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Integrated Solar Energy Application System Development to Catalyze Public Participation Towards Bali Clean Energy Through Crowd-Based Business Models

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Abstract

Through the Minister of ESDM K/20/MEM/2015 and Bali Governor Regulation No. 45/2019, Bali is designated as a clean energy area and has the advanced implementation of the energy transition towards renewable energy to attain SDG 7, "Affordable and Clean Energy." One of the main intensified directions is the development of solar rooftop energy. However, its development has encountered obstacles that hinder the operation's sustainability. Constraints include financing and community participation. This paper aims to provide solutions to catalyze public participation (especially in youth) for energy transition through the Crowd-Based Business Model, especially for Rooftop Solar Energy Power Plant or *Rooftop Solar PV*. An integrated information system in the application that can increase investor interest in renewable energy, especially *Rooftop Solar PV*, could be the answer. This Study uses data from literature studies and will be processed through qualitative content analysis, business model canvas, system design/flow analysis and SWOT analysis. This research will produce an application that is expected to be able to (1) understand the potential, benefits and considerations in using renewable energy, especially solar energy, by installing *Rooftop Solar PV* in Bali (2) inform about the general overview of the business model and then analyze their strategy to build the crowdfunding platform based on internal and external conditions in Bali. (3) explain a system flow diagram that integrates process elements and parties involved in the crowdfunding platform based on the business model and business strategy.

Keywords:
crowd-based, information system, *Rooftop Solar PV*, public participation

1. Introduction

1.1 Background of the Study

"*Nangun Sat Kerthi Loka Bali*"

This sentence is the vision of the Province of Bali which means maintaining the harmony of Bali's nature and contents to realize a prosperous and happy life of Balinese manners, the seen and unseen life of Balinese manners (RPJMD, 2019).

Bali is one of the progressive provinces in increasing renewable energy and energy conservation. In 2007, Bali was appointed to host the Climate Change Summit. Then, the 2015 Minister of Energy and Mineral Resources Decree established Bali as a clean energy national area. Afterward, through Governor Regulation No. 45/2019, Bali proclaimed itself as Bali Clean Energy. This was the first

Governor Regulation in Indonesia for areas with clean energy. In addition, there are various clean energy development pilot projects placed in Bali, such as a biomass power plant in Bangli, a wind power plant and solar energy power plant (PLTS) in Puncak Mundi Nusa Penida and a solar energy power plant (PLTS) in Kubu, Karangasem. However, the development of this clean energy plant is still constrained in its sustainability (Suriyani, 2020).

As an area with a tropical climate, the Province of Bali has massive potential for clean energy, especially solar power, to meet the electricity needs of its people. Compared to other clean energy, solar energy in Bali Province has the highest potential, around 98% of Bali's total pure energy potential (CORE, 2019). However, limited land is a challenge for developing PLTS based on ground mound systems in Bali, so the focus of development is on rooftop-based solar power plants or *Rooftop Solar PV*.

Rooftop Solar PV is a solar power generation system installed on the roofs or walls of houses, buildings, warehouses or parking lots. *Rooftop Solar PV* is one solution to accelerate the growth of solar power plants in Bali. This is due to the geographical and demographic characteristics of Bali, which have minimal land area and a large enough population, so there is also a crowd-based roof for houses or buildings. In addition, the development of a tourism-based industry in Bali, especially the tourist accommodation sector, also contributes to a large enough roof area. Therefore, the roofs of buildings belonging to the government, industry, businesses, educational institutions and Balinese Traditional Village assets have the potential to use *Rooftop Solar PV*.

Comparing it with the target achieved in 2025, this increase is relatively slow. Until now, the total capacity of PLTS installed in Bali has only reached 3–4 MWp. This figure is still very far from the target, so it needs acceleration in its application (Pawitra, 2020). This is due to several taboos, such as limited public knowledge about solar power plants, significant initial investment, constraints related to operation and maintenance, after-sales service and regulations (CORE, 2019).

1.2 The Objective of the Study

Based on RUEN (2017), the low utilization of New Renewable Energy (NRE) is caused by several problems, some of which are regulations or policies that have not been able to attract investment and the lack of availability of financing instruments following investment needs. Based on the ADB Report (2019), financing is the biggest challenge in commercial renewable energy. Based on PLN information in Indriani (2019), 19 out of 28 renewable energy projects are currently trying to get financial support due to the difficulty of achieving financial closing. Based on the CPI (2020), several obstacles and risks can still hinder investment in the NRE sector. These include the unattractive risk profile of renewable energy projects, high capital requirements, limited financial products that match the characteristics of NRE projects, the scale of the projects offered being less attractive and the lack of interest from local financial institutions.

