JAMBE: Jurnal Akuntansi Manajemen Bisnis dan Ekonomi
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REVITALIZATION OF STREET LIGHTING ON THE SELINDUNG BRIDGE OF PANGKALPINANG CITY USES SOLAR ENERGY TO IMPROVE NIGHTTIME AESTHETICS AND SAFETY

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Abstract: This study analyzes the opportunities for revitalizing street lighting on the Selindung Bridge, Pangkalpinang City using solar energy. The analysis used several financial analysis methods, including Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), and Payback Period (PP). This study aims to evaluate the planning of solar-based public street lights in improving aesthetics and nighttime safety. The results of the study indicate that this project is feasible and can be implemented financially based on the parameters evaluated. The budget used in the planning of the solar-powered public street lighting project along the Selindung Bridge road in Pangkalpinang City uses funds from the 2025 Pangkalpinang City Regional Revenue and Expenditure Budget. To consider the safety aspect of road users, it is necessary to plan public street lighting that utilizes solar energy.

Article Information:
Received 04 March 2024
Revised 10 April 2024
Accepted 05 May 2024

Keywords: Lighting, Street Light, Solar Panel, Night Security

Introduction

The Bangka Belitung Islands Province, which consists of several large islands, especially Bangka Island and Belitung Island, has significant economic and tourism potential. However, one of the main problems of the province is the limitation of infrastructure, such as public street lighting (PJU). Adequate lighting on main roads, connecting roads, and other important sites is essential for the mobility, safety, and comfort of the general public and tourists. Transportation is one of the important factors in facilitating daily activities, therefore roads as the main infrastructure in connecting land routes must be considered in terms of condition and use. This has an impact on the lack of visibility and safety for road users, including motorcyclists and car users. Lighting on public infrastructure, such as bridges, plays an important role in improving public safety and comfort, especially at night (Rumbayan et al., 2020).

One of them is in the Selindung Bridge area of Pangkalpinang City where the lighting in this area is less than optimal, so it is necessary to revitalize the area. Road infrastructure is an important public facility for public transportation, because it can reduce the risk of accidents and increase comfort for road users at night. In addition, the lack of lighting aesthetics makes the bridge look less attractive and does not reflect the progress of modern, environmentally friendly infrastructure. To improve aesthetics and safety at night, an

initiative is needed to update the lighting on the Selindung Bridge.

The Selindung Bridge located in Pangkalpinang City is one of the infrastructures that connects several strategic areas in the city. Along with the growth and development of the city, this bridge has become a transportation route that is increasingly busy with various vehicles and pedestrians, both during the day and at night. However, the condition of street lighting in the bridge area is currently still not optimal and requires special attention, considering its very important role The Selindung Bridge located in Pangkalpinang City is one of the infrastructures that connects several strategic areas in the city. Along with the growth and development of the city, this bridge has become a transportation route that is increasingly busy with various vehicles and pedestrians, both during the day and at night. However, the condition of street lighting in the bridge area is currently still not optimal and requires special attention, considering its very important role in supporting the mobility and safety of road users (Ullah & Oktaviandra, 2020).

One of the proposed options is to use solar energy. The use of this technology is not only environmentally friendly but can also reduce dependence on fossil fuels and reduce greenhouse gas emissions which are one of the causes of climate change, which sometimes fossil fuels have high operational costs. Solar energy is abundant in tropical countries like Indonesia, so using it for bridge lighting is an efficient and sustainable solution.

Revitalizing the lighting system on the Selindung Bridge using solar energy will not only solve the lighting problem, but also provide added value in terms of aesthetics. The modern design of solar-powered lights can improve the visual appearance of the bridge, create an attractive landmark, and provide a new identity for Pangkalpinang City as a city that cares about the environment and technological innovation. The presence of adequate lighting will also create a sense of security and comfort for people passing by, so that it can encourage economic and social activities around the bridge area at night.

