Life Cycle Cost Identification on Building Maintenance of *Badan Pengelola Keuangan Daerah Pematangsiantar*

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Abstract. *Badan Pengelola Keuangan Daerah Pematangsiantar* building has been established since 1981 and has been operating for more than 30 years. In order for the function of the building not to decrease during the life of the plan, routine maintenance is needed. However, maintenance carried out on the building so far has only been carried out in the events of damage or just as needed. Therefore, it is necessary to conduct a Life Cycle Cost study at *Badan Pengelola Keuangan Daerah Pematangsiantar* building to analyze the economic value of the building by considering the operating costs throughout the life of the plan. The purpose of this research is to make a long-term plan of Life Cycle Cost and to identify maintenance components of the building by making a financial schedule of maintenance costs over the life of the plan and to know the biggest maintenance costs. From the results of the research carried out, the total maintenance costs for the next 15 years amounted to Rp 2,052,491,356 which consisted of mechanical components maintenance amounted to Rp 386,534,267, electrical components amounted to Rp 1,078,841,811 and external spatial components amounted to Rp. 578,115,279. As well as the biggest maintenance costs on the maintenance of all components reviewed is the maintenance of electricity network with an average weight for the next 15 years of 29.86%.

Keywords: Building maintenance, financial schedule, life cycle cost, maintenance component

1 Introduction

Pematangsiantar City is the second largest city in North Sumatra Province. Pematangsiantar City is also has various characteristics of economic activities and consumption as a potential source of regional income. Therefore, the government of Pematangsiantar City built the *Badan Pengelola Keuangan Daerah* building in Pematangsiantar as the organizer of government affairs in the area of regional revenue in 1981 and has been operating for more than 30 years.

In order for the function of a building is not reduced throughout the life of the plan, there is a need for routine maintenance of buildings. However, maintenance of buildings so far has only been carried out if there is a damage that occurred or according to the required needs. With routine maintenance, the frequency of replacements and repairs will be increasingly frequent over the life of the building plan, resulting in high maintenance costs, then the overall costs of the project cycle will also be high [1].

To analyze the economic value of a building by considering maintenance costs throughout the life of the building plan, it is necessary to do studies of *Life Cycle Cost* [2]. The life cycle cost – LCC is the total cost of a building or its parts throughout its life, and it includes the costs of planning, design, operation, maintenance and disposal, less any residual value [3]. The purpose of the *Life Cycle Cos*t is to manage life cycle costs (long-term) rather than short-term savings, to ensure a consistent service according to the purpose of designing a building, to increase sustainability and to reduce the risk of failure [4].

Based on the background above, it is necessary to do research by identifying the *Life Cycle Cost* on the components to be examined in the Badan Pengelola Keuangan Daerah building of Pematangsiantar by making a *financial schedule* of maintenance costs during the life of the plan. So that the results of this research will later provide an overview and input about *Life Cycle Cost* in the building to consider various alternatives and to find out the biggest maintenance cost during the life of the building plan.

The research purposes are as follows:

First, to calculate the long-term plan of *Life Cycle Cost* on the maintenance of the building for the next 15 years.

Secnd, to identify the maintenance components which its *Life Cycle Cost* to be calculated by making a financial schedule of maintenance costs and knowing the biggest maintenance costs during the life of the plan.

2 Methodology

Hidayat and Sedarmayanti suggested that research methodology is a discussion of theoretical concepts of various methods, advantages and disadvantages, which in the scientific work continued with the selection of the methods used [5]. The purpose of the existence of a research methodology is to direct the thinking process and work process to answer the problems that will be investigated further.

The research which its maintenance components to be reviewed is located in the *Badan Pengelola Keuangan Daerah Pematangsiantar* building at *Jalan Merdeka No. 8, Pematangsiantar* City.

2.1 Research Processes

The problem chosen as the topic of this research is to find the background, in this case the author chooses the *Badan Pengelola Keuangan Daerah Pematangsiantar* building.

After identifying the problem and determining the title of the research, the next thing to do is to determine the purpose of the research.