For this reason, a mechanism is needed to answer the financing challenges currently being faced. However, it should be realized that public participation in financing seems to be sidelined at this time. Even though the potential for crowd-based financing is currently emerging during people's lives outside Indonesia in realizing development. Currently, in Indonesia, there are platforms engaged in social activities to collect crowd-based funds, such as "KitaBisa." However, this alternative method of financing has not been commonly applied, so it has a high novelty or innovative value and can be developed further, especially in NRE development. By seeing this potential, the energy transition becomes a great opportunity that can be utilized to raise crowd-based development funds. A platform that implements alternative financing can be one of the triggers for mainstreaming the use of renewable energy in Indonesia so that it can ultimately increase awareness and encourage people to obtain renewable energy. This research is expected to provide knowledge and benefits for readers and parties in need, with the following details.

1. Provide knowledge and understanding of the potential, benefits and considerations in using renewable energy, especially solar energy, by installing *Rooftop Solar PV* in Bali.

2. Provide a general overview of the business model and system flow diagram that integrates process elements and parties involved in the crowdfunding platform based on the business model.
3. Provide information about drivers and barriers of crowdfunding platforms based on internal and external conditions from the business model overview and market conditions in Bali.

2. Method

This analysis will be explained to answer the problems and achieve the related research objectives, such as qualitative content analysis, business model canvas, system design analysis and SWOT analysis.

2.1 Qualitative Content Analysis

According to Sugiyono (2013), qualitative analysis is a way to interpret information findings to find patterns of relationships between variables related to the object. There are several types of qualitative data analysis, one of which is content analysis, used to examine information in certain literature in textual and contextual forms (Khotimah, 2008). This analysis is used to conclude the theoretical potential and location of the use of solar energy as well as market potential related to investment in the installation of *Rooftop Solar PV* in Bali Province based on the results of literature reviews from academic journals and related documents.

2.2 Business Model Canvas

According to Baumassepe (2017), the business model canvas is a framework created to describe a product/innovation based on key business elements. The relationship between elements will be explained in the model to be seen as the relationship between business aspects in the workings of an innovation/product within the company. This analysis is used to describe the business elements of the application system/platform, starting from key activities, main resources, main partners and capital/financing structure, as well as matters related to customers, such as superior value, customer segmentation, relationships & ways of communicating the company with customers, as well as sources of business income. By using BMC, the results of this analysis can represent the consideration of using *Rooftop Solar PV* with a crowd-based concept and support the results of other research related to financing schemes and investment alternatives.

2.3 System Design / Flowchart Analysis

According to Whitten et al. (2004), the system is a collection of interconnected or integrated elements with one goal. In the analysis process, models are used to explain the design flow, one of which is data flow-oriented or flow-oriented using Data Flow Diagrams or DFD (Al Fatta, 2007). DFD describes system functions that explain the data flow of a system or task or processing, including the source & destination of data and the processing & storage of data. This analysis is a tool to answer the first and second objectives, especially to explain financing schemes for mainstreaming the use of renewable energy in the form of installing *Rooftop Solar PV* through a crowd-based model. It also describes the workflow of the platform system, especially regarding the features and stakeholders who are the main segment of customers and partners.

2.4 SWOT Analysis

Based on BPS (2021), SWOT analysis is a tool to describe the internal (strengths & weaknesses) and external (opportunities & challenges) conditions of an object. There are two approaches to SWOT analysis: a qualitative approach using the Kearns SWOT Matrix and a quantitative approach using Pearce & Robinson calculations. In this study, SWOT analysis with a qualitative approach was used to map the platform system's internal and external potentials and challenges. In addition, the analysis will result in further evaluation and system development strategies from related studies as consideration for using *Rooftop Solar PV* through a crowd-based model.

3. Theory

The literature will describe a theoretical discussion of the main objects of research and innovation applied to the platform, *Rooftop Solar PV*, crowdfunding and crowdsourcing.

3.1 Solar PV Rooftop and Its Issues

According to Mursanti (2017) and Rachmi et al. (2020), *Rooftop Solar PV* is a solar power generation system installed on the roof or walls of houses, buildings, warehouses or parking lots. The system, known as the "Rooftop PLTS System" or *Rooftop Solar PV* in Indonesia, comprises several tools, such as solar modules, inverters, customer electrical connections, safety systems and kWh meters for export-import of solar and electrical energy. The installation of *Rooftop Solar PV* has several benefits. However, these benefits still need to be reviewed further because they can lead to other obstacles, especially in financing.