The security aspect is a major consideration in this revitalization project, considering that the Selindung Bridge is a route that is often used by various levels of society. The solar-powered lighting system equipped with smart lighting technology also allows for automatic light intensity adjustment according to environmental conditions, so that it can optimize energy consumption while ensuring adequate lighting levels throughout the night.

Literature Review

Previous research conducted by (Poliama et al., 2021), in their research entitled Design and Construction of Solar Powered Public Street Light Monitoring System Based on Lo-Ra Technology. Research variables Lo-Ra technology system and street light monitoring system. The research method uses a quantitative method. The results of the study indicate that it was successful in implementing a remote monitoring system using Lo-Ra technology.

Previous research conducted by (Ihsanto & Dawud, 2016), in his research entitled Public Street Lighting Monitoring System Using Arduino Microcontroller and LDR Sensor with SMS Notification. The variables used are LDR (Light Dependent Resistor) Sensor and PJU lamp monitoring system. The research method uses quantitative method. The research results show that this system successfully integrates all components (Arduino, GSM Shield, RTC, and LDR sensor).

Previous research conducted by (Rumbayan et al., 2020), in their research entitled Application of Appropriate Technology Based on Renewable Energy in Kiama Village, Talaud Islands Regency. The variables used are the first Appropriate Technology and the second is Renewable Energy. The research method uses a quantitative method. The results of the study showed that it was successful in integrating all components (Arduino, GSM Shield, RTC, and LDR sensor), and the LDR sensor succeeded in detecting the status of the lights (on/off) accurately and the use of two sensors provided cross-validation to reduce detection errors.

Previous research conducted by (Sujono et al., 2022), in his research entitled Assistance for Solar and LED-Based Street Lighting (PJU) in Jatiwates Village, Tembelang District with the research

variables of Solar and LED-based Street Lighting (PJU) and Condition and maintenance of PJU in Jatiwates Village. The research method uses a qualitative descriptive method. The results of the study show that the people of Jatiwates Village, especially village officials, do not have sufficient skills in maintaining and operating the PJU provided by the government, causing the PJU to not function properly or become a vacuum.

Previous research conducted by (Artiyasa et al., 2021), in their research entitled Installation of Solar-Based Street Lights for Village Street Lighting in Cibolang Kaler Village with research variables of installation of solar-based street lights in Cibolang Kaler Village and community knowledge about renewable energy. The research method uses a qualitative descriptive method. The results of the study showed that before the installation of solar-based street lights, Cibolang Kaler Village experienced a lack of street lighting, which caused difficulties for the community, especially at night. This also increases the risk of accidents on village roads.

According to (Setiawan et al., 2022), in his research entitled Solar Energy as a Solution for Public Street Lighting in Girikerto Village, Turi District, Sleman Regency with the research variables being the use of solar energy (Solar Powered Public Street Lighting or PJUTS) and geographical location and the problem of power outages in Girikerto Village. The research method uses a qualitative descriptive method. The results of the study show that Girikerto Village often experiences power outages due to its location near the slopes of Mount Merapi, which makes street lighting inadequate. This hampers the evacuation of residents and increases the risk of traffic accidents, especially during the eruption of Merapi.

According to (Ullah & Oktaviandra, 2020), in their research entitled Implementation of Solar Street Lighting Savings (PJUTS) on Primary Collector Roads with research variables (PJUTS) with an automatic saving system and the use of PIR (Passive Infrared Sensor) sensors. The research method uses a qualitative descriptive method. The results of the study show that PJUTS equipped with an automatic saving system has been proven to be able to reduce energy consumption significantly. This system uses a PIR sensor to detect the presence of pedestrians or vehicles, which allows automatic adjustment of light intensity. When there is no activity, the lights can dim to save energy, and the lights only increase when needed.

