

- The initial cost of the construction of each work:
- The calculation of maintenance costs over the life of the building uses interest rate inflation with the calculations in Table 1.

Table 1. Calculation of maintenance costs

2016				
No	Type of Work	Services/Wages	Material	TOTAL (+VAT)
1	Preparatory Work	Rp 5.628.466,80	Rp 27.446.116,72	Rp 33.074.583,52
2	Foundation Soil Excavation Work	Rp 9.040.779,33	Rp 2.296.800,00	Rp 11.337.579,33
3	Foundation and Solitary Work	Rp 63.287.223,82	Rp 225.928.416,12	Rp 289.215.639,94
4	Floor Work	Rp 67.735.537,98	Rp 157.855.723,56	Rp 225.591.261,54
5	Ceiling Work	Rp 32.879.728,33	Rp 47.275.476,34	Rp 80.155.204,67
6	Wall Work	Rp 51.008.556,82	Rp 138.414.582,25	Rp 189.423.139,07
7	Drainage Work	Rp 14.604.999,56	Rp 9.814.291,81	Rp 24.419.291,37
8	Bathroom and Dressing Room Work	Rp 30.466.484,95	Rp 120.369.644,24	Rp 150.836.129,19
9	Miscellaneous Work	Rp 5.918.777,09	Rp 82.226.725,74	Rp 88.145.502,82
10	Steel Construction Works	Rp 256.366.084,26	Rp 755.727.856,80	Rp 1.012.093.941,06
11	Electrical Works	Rp 9.700.115,04	Rp 47.907.813,80	Rp 57.607.928,84
12	Futsal Field Pavement Work (Interlock Type)	Rp -	Rp 256.410.685,12	Rp 256.410.685,12
13	Special and Additional Work	Rp -	Rp 23.650.000,00	Rp 23.650.000,00
TOTAL NUMBER		Rp 546.636.753,98	Rp 1.895.324.132,49	Rp 2.441.960.886,47

The amount of inflation obtained from the Central Statistics Agency of Bandung City yearly was 3.68%. Based on the Regulation of the Minister of Public Works and People Housing Number: 24/PRT/M/2008 concerning Guidelines for Building Maintenance and Maintenance (Rakyat, 2008), ceiling replacement is carried out at least once every 10 (ten) years. Ceiling maintenance over the next ten years with inflation of 3.68%. *The Sports Center* was built in 2016.

Known: P = IDR 80.155.204,67

$$i = 3.68 \%$$

$$N = 10 \text{ years}$$

Then, $F = P (F/P, i\%, N)$

$$= \text{IDR } 80.155.204,67 (F/P, 3.68\%, 10)$$

$$= \text{IDR } 80.155.204,67 (1,435)$$

$$= \text{IDR } 115.048.672,70$$

The calculation of the cost of maintaining floors and walls over the life of the building is carried out using the same formula. For the floor itself, the treatment is carried out by replacing it once every ten years and on the walls

themselves, painting is done once every four years. Table 2 elaborates the maintenance costs each year.

Table 2 Yearly maintenance costs

	LCC ceiling	LCC Ceramic Flooring	LCC Concrete Flooring	LCC Paintings
2016	IDR 80.155.204,67	IDR 138.424.960,32	IDR 98.063.669,26	IDR 43.347.914,97
2017	IDR 83.104.916,20	IDR 143.518.998,86	IDR 101.672.412,29	IDR 44.943.118,24
2018	IDR 86.163.177,12	IDR 148.800.498,02	IDR 105.413.957,07	IDR 46.597.025,00
2019	IDR 89.333.982,03	IDR 154.276.556,35	IDR 109.293.190,69	IDR 48.311.795,52
2020	IDR 92.621.472,57	IDR 159.953.726,26	IDR 113.315.180,10	IDR 49.623.447,29
2021	IDR 96.029.942,76	IDR 165.840.033,38	IDR 117.485.178,73	IDR 51.449.590,15
2022	IDR 99.563.844,66	IDR 171.942.936,25	IDR 121.808.633,31	IDR 53.342.935,07
2023	IDR 103.227.794,14	IDR 178.270.436,30	IDR 126.291.191,01	IDR 55.305.955,08
2024	IDR 107.026.576,96	IDR 184.830.788,36	IDR 130.938.706,84	IDR 57.341.214,23
2025	IDR 110.965.155,00	IDR 191.632.561,37	IDR 135.757.251,25	IDR 59.451.370,91
2026	IDR 115.048.672,70	IDR 198.684.639,62	IDR 140.753.118,10	IDR 61.639.181,36
2027	IDR 119.282.463,86	IDR 205.996.234,36	IDR 145.932.832,85	IDR 63.907.503,23
2028	IDR 123.672.058,53	IDR 213.576.895,79	IDR 151.303.161,10	IDR 66.259.299,35
2029	IDR 128.223.190,28	IDR 221.436.525,55	IDR 156.871.117,42	IDR 68.697.641,57
2030	IDR 132.941.803,68	IDR 229.585.389,69	IDR 162.643.974,34	IDR 71.225.714,78
2031	IDR 137.834.062,06	IDR 238.034.132,03	IDR 168.629.272,81	IDR 73.846.821,08
2032	IDR 142.906.355,54	IDR 246.793.788,09	IDR 174.834.830,05	IDR 76.564.384,10
2033	IDR 148.165.309,43	IDR 255.875.799,49	IDR 181.268.751,79	IDR 79.381.953,43
2034	IDR 153.617.792,81	IDR 265.292.028,92	IDR 187.939.441,86	IDR 82.303.209,32
2035	IDR 159.270.927,59	IDR 275.054.775,38	IDR 194.855.613,32	IDR 85.331.967,42
2036	IDR 165.132.097,72	IDR 285.176.791,32	IDR 202.026.299,89	IDR 88.472.183,82

The total maintenance cost during the life of the building is IDR 1.445.082.148,15, with details of painting work carried out 2 times, floor repairs 2 times, and wall painting 5 times in 20 years, as depicted in Table 3.

Table 3 Detail of maintenance costs

Description	Total Price
Ceiling Maintenance Costs	IDR 280.180.770,42
Wall Maintenance Cost	IDR 338.260.528,79
Floor Maintenance Costs	IDR 826.640.848,94
Total Cost	IDR 1.445.082.148,15

CONCLUSION

Using the basic calculation of Life Cycle Cost (LCC) at the Sports Center Building for wall, floor, and ceiling work items, the total maintenance cost with inflation of 3.68% in the

20 years since the building was built was IDR. 1.445.082.148,15. A breakdown of costs consisting of:

- Wall Maintenance Cost is IDR 338.260.528,79, maintenance costs with five times of paintings.
- Floor Maintenance Cost of IDR 826.640.848,94, maintenance costs with two replacements of ceramics and concrete.
- Ceiling Maintenance Cost IDR 280.180.770,42, maintenance costs with two times ceiling replacement

Implications and recommendations from the results of the study of Life Cycle Cost Analysis of Building Maintenance:

- In the calculation of Life Cycle Cost (LCC), it is known that the costs that need to be prepared by the project owner are not only construction costs; there are other costs for the building to remain fit to function for the life of the planned building. Life Cycle Cost can be applied to every construction calculation to make it easier for building managers to determine yearly maintenance costs.
- Calculations using the Life Cycle Cost (LCC) method in determining planning costs need to be carried out in the entire scope of maintenance following the Regulation of the Minister of Public Works No. 24/PRT/M/2008 concerning Building Maintenance Guidelines, not only the scope of architecture.

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