Selection Alternative Electrical System Design at Property Mall, a Case in Ciputra World Surabaya Phase 3

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Abstract— A superblock area has a high complexity, both in the development process and later when it is operational, so it required the right design at the beginning. At project Ciputra World phase 3, especially on the electrical system (PLN combination with generator), required the selection of appropriate design. In determining the design which will be used there are several considerations, so the decision will be made is an alternative that has the highest value. The considerations in determining the design of this project are the Initial cost, Maintenance Cost, Energy Cost. Based on the background above, the methodology to be used in determining the selection of the best design for the electrical system in Ciputra World phase 3 is a Life Cycle Cost Analysis, where the costs of each alternative will be compared. The results of research show Cost of alternative 1 about IDR 570 billion (1 PLN – Diesel Engine), Alternative 2 about IDR 555 billion (1 PLN – Diesel Engine – Gas Engine) and Alternative 3 about IDR 580 billions (2 PLN - Gas Engine). The best alternative design based on LCC is alternative 2 (1 PLN – Diesel Engine - Gas Engine).

Keywords— Life Cycle Cost, Alternative, Electrical System.

I. Introduction

A superblock area has a high complexity, both in the development process and later when it is operation, so it required the right design at the beginning. The complexity of the project is one of cause over budget at project[1]. The election of design very important, if our design appropriates we can get optimum result in Cost and operation a system.

In the Pertamina project research, the impact of design errors are the result of unusable or unoptimal operation, disturbed operations, repairing cost and time necessary, conflict, the findings and the risks of safety and health[2]. Economic analysis for design solar cell Pertamina's building in Dumai with capacity 496 kwh per day, the cost is IDR 6,2 billion with payback period 18 years[3]. Each design certainly has a superior point than the other. It will be analyzed by the method of Life Cycle cost so that alternate designs were selected that has the optimum cost. System building elements always have a real cost estimate, so the right decision value based method is used because this method is split between cost and function are obtained[4]. Based On study literature in electrical power system the appropriate design electrical system at Ciputra world phase 3 is

1. Alternative 1st (1 PLN – Diesel Engine)
2. Alternative 2nd (1 PLN – Diesel Engine – Gas Engine)
3. Alternative 3rd (2 PLN - Gas Engine)

The reason using life-cycle cost analysis is, we will know total cost each alternative and any strong relation between operation, maintenance cost and function reliability of product. Life Cycle Cost method using Present value to calculate the cost of each alternative[5]. After we know Life cycle cost for each alternative we can select the best design of the electrical system.

II. Literature Review

A. Electrical System

About 80% of the operational cost of generator set is from resource[6]. Based on research in Hongkong, the Gas engine has a high efficiency beside electrical power it can produce another energy such as hot water and Cooling system[7].

B. Life Cycle Cost Analysis

Cost is a sum of all efforts and expenditures in developing, producing, and applying the product. Producers always think about the costs of quality, reliability, and maintenance because it will affect the cost to the users[8]. All cost of alternative such as maintenance periodic, energy cost every year will be calculated in present worth[9].

Development costs are a considerable component of the total cost while attention to production costs is very necessary because it contains a number of unnecessary costs For LCC calculation, the following equation is Present Worth (PW) of LCC = Investment Cost + PW of Operation Cost + PW of Maintenance cost + PW of Energy cost + PW of replacement cost + PW replacement cost + PW of Salvage Value[4].

Present Worth can be calculated using the theory value of money by equations (1) and (2) as follows:

$$P = F\ x\ \frac{1}{(1+i)^n} \quad (1)$$

$$P = A\ x\ \frac{(1+i)^n - 1}{i\ x\ (1+i)^n} \quad (2)$$

Where:
P = Present value
F = Future value

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A = Annual value
I = Interest rate %
N = Period (years)

III. METHODOLOGY

The methodology for Life Cycle Analysis combines Initial, maintenance and Energy cost. It consists of three stages base on the process.

The Selection of electrical system design in this paper undergoes the following steps :

Stage 1 : Determining the alternative design for electrical system.
Stage 2 : Estimation initial, maintenance and energy cost each alternative using Life Cycle Cost Analysis.
Stage 3 : Finally determining the best-fit alternative.