3.1.1 The Installation of Rooftop Solar PV Did Not Reduce Electricity Bills

According to Rachmi et al. (2020), installing *Rooftop Solar PV* reduces electricity bills by adding electricity-generating sources other than conventional ones. With an installation cost of around IDR 14 million to IDR 25 million, this can be a suitable investment because, in the future, it will reduce electricity bill costs (EBTKE-KSDM, 2019). However, many costs have not been considered in using *Rooftop Solar PV*, such as network maintenance and investment return costs (Hariyanto, 2021). In addition, the electricity pay price will also increase due to the difference in the selling price of electricity from PLN to end-user, whereas for conventional electricity (non-solar PV, mainly coal-based), that is IDR 600.00 per kWh, while the electricity sourced from solar power is IDR 1,440.00 per kWh (EBTKE-KSDM, 2019). Therefore, if there is a reduction in kWh consumption, there is a possibility that the price paid for electricity with the installation of *Rooftop Solar PV* will still be higher than the price for paying for conventional electricity, with details as follows.

Table 1. Comparison of conventional electricity prices and *Rooftop Solar PV from PLN* (Source: Analysis results).

Source of Power	Assumption: Electricity Usage (kWh)	Selling Price of Electricity from PLN (IDR/KWh)	Electricity Pay Price (IDR)	Total Paid Price (IDR)
Conventional	400	600	240,000	240,000
Conventional & *Rooftop Solar PV*/solar power	Conventional: 323	600	193,800	304,680
	PLTS Atap: (400–323) = 77	1,440	110,880	
Rooftop Solar PV/solar power	400 (based on newest policy about 100% electricity utilization from *Rooftop Solar PV*)	1,440	576,000	576,000

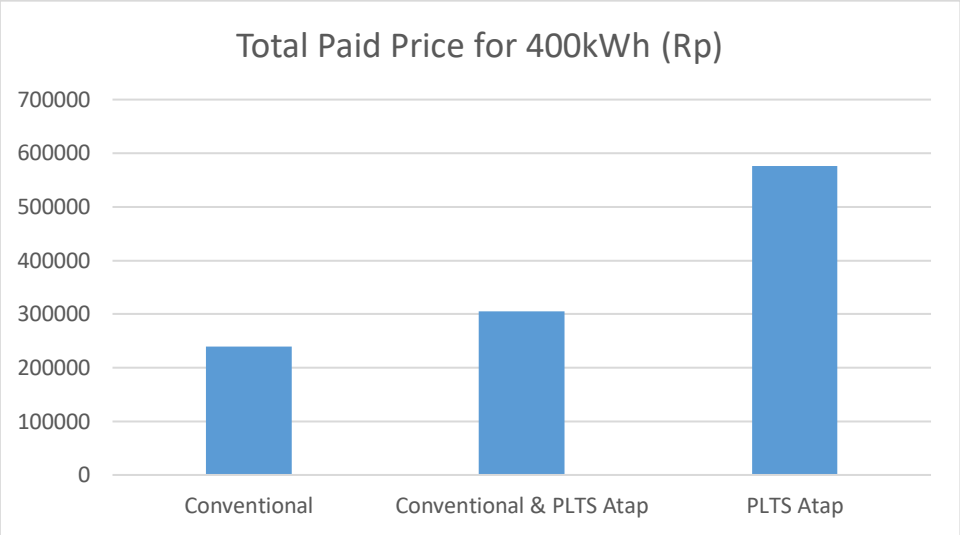


Figure 1. Possible electricity costs to be Paid (Source: Analysis results).
Disclaimer: KWh for installing conventional electricity & Rooftop Solar PV is taken based on the price comparison exemplified by EBTK-KSDM (2019) in the early days of installing Rooftop Solar PV.

Based on the detail above, it can be seen that the cost of using electricity based on electricity tariff from PLN through conventional sources with *Rooftop Solar PV* or pure *Rooftop Solar PV* tends to be more expensive than the conventional ones. Therefore, the statement at the beginning regarding whether the use of *Rooftop Solar PV* can reduce electricity bills or the price paid is not entirely true. The high selling price of electricity per kWh from solar energy or *Rooftop Solar PV* will limit people from making the transition because the purchasing power of Indonesian people is relatively low, especially for low-income household consumers (Assagaf, 2010). At this point, mainstreaming the use of *Rooftop Solar PV* will be difficult due to tariffs that cannot be reached by society due to being higher than conventional electricity rates.