Previous research conducted by (Arirohman et al., 2021), in his research entitled Utilization of Solar Panels as Public Street Lighting (PJU) in Agrowidya Tourism Village, Rajabasa Jaya, Lampung with the research variables of the use of solar panels for public street lighting and the achievement of lighting levels. The research method uses a qualitative descriptive method. The results of the study showed that the Philips BRP130 LED lamp with a power supply from a 210 Wp solar panel and 140 Ah energy storage media is the best choice to meet the recommended lighting standards. This study also resulted in an effective PJUTS installation in Agrowidya Village and succeeded in increasing public understanding of the use of solar energy through the training carried out.

Previous research conducted by (Sukma et al., 2021), in his research entitled Planning for Public Street Lighting Using Solar Power (Solar Cell) for Alternative Street Lighting in Talang Pete Plaju Darat with the research variables of Solar Powered Public Street Lighting (PJUTS) and Solar Panels. The research method uses a qualitative method. The results of the study show that the planning of PJUTS on Jalan Talang Pete uses 60 Watt LED lights with a light intensity of 477.70 cd and an illumination of 11.35 lux. This system uses a 100 Wp solar power module, a 12 V/10 solar charging controller, and a 12 V battery with a capacity of 100 Ah. This planning system is in accordance with the SNI 2008 standard, for a road with a length of 350 meters and a width of 2 meters, with 12 lamp posts that can meet the needs of efficient lighting using solar energy.

According to (Adhiharto et al., 2024), in his research entitled Lighting Installation by Considering Community Economic Factors in the Form of Solar Powered Public Street

Lighting Technology (PJUTS) with the variable PJUTS Technology for public street lighting and its Effect on community mobility. The research method uses a qualitative descriptive method. The results of the study showed that two PJUTS units were successfully installed and functioned well, providing the lighting needed by the community at night, and helping to increase community mobility, especially in areas with limited facilities and energy resources. This technology has proven effective as a cost-effective and environmentally friendly lighting solution for the local community.

Method

This study uses quantitative descriptive methodology. Quantitative descriptive research is a type of research that uses data in numerical format as its source. This method is used to provide illustrations or descriptions of existing phenomena systematically, accurately, and factually. Quantitative descriptive research is a type of research that consistently compares variables with data derived from observable phenomena.

This method is known as "quantitative descriptive" which means it is useful for building a project that involves describing a particular feature, condition, or situation. The main purpose of this method is to provide an objective description or explanation of the situation that is relevant to the problem being studied (Sutomo et al., 2016).

Research Location

Selindung Bridge is one of the bridges that coincides in the sub-district in Gabek District, Pangkalpinang City, Bangka Belitung Islands. Selindung Bridge as the name implies has a bridge that connects Pagarawan Village with Selindung. Along this road, there were previously street lights, but unfortunately the lights were considered less effective in providing adequate lighting, so revitalization is needed. So, road users can feel the benefits of better lighting and support safety and comfort while crossing the area.

Stages of Research

a. Data Preparation and Collection Phase

Data collection in this study used both data sets. Secondary data refers to data that has been collected, discussed, and analyzed by others for this study. This type of information comes from previous sources compared to original sources or the researcher's personal experiences (Rianti & Harahap, 2021).

Observation

Observation is to give researchers insight into the daily activities of individuals who are observed or used as research data. Apart from conducting research to collect data, researchers also visit research locations to see and understand what is happening there. The purpose of the observation is to determine the current state of the road infrastructure and the initial state of the protected bridge area.

Documentation

Documentation is the process of collecting meaningful information such as images, text, or written parts. Observations are needed, especially regarding the width and length of the road, for the planning of general street lighting with the use of solar panels. The documentation used in this study consists of photographs and comments related to the project being implemented.

b. Data Processing and Analysis Stage

Data management is the process of organizing data according to the purpose, plan, nature, and needs of the decision. It also changes the raw data from the measurement results into data that is used for further research. After the process of identifying and collecting the necessary data, the next step is to organize the data using the Data Examination, Classification, Verification and Conclusion techniques. Continued with the analysis calculation technique as follows:

1. NPV (Net Present Value)

Net Present Value or present value, also known as actual value, is the difference between the actual value of cash inflows and cash outflows over a given period of time. Actual value, or NPV, is an estimate of the

actual value of a project, asset, or investment. Actual value is based on expected future cash inflows and outflows, adjusted for interest rates and the initial purchase price (Kurniawan, 2019). Therefore, the present value of an asset is its value minus the initial purchase price.