Literature studies in this research is needed to be done to find the data in the form of journals, books, and the internet that relate and support this research.

In this research, the data needed are: Primary data, direct interviews with respondents regarding main-tenance on the office building of *Badan Pengelola Keuangan Daerah* of *Pematangsiantar*, and Secondary Data, maintenance data of the building in 2013-2017 and inflation data in 2013-2017 based on *Badan Pusat Statistik* of *Pematangsiantar* City.

In analyzing the data in this research is by using *Life Cycle Cost* Analysis. The calculation of *Life Cycle Cost* Analysis in this research is based on the maintenance data of the building for the last 5 (five) years.

At the final stage, conclusions are made based on the data that has been analyzed which is directly related to the purposes of the research along with suggestions for further research.

2.2 Preliminary Survey

Survey is an activity to visit the object of the research directly to obtain important information related to this research.

2.3 Data processing stage

Maintenance components that will be reviewed are divided into 3 types of maintenance [6], which are:

a. Mechanical components. Included in the maintenance is: water network.
b. Electrical components. Included in the maintenance are: *generatorset*, electricity network and internet / computer network.
c. Outer spatial components. Included in the maintenance are: roof, fence and wooden *listplank*.

2.3.1 Inflation

Inflation is used to calculate the amount of building maintenance costs over the next 15 years. The amount of the inflation can be taken *from Badan Pusat Statistik (BPS) of Pematangsiantar* City for the last 5 (five) years. The next stage is to get the average of the inflation value for the last 5 (five) years with the formula:

$$\text{Average} = \frac{\sum(inflation\ 2013-2017)}{amount\ of\ samples} \tag{1}$$

2.3.2 Table of interest

The interest table is used to get the value of the inflation factor. The table of interest used is taken from a book of compound interest tables.

2.3.3 Calculating maintenance costs using the interest rate formula

Calculating maintenance costs for 15 years is by using the single payment interest rate formula [7]:

$$F = P\ (F/P,\ i\%,\ N\ ) \tag{2}$$

2.3.4 Calculating the biggest maintenance cost

Determining the biggest amount of maintenance cost by calculating the percentage of component maintenance costs each year with the formula [7]:

$$\text{Average} = \left(\frac{\sum(maintennace\ costs\ 2018-2027)}{15}\right) \tag{3}$$

Then, to get the percentage of maintenance costs each year is by using the formula [7]:

$$\text{Percentage} = \left(\frac{components\ maintenance\ costs}{total\ of\ maintenance\ costs}\right) \text{X } 100\% \tag{4}$$

3 Result and Discussion

3.1 Identification of the Reviewed Building Components

Mechanical Components. Included in the mainte-nance of mechanical components is:

Table 1. Maintenance Costs of Mechanical Components in 2013-2017

Maintenance	Maintenance Cost
	Water Network
2013	
2014	
2015	Rp 15.000.000
2016	Rp 15.000.000
2017	Rp 17.000.000

Source*: Kasubbag Data dan Program Badan Pengelolaan Keuangan Daerah Pematangsiantar*

Electrical Components. Included in the maintenance of electrical components are:

Table 2. Maintenance Costs of Electrical Components of in 2013-2017

Maintenance	Maintenance Cost		
	Generatorset	Electrical Network	Internet/Computer Network
2013	Rp 10.000.000		Rp 5.000.000
2014	Rp 12.300.000		
2015	Rp 12.000.000	Rp 20.000.000	Rp 10.000.000
2016	Rp 12.000.000	Rp 40.000.000	Rp 10.000.000
2017	Rp 14.000.000	Rp 35.000.000	Rp 12.000.000

Source: *Kasubbag Data dan Program Badan Pengelolaan Keuangan Daerah Pematangsiantar*

Outer Spatial Components. Included in the mainte-nance of outer spatial components are:

Table 3. Maintenance Costs of Outer Spatial Components in 2013-2017

Maintenance	Maintenance Cost		
	Roof	Fence	Wooden *Lisplank*
2013			
2014			
2015			
2016			
2017	Rp 20.824.732	Rp 2.019.689	Rp 16.823.445