3.1.2 Installation of Rooftop Solar PV Reduces the Impact of Climate Change

Installation of *Rooftop Solar PV* is assumed to reduce the effects of climate change because it is proven to affect the production of greenhouse gas emissions, especially in reducing the production of CO_2 gas in the electricity production process per kWh. Based on Burkhardt et al. (2012) and Whitaker et al. (2012), rooftop solar panels can reduce ±40% of CO_2 gas production by transforming solar energy into electricity. From the energy acquisition process to electricity, it was also explained that *Rooftop Solar PV* only produces ±40 grams of CO_2 eq/kWh. In contrast, conventional electricity makes ±1000 grams of CO_2 eq/kWh. Therefore, using *Rooftop Solar PV* as the source of electricity significantly reduces climate change's impact in the future (Burkhardt et al., 2012; Whitaker et al., 2012).

3.2 Crowdfunding and Crowd Sales

Crowdfunding is one of the existing alternative options for new and renewable energy financing schemes. Currently, compared to bank loans, share capital, grants or subsidies, crowdfunding is the most frequently used and popular form of financing in recent years (Candelise, 2015). This financing utilizes internet access through a platform to mobilize people to participate in new and renewable energy projects. Crowdfunding is gaining popularity as creative funding to attract the attention of philanthropists, even crowdfunding applications for businesses (Bonzanini et al., 2016). According to Massolution (2013), in 2013, crowdfunding platforms around the world raised a total capital of USD 5.1 billion, with a projection of USD 8 billion in 2014. Funding made through crowdfunders is divided into several forms based on the business model of Crowdfunding (Bonzanini et al., 2016):

Table 2. Types and description of crowdfunding (Bonzanini et al., 2016).

Types of Crowdfunding	Description
Equity-Based	Crowdfunders become part of the existing share ownership in the project and are entitled to a share of the profits in the project.
Lending Based	The costs that the crowd funders have given to the party who built the project will be returned to the crowdfunders with additional loan interest.
Donation Based	Funding made without any compensation by Philantopics or sponsors through submission of proposals.
Reward-Based	Funds are provided in exchange for nonmonetary benefits.

In addition to being a financing scheme, crowdfunding also has the advantage of marketing and receiving profit by utilizing the potential for community development.

In Indonesia, crowdfunding is believed to have provided help in the form of reducing business risk due to the large number of investors who can enter, reducing financing through banks with high-interest rates, being able to finance small project businesses that have financial uncertainty and being able to involve the public in the form of community to develop energy transition development. However, crowd funders have little influence and cannot form deals. In addition, there is a considerable risk of misinformation and fraud, so government agreement is needed when you want to run this business model.

In contrast, crowdsales is one of the crowdfunding-based financings which mainly uses tokens, used as a tool to buy goods or services (Citizenenergy, 2022), but crowdsale can also be used as a term loan that will be returned with additional loan interest. This type of Crowdfunding is very similar to the kind of lending-based.

3.3 Crowdsourcing

Crowdsourcing originated from the term outsourcing, often referred to as outsourcing. Crowdsourcing is a type of participatory online activity in which an individual, an institution, a non-profit organization, or a company, a group of individuals with diverse knowledge, heterogeneity and number, through flexible open calls, voluntarily assigns a task (Garrigos-Simon et al., 2015). Crowdsourcing is an umbrella term for various approaches that harness many people's potential by issuing an open call for contributions to specific tasks (Brocke et al., 2012).

Crowdsourcing is an online strategy in which an organization proposes assigned tasks to crowd members through flexible open calls. By performing tasks, members contribute to their work, knowledge, skills and experience and receive economic rewards, social recognition, or individual skill development. The organization will contribute and utilize the results for the specified purpose (Antunes et al., 2013). the crowdsourcer will derive and use for what advantage the user has brought to the company, depending on the activity performed. (Estellés-Arolas & Ladrón-De-Guevara, 2012). This activity can increase public participation in supervising the development of new and renewable energy and increase public awareness of the energy transition by utilizing existing communities.

The crowd does provide various approaches to help companies operate more efficiently during the continuous policy, science, technology and skills changes (Howe, 2009). Therefore, several initially

underestimated concepts began to be looked at more seriously, including open system and co-creation). In addition, the outsourcing concept also catalyzes the following sourcing method: crowdsourcing (Andriansyah et al., 2009).