IV. RESULT AND DISCUSSION

The cost will be calculated by the concept of Life Cycle Cost (LCC). The main reason for using LCC for evaluating total economics worth. An Alternative can be low at initial cost but high at energy cost. The results are discussed as follow:

A. Initial Cost

1) Diesel Engine

Price of Diesel we can see in table 1.

$$P = 14.310.000.000\ x\ (1+0{,}05)^8$$
$$P = 14{,}310{,}000{,}000\ x\ 1{,}4774$$
$$P = Rp. 21{,}142{,}387{,}401,-$$ (Price in 2018)

P = Estimation price in 2018
i = interest rate 5%
n = 8 years

2) Gas Engine

Price of Gas Engine we see in table 2

$$P = 34.920.000.000\ x\ (1+0{,}05)^8$$
$$P = 34.920.000\ x\ 1{,}4774$$
$$P = Rp. 51.592.744.097,-$$

P = Estimation price in 2018
i = Interest rate 5%
n = 8 years

B. Maintenance Cost

1) Diesel Engine

Cost maintenance diesel every year is Rp. 137.371.735,

$$P = A\ x\ \frac{(1+i)^n - 1}{i\ x\ (1+i)^n} \quad ⟐$$
$$P = 137.371.735\ x\ \frac{(1+0{,}05)^{13} - 1}{0{,}05\ x\ (1+0{,}05)^{13}}$$
$$P = Rp. 1.290.411.421,-$$

P = Estimation maintenance price for 13 years
i = interest rate 5%
n = 13 years

2) Gas Engine

Cost maintenance Gas Engine every year is Rp. 2.633.801.736,

$$P = A\ x\ \frac{(1+i)^n - 1}{i\ x\ (1+i)^n} \quad ⟐$$
$$P = 2.633.801.736\ x\ \frac{(1+0{,}0125)^{13} - 1}{0{,}0125x\ (1+0{,}0125)^{13}}$$
$$P = Rp. 31.421.741.066,-$$

P = Estimation maintenance price for 13 years
i = interest rate 1,25%
n = 13 years

C. Energy Cost

1) 1st Alternative

Energy Cost 1st alternative every year is Rp. 58.309.571.250,

$$P = A\ x\ \frac{(1+i)^n - 1}{i\ x\ (1+i)^n} \quad ⟐$$
$$P = 58.309.571.250\ x\ \frac{(1+0{,}05)^{13} - 1}{0{,}05\ x\ (1+0{,}05)^{13}}$$
$$P = Rp. 547.735.213.383,-$$

P = Estimation maintenance price for 13 years
i = interest rate 5%
n = 13 years

2) 2nd Alternative

Energy Cost 2nd alternative every year is Rp. 47.906.250.000,

$$P = A\ x\ \frac{(1+i)^n - 1}{i\ x\ (1+i)^n} \quad ⟐$$
$$P = 47.906.250.000\ x\ \frac{(1+0{,}05)^{13} - 1}{0{,}05\ x\ (1+0{,}05)^{13}}$$
$$P = Rp. 450.010.855.913,-$$

P = Estimation maintenance price for 13 years
i = interest rate 5%
n = 13 years

3) 3rd Alternative

Energy Cost 2nd alternative every year is Rp. 52.936.406.250,

$$P = A\ x\ \frac{(1+i)^n - 1}{i\ x\ (1+i)^n} \quad ⟐$$
$$P = 52.936.406.250\ x\ \frac{(1+0{,}05)^{13} - 1}{0{,}05\ x\ (1+0{,}05)^{13}}$$
$$P = Rp. 497.261.955.784,-$$

P = Estimation maintenance price for 13 yeras
i = Interest rate 5%
n = 13 years

Finally, the total cost of each alternative shown on table III, 1 PLN – Diesel Engine – Gas Engine (a2) is found to be the 'best alternative'. Figure 5,6,7 provide diagram Pie for each alternative.

TABLE 1.
PRICE OF DIESEL ENGINE IN 2010

No	Item	Satuan	Vol	Harga Satuan	Jumlah
1	Genset 2000KVA + Instalasi	Bh	4	3.577.500.000	14.310.000.000
	TOTAL				14.310.000.000

TABLE 2.
PRICE OF GAS ENGINE IN 2010

No	Item	Satuan	Vol	Harga Satuan	Jumlah
1	Genset 2500KVA + Instalasi	Bh	3	11.640.000.000	34.920.000.000
	TOTAL				34.920.000.000

TABLE 3.
THE TOTAL COST OF THE ELECTRICAL SYSTEM

	Alternatif 1	Alternatif 2	Alternatif 3
Initial Cost	Rp 21.142.387.401	Rp 72.735.131.498	Rp 51.592.744.097
Energy Cost	Rp 547.735.213.383	Rp 450.010.855.913	Rp 497.261.995.784
Maintenance Cost	Rp 1.290.411.421	Rp 32.712.152.487	Rp 31.421.741.066
Total	Rp 570.168.012.205	Rp 555.485.139.898	Rp 580.276.480.947