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t} - C_0 \text{.....1.1}$$

CF_t : Cash flow iin the period t
R : Discount rate
n : number of years (economic life) of the project
C_0 : initial investment

The following conclusion criteria show the relationship between the NPV value and the feasibility of a project or business. If NPV>0, the project or business is feasible. and if the NPV is less than zero then the project or business is not feasible

2. IRR (internal Rate Of Return)

Internal rate of return (IRR) analysis is usually required to determine whether a project plan is attractive from the standpoint of a stated rate of return. Reviewing the internal rate of return, or IRR, is a commonly used procedure. The internal rate of return is the rate of return at which the net present value of cash inflows and outflows are equal. In the analysis method, the net present value (NPV) is determined by calculating the amount of return (discounted) (i), then calculating the net present value (NPV) of the cash inflows and outflows. The NPV value = 0 for the IRR, and the rate of return (discounted) (i) is found using the following formula:

$$IRR = i_t + \frac{NPV_1}{NPV_1 + NPV_2} \times (i_2 - i_1) \text{.....2.1}$$

Where:

NPV_1 : NPV at interest rate i_1

NPV_2 : NPV at interest rate i_2

i1 : Discount rate resulting in NPV_2

3. BCR (Benefit Cost Ratio)

Benefit Cost Ratio serves as validation of the evaluation results that have been carried out using other methods. The Benefit Cost Ratio method is a way to compare alternative methods with the Benefit Cost Ratio approach. This is similar to the Internal Rate of Return (IRR), this criterion is based on the calculation of the comparison results between the amount of the present value of the profit flow minus the costs that are positive or negative.

$$\text{BCR} = \frac{Total\ benefit}{Total\ cost} \text{.....3.1}$$

Total benefit : The value of benefits generated from the project.

Total cost : The total cost incurred to implement the project.

If BCR is greater than 1, the project is feasible. If BCR is less than 1, the project is not feasible. If BCR is equal to 1, it means that the benefits are equal to the costs, so the project is "break even" in economic terms.

4. PP (Payback Period)

Payback period or Payback period is a method to calculate how long an investment will last or how long it will take to recover the initial investment using cash flow analysis. In other words, the payback period is the ratio between the initial investment and the cash flow, which is the result of one period of time. The estimated payback period is equal to the number of years in a particular project or investment.

$$\text{PP} = \frac{nilai\ investasi}{pendapatan} \times 1\ year \text{.....4.1}$$

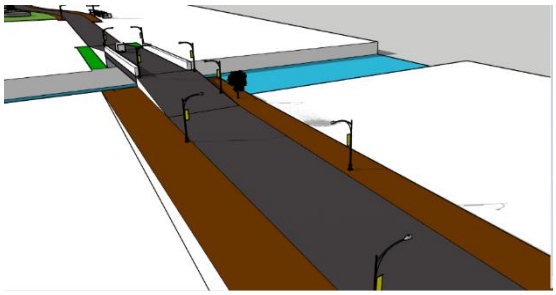
The formula above assumes that the amount of net cash inflow is the same in each period or that cash flow remains constant every year. Payback period helps assess how quickly an investment can be returned. Some basic rules in decision making are:

If the payback period (PP) is shorter than the set limit (cut-off period). If the payback period (PP) is longer than the set limit, the

project is considered unfeasible because the return on investment period is too long.