Source: *Kasubbag Data dan Program Badan Pengelolaan Keuangan Daerah Pematangsiantar*

3.2 Inflation

Cost estimation is calculated by the effect of inflation. Inflation data taken at *Badan Pusat Statistik* of Pematangsiantar City are as follows:

Table 4. Inflation of Pematangsiantar City

Year	Inflation (%)
2013	12,02
2014	7,94
2015	3,36
2016	4,76
2017	3,10

Source: *Indeks Harga Konsumen dan Inflasi Kota Pematangsiantar*

Next, to get the average inflation value for the last 5 (five) years is by using the formula:

$$\bar{x} = \frac{x1+x2+x3+\cdots+xn}{n} \tag{1}$$

which:

$\bar{x}$ = Average

x1, x2, x3 = Value of samples

n = Amount of sampels

So that the average is obtained as follows:

$$\bar{x} = \frac{12,02\%+7,94\%+3,36\%+4,76\%+3,10\%}{5}$$

$$\bar{x} = 6 \%$$

Based on the calculation above, the inflation value to be used for the next 15 years is 6% and is assumed to be fixed. Then, to get the value of the inflation factor of 6% can be seen in the following table:

Table 5. Factors of 6% Compund Interest

N	Single Payment	
	Factors of Number of Compound F/P	Factors of Present Value P/F
1	1.0600	0.9434
2	1.1236	0.8900
3	1.1910	0.8396
4	1.2625	0.7921
5	1.3382	0.7434
6	1.4185	0.705
7	1.5036	0.6651
8	1.5938	0.6274
9	1.6895	0.5919
10	1.7908	0.5584
11	1.8983	0.5268
12	2.0122	0.4970
13	2.1329	0.4688
14	2.2609	0.4423
15	2.3966	0.4173

Source: *Taufik, Hendra. 2009. Tabel – Tabel Bunga Majemuk, Department of Civil Engineering The University of Riau Pekanbaru.*

3.3 Maintenance Cost Estimation With the Effect of Inflation by Using Rate Interest Formula

The calculation of components maintenance costs estimation that will be calculated to the next 15 years, can use a single payment interest rate formula (looking for F if P is known) as follows [7]:

$$F = P (F/P, i\%, N) \tag{2}$$

3.4 Recapitulation of Maintenance Costs of Mechanical Components

For the recapitulation of maintenance costs of mechanical components, it will be shown in table 6 and figure 1.

Table 6. Recapitulation of Maintenance Costs of Mechanical Components for 15 Years

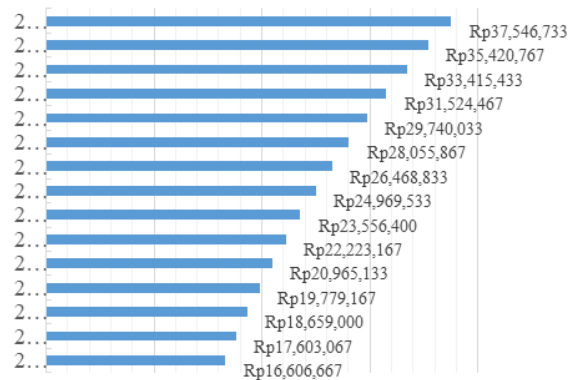| Maintenance	Maintenance Cost Water Network
2018	Rp 16.606.667
2019	Rp 17.603.067
2020	Rp 18.659.000
2021	Rp 19.779.167
2022	Rp 20.965.133
2023	Rp 22.223.167
2024	Rp 23.556.400
2025	Rp 24.969.533
2026	Rp 26.468.833
2027	Rp 28.055.867
2028	Rp 29.740.033
2029	Rp 31.524.467
2030	Rp 33.415.433
2031	Rp 35.420.767
2032	Rp 37.546.733