Figure 1. Pie Chart 1st Alternative

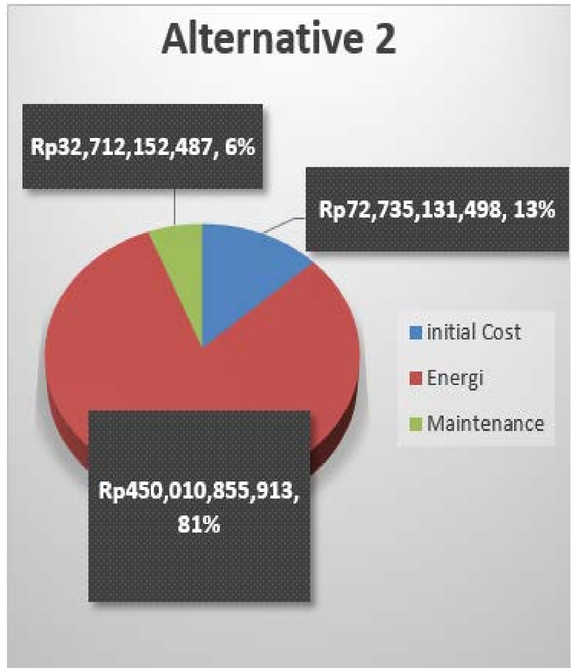

Figure 2. Pie Chart 2nd Alternative

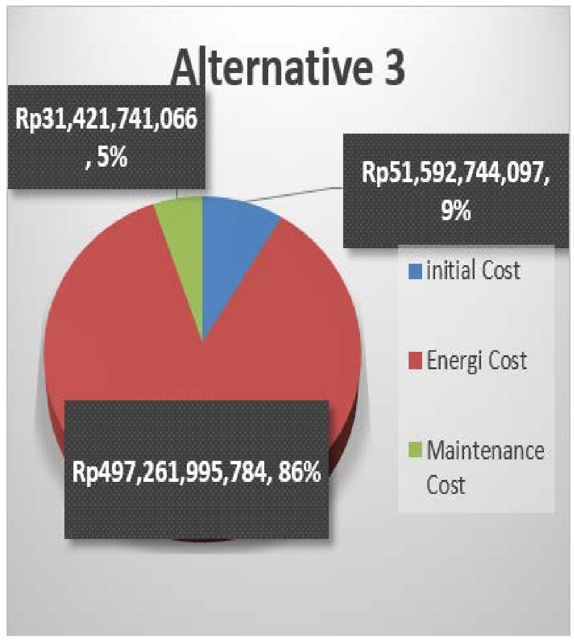

Figure 3. Pie Chart 3rd Alternative

V. CONCLUSION

Based on the discussion that has been done, it can be drawn conclusion as follows:

1. For Initial & maintenance cost the best alternative is 1st alternative (1 PLN – Diesel Engine), while for Energy cost the best alternative is 2nd alternative (1 PLN – Diesel Engine – Gas Engine) as the best design electrical system.
2. For the total cost (Initial, Maintenance and Energy cost), the 2nd alternative (1 PLN - Diesel Engine – Gas Engine) as the best design electrical system.

ACKNOWLEDGMENT

The writer would like to thanks Magister Management Technology ITS for supporting this research. The writers are also indebted to management Ciputra World Surabaya for data which the project was based.

REFERENCES

[1] S. Sesmiwati, V. Ariani, and F. Roza, "Review penyebab keterlambatan pada proyek konstruksi," in *Seminar Nasional Strategi Pengembangan Infrastruktur ke-3 (SPI-3)*, 2017, pp. 15–22.

[2] D. F. Fuadie, "Analisis faktor penyebab dan dampak kesalahan desain pada proyek-proyek di PT. Pertamina MOR V," Institut Teknologi Sepuluh Nopember, 2017.

[3] Jufrizel Jufrizel and M. Irfan, "Perencanaan teknis dan ekonomis pembangkit listrik tenaga surya sistem on – grid," in *Seminar Nasional Teknologi Informasi, Komunikasi dan Industri (SNTIKI) 9*, 2017.

[4] C. Utomo and A. Idrus, "Value-based group decision support bridge selection," *Int. J. Econ. Manag. Eng.*, vol. 4, no. 7, pp. 1688–1693, 2010.

[5] C. Utomo, A. Idrus, A. Nugraheni, and Rahmawati Farida, "Negotiation support for value–based decision in construction," *Int. J. Econ. Manag. Eng.*, vol. 5, no. 7, p. 2001, 2011.

[6] I. Amriadi, "Optimasi bahan bakar pada pembangkit listrik PT CPI dengan metode linear programming," Institut Teknologi Sepuluh Nopember, 2013.

[7] K. F. Fong and C. K. Lee, "Performance analysis of internal-combustion-engine primed trigeneration systems for use in high-rise office buildings in Hong Kong," *Appl. Energy*, vol. 160, pp. 793–801, Dec. 2015.

[8] M. F. Pasaribu and R. Puspita, "Tahap informasi, kreatif, dan analisa pada rekayasa nilai untuk meningkatkan kualitas pelayanan hotel," *Ind. Eng. J.*, vol. 5, no. 2, Nov. 2016.

[9] C. Utomo, A. Idrus, M. Napiah, and M. F. Khamidi, "Aggregation and coalition formation on value-based decision," in *2009 IEEE Symposium on Computational Intelligence in Milti-Criteria Decision-Making*, 2009, pp. 118–125.