Results and Discussion

Project Design

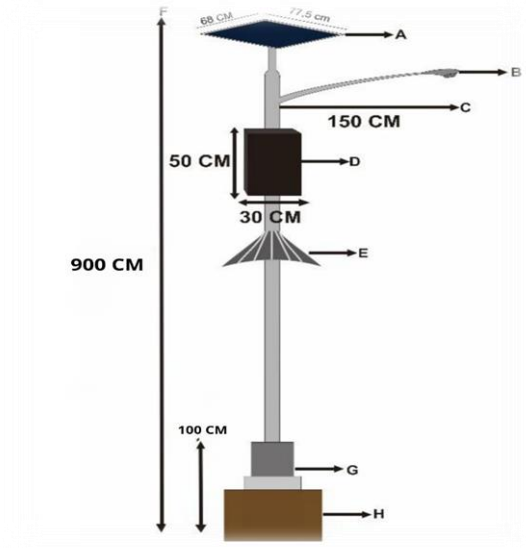


Source: Processed Data, (2024)

Source: Processed Data, (2024)

The road lighting plan for this protected bridge is 1 km long using 18 light poles with a distance of 55.5 meters per pole.

Lamp Post Design



Source: Processed Data, (2024)

Information:

a. Mono solar panel 150 wp
b. LED lights
c. Distance of lamp to pole 1.5 meters
d. Control panel box
e. Safety fence
f. PJU height 9 meters
g. Foundation
h. Foundation depth 1 meter

A. Financial Analysis

1. *Net Present Value* (NPV)

Table 3.1 Net Present Value (NPV) 10%

Year	*Cash Flow*	*Present Value*
Year 0	282,115,000	IDR 282,115,000
Year 1	155,163,250	IDR 141,057,500
Year 2	146,699,800	IDR 121,239,504
Year 3	15,342,100	IDR 114,456,874
Year 4	141,057,500	IDR 96,344,170
Year 5	138,236,350	IDR 85,833,897
	Total NPV	**IDR 558,931,945**
	NPV 10%	**IDR 276,816,945**

Source : Data Processed (2024)

Table 3.2 Net Present Value (NPV) 15%

Year	*Cash Flow*	*Present Value*
Year 0	282,115,000	IDR 282,115,000
Year 1	155,163,250	IDR 134,924,565
Year 2	146,699,800	IDR 110,926,124
Year 3	152,342,100	IDR 100,167,403
Year 4	141,057,500	IDR 80,650,083
Year 5	138,236,350	IDR 68,727,897
	Total NPV	**IDR 495,396,072**
	NPV 15%	**IDR 213,281,072**

Source : Data Processed (2024)

2. *Internal Rate of Return* (IRR)

Known :

i1= 10% NPV_1 = IDR 276,816,945

i2= 15% NPV_2 = IDR 213,281,072

$$IRR = it + \frac{NPV1}{NPV1+NPV2} \text{ x } (i_2 - i_1)$$

$$IRR = 10\% + \frac{IDR\ 276.816.945}{\text{IDR 276,816,945 + IDR 213,281,072}} \text{ x } (15\% - 10\%)$$

$$IRR = 10\% + \frac{Rp\ 276.816.945}{Rp\ 490.098.017} \times 5\%$$

IRR = 10% + 0.56 x 5%

IRR = 10% + 2.8 %

IRR = 12.8%

3. *Benefit Cost Ratio* (BCR)

Benefits = $\sum PV\ manfaat$ (1 – 5)

= IDR 558,931,945

Cost = IDR 282,115,000

$$B/C = \frac{Benefit}{Cost} = \frac{IDR\ 558.931.945}{IDR\ 282.115.000}$$

B/C = 1.9

4. *Payback Period* (PP)

Known :