Fig.1. Graph Total of Maintenance Costs of Mechanical Components for 15 Years

3.5 Recapitulation of Maintenance Costs of Electrical Components

For the recapitulation of maintenance costs of electrical components, it will be shown in table figure 2
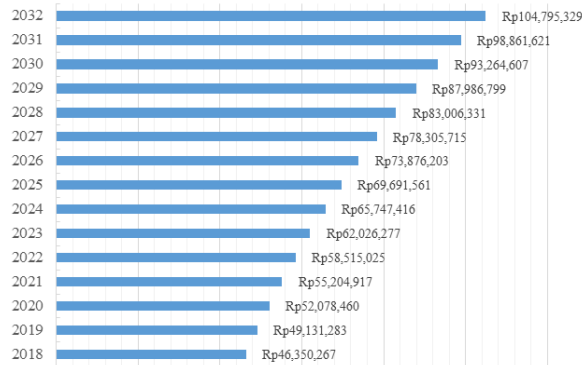
Fig.2. Graph Total of Maintenance Costs of Electrical Components for 15 Years

3.6 Recapitulation of Maintenance Costs of Outer Spatial Components

For the recapitulation of maintenance costs of outer spatial components, it will be shown in table 7 and figure 3 below.

Table 7. Recapitulation of Maintenance Costs of Outer Spatial Components for 15 Years

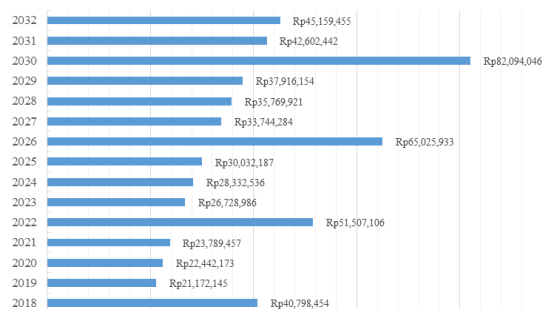| Maintenance	Maintenance Cost		
	Roof	Fence	Wooden *Lisplank*
2018	Rp 20.824.732	Rp 2.140.870	Rp 17.832.852
2019		Rp 2.269.323	Rp 18.902.823
2020		Rp 2.405.450	Rp 20.036.723
2021		Rp 2.549.857	Rp 21.239.599
2022	Rp 26.291.224	Rp 2.702.748	Rp 22.513.134
2023		Rp 2.864.929	Rp 23.864.057
2024		Rp 3.036.804	Rp 25.295.732
2025		Rp 3.218.980	Rp 26.813.207
2026	Rp 33.190.458	Rp 3.412.265	Rp 28.423.210
2027		Rp 3.616.859	Rp 30.127.425
2028		Rp 3.833.976	Rp 31.935.946
2029		Rp 4.064.018	Rp 33.852.136
2030	Rp 41.903.526	Rp 4.307.795	Rp 35.882.726
2031		Rp 4.566.315	Rp 38.036.127
2032		Rp 4.840.387	Rp 40.319.068

Fig.3. Graph Total of Maintenance Costs of Outer Spatial Components for 15 Years

3.7 Total of Maintenance Costs

For the recapitulation of the total of maintenance costs, it will be shown in table 8 and figure 4.