Investment Value = IDR 282,115,000

$$Income = \frac{Rp\ 733.499.000}{5} = IDR\ 146.699.800$$

$$PP = \frac{Nilai\ Investasi}{Pendapatan} \times 1\ year$$

$$PP = \frac{Rp\ 282.115.000}{Rp\ 146.699.800} \times 1\ year$$

PP = 1,92 years

Operating expenses are a work plan outlining all the concrete actions aimed at generating revenue over a specific period of time. Thus, an operating budget contains:

a. Preparation Costs are costs incurred before construction. The preparation costs required are IDR 2,850,000.
b. Operational Costs are costs incurred to pay for labor salaries, electricity, water, telecommunications and consumables such as cement, concrete sand and casting stones. The operational costs in this construction are IDR 42,345,000.
c. The cost of procurement and installation of poles is the cost incurred for the purchase of galvanized octagonal poles, MDP panel assemblies and installations and also PJUTS lamp assemblies and installations at a cost of IDR 114,300,000.
d. Investment costs are costs incurred to make investments such as purchasing assets. The costs required are IDR 2,300,000. Safety costs are investments made to ensure the safety of workers and maintain the success and reputation of the project. These safety costs are to pay for project helmets, boots, gloves, work clothes/vests and protective glasses with a total of IDR 1,670,000.
e. The cost of new installation work and commissioning tests are the costs required for the installation of new PJUTS and testing. The required financing is IDR 36,900,000.
f. Renewal/replacement costs are additional costs in the construction process. The required renewal costs are IDR 80,000,000. Where Rental costs for 12 working days are costs incurred to use assets that are not theirs. The rental costs required are IDR 1,750,000.

From the calculation results of the financial feasibility analysis of the street lighting construction project on the Selindung Bridge in Pangkalpinang City, that in the construction of this project is said to be financially feasible using the Net Present Value (NPV) analysis with an interest rate of 10% getting a result of Rp 276,816,945 and an interest rate of 15% getting a result of Rp 213,281,072.

Next, the Internal Rate of Return (IRR) gets a value of 12.8% and the Benefit Cost Ratio (BCR) with a benefit of Rp 558,931,945 and a cost of Rp 282,115,000 produces a value of 1.9. In the calculation of the Payback Period, the result is 1.92. So within a period of 1.92 years the investment capital from the street lighting project using solar power on the Selindung Bridge in Pangkalpinang City can be returned.

The installation of lighting on the Selindung Bridge has a positive impact on community activities, where lighting infrastructure is a key element in the development of urban and rural areas that can have a significant impact on the quality of life of the community. The Selindung Bridge, after being equipped with a modern lighting system, presents real evidence of how simple infrastructure interventions can change the social and economic dynamics of a region.

The safety aspect is the main focus in the development of this lighting infrastructure. Previously, the dark and scary

bridge posed various risks to users, both motorized vehicles and pedestrians. With the installation of adequate lighting, visibility becomes much better, significantly reducing the potential for accidents and increasing the sense of security for people crossing the area.

Conclusion

Based on the calculation of the financial feasibility analysis of the project public street lighting solar power plants along the bridge road As protected as the city of Pangkalpinang, the construction of this project is declared feasible from all financial aspects using the NPV (Net Present Value), IRR (Internal Rate of Return), BCR (Benefit Cost Ratio) and PP (Payback Period).

Budget used in planning public street lighting projects solar power plant along the city's Selindung bridge road Pangkalpinang uses City Regional Revenue and Expenditure Budget funds Pangkalpinang in 2025.

Acknowledgement

We would like to express our gratitude to the presence of Allah SWT who has given His guidance for giving us the ability to complete the proposal entitled "Revitalization of Street Lighting on the Selindung Bridge in Pangkalpinang City Using Solar Energy to Improve Aesthetics and Security at Night." The authors would like to express their thanks and appreciation to everyone who helped them complete this article.

Conflict of Interest

This research was conducted to overcome the problem of public street lighting that is often passed by vehicles. so that road users can feel the benefits of better lighting and support safety and comfort while crossing. in this case we as designers provide the feasibility of street lighting projects

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