Table 8. Table of the Total of Maintenance Costs for 15 Years

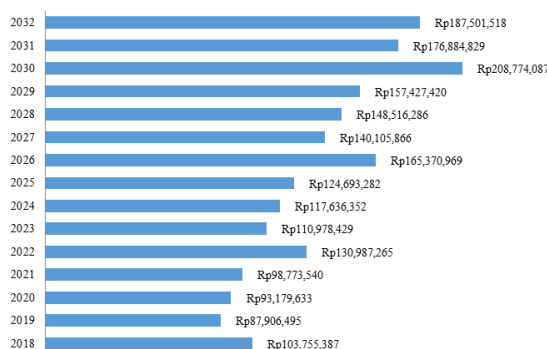| Maintenance	Total of Maintenance Cost		
	Mechanical	Electrical	Outer Spatial
2018	Rp 16.606.667	Rp 45.626.667	Rp 40.798.454
2019	Rp 17.603.067	Rp 48.364.267	Rp 21.172.145
2020	Rp 18.659.000	Rp 51.265.616	Rp 22.442.173
2021	Rp 19.779.167	Rp 54.342.627	Rp 23.789.457
2022	Rp 20.965.133	Rp 57.602.083	Rp 51.507.106
2023	Rp 22.223.167	Rp 61.057.859	Rp 26.728.986
2024	Rp 23.556.400	Rp 64.721.110	Rp 28.332.536
2025	Rp 24.969.533	Rp 68.603.749	Rp 30.032.187
2026	Rp 26.468.833	Rp 72.722.061	Rp 65.025.933
2027	Rp 28.055.867	Rp 77.084.037	Rp 33.744.284
2028	Rp 29.740.033	Rp 81.709.881	Rp 35.769.921
2029	Rp 31.524.467	Rp 86.613.165	Rp 37.916.154
2030	Rp 33.415.433	Rp 91.808.965	Rp 82.094.046
2031	Rp 35.420.767	Rp 97.317.941	Rp 42.602.442
2032	Rp 37.546.733	Rp 103.158.787	Rp 45.159.455

Fig.4. Graph of the Total of Maintenance Costs for 15 Years

3.8 Graph of the Average of Maintenance Costs

To find the average maintenance cost every year, the following formula can be used:

$$\text{Average} = \left(\frac{\sum(maintenance\ costs\ 2018-2032)}{15}\right) \tag{3}$$

Then, to find the percentage of maintenance costs every year, the following formula is used:

$$\text{Percentage} = \left(\frac{components\ maintenance\ costs}{total\ of\ maintenance\ costs}\right) \times 100\% \tag{4}$$

Based on the formula above, the results of the average maintenance costs of all components are reviewed in the following table:

Table 9. The average maintenance costs of all components for 15 years

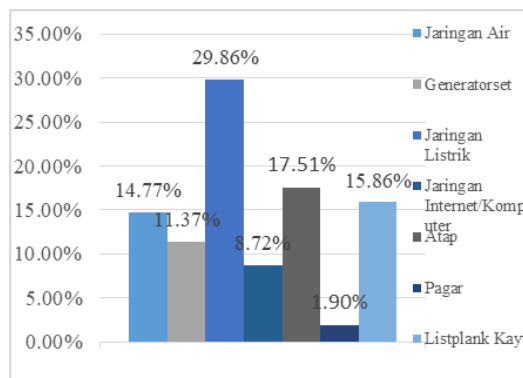| Maintenance	Maintenance Costs
Water Network	Rp 25.768.951
Generatorset	Rp 19.836.610
Electrical Network	Rp 52.086.178
Internet/Computer Network	Rp 15.214.647
Roof	Rp 30.552.485
Fence	Rp 3.322.038
Wooden *Listplank*	Rp 27.671.651
Total	**Rp 174.452.559**

Fig.5. Graph of the Average of Maintenance Costs of All Components for 15 Years

Based on Figure 3.5 above, it can be concluded that the highest cost of maintenance on the maintenance of all reviewed components is in the maintenance of electricity network with an average weight of 29.86% for the next 15 years.

4 Conclusion

From the results of the discussion, the amount of maintenance costs based on *financial schedule* for the next 15 years can be summarized as follows:

a. the total cost of the building maintenance is Rp. 2,052,491,356 and it is expected that an increase in maintenance costs will not be constant due to differences in maintenance cycle time for each components.

b. the maintenance of mechanical components is Rp. 386,534,267 and it is estimated that there will be an increase in maintenance costs every year.

c. the maintenance of electrical components is Rp 1,078,841,811 and it is estimated that there will be an increase in maintenance costs every year.

d. the maintenance of the outer spatial components is Rp. 578,115,279 and it is estimated that there will be an increase in maintenance costs every 4 years.

e. the biggest maintenance costs on the maintenance of all reviewed components is in electricity network maintenance with an average weight of 29.86% for the next 15 years.

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