There are seven common characteristics of crowdsourcing (Arolas & Fernando, 2012):

1. There is an apparent crowd (size and typology-crowd skills/knowledge)
2. There are tasks with clear objectives (task-based, what participants have to do)
3. The compensation received by the crowd is transparent (what they get in return-material or not)
4. Crowdsourcer identified (entity or individual)
5. The compensation that crowdsourcers will receive is clearly defined (the benefit to crowdsourcers)
6. Online assigned process type of participatory type (process type)
7. Using an open call with a variable rate (call type)

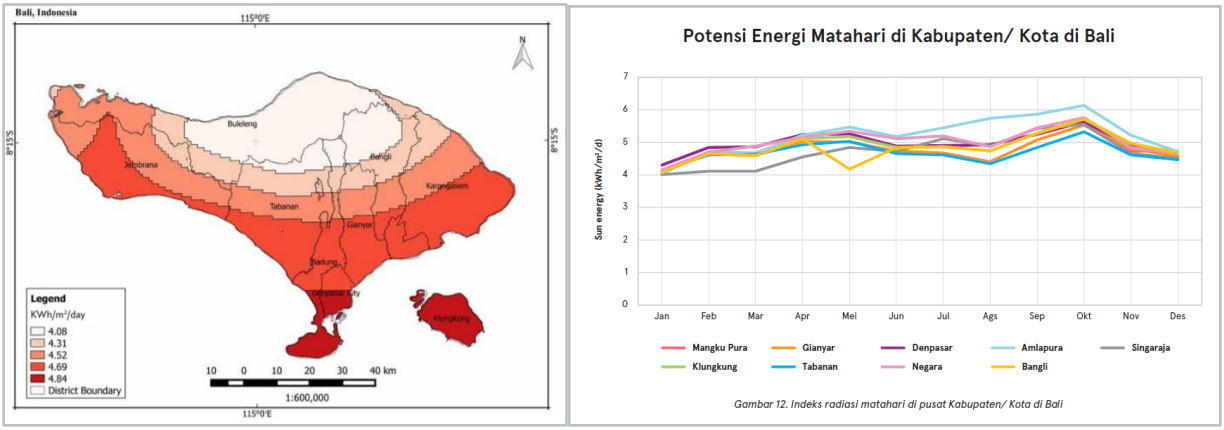
4. Results and Discussions

The data processing and analysis will be explained the potential of solar energy in Bali, solar energy market conditions, business model canvas, flowchart analysis and SWOT analysis.

4.1 Analysis of the Potential of Solar Energy in Bali

4.1.1 Theoretical Potential

The theoretical potential identifies the physical upper limit of the energy available from a specific source. This would be the total solar radiation falling on a particular surface (Teske, 2019). Solar energy in Bali Province has the highest theoretical potential, around 98% of Bali's total clean energy potential. The magnitude of the potential is simulated in the roadmap for the development of solar power plant (CORE, 2019) with RETScreen and Helioscope showing the potential for solar energy in the district/city centre in Bali ranging from 4.01–6.13 kWh/m²/day with an average of 4.89 kWh/m²/day. Meanwhile, based on research conducted by Sah, B.P. and Wijayatunga, P. (2017) in the Asian Development Bank Sustainable Environment Working Paper Series, the entire island of Bali has a potential source of solar energy that exceeds 900 kilowatt-hours per square meter per year (kWh/m^2 /year) requirement. In Europe, solar radiation should be at least 900 kWh/m^2/year for a site to be considered suitable for a solar project (Castillo et al., 2016). The island of Bali has solar irradiance from 1,490 to 1,776 kWh/m^2/year, which indicates that Bali has the potential for commercially viable solar energy projects.



(a) (b)

Figure 2. The theoretical potential of solar energy in Bali **(**Castillo et al. 2016 (a); CORE, 2019(b)).

4.1.2 Potential Location

According to the governor's regulation, Rooftop PLTS will be focused on conservation in developing Green Buildings with the principle of zero energy building. Government and private buildings must install *Rooftop Solar PV* and are regulated in the IMB. Government buildings are required to install a *Rooftop Solar PV* system for at least 20 percent of the installed electricity capacity or roof area. Meanwhile, commercial, industrial, social, and household buildings with a floor area of more than 500 square meters are required to install a *Rooftop Solar PV* system of at least 20 percent of the installed electricity capacity or roof area (Governor Regulation No. 45/2019).

Therefore, rooftop solar panels are crucial in capturing target markets such as the government, the private sector, industry, and the community, especially traditional villages in Bali. The CORE (2019) study mapped potential stakeholders according to the above classification in the South Bali section. The total roof area of the buildings belonging to the stakeholders identified in this Study is 1.127.187 square meters. The potential of the *Rooftop Solar PV* in this area ranges from 49.504–129.778 kWp, depending on the solar energy potential in that area. This figure shows that Bali has sufficient potential to achieve the 108 MW PLTS target by 2025.

Table 3. The potential area of the roof and PLTS Roof (CORE, 2019).

Potential Targets for PLTS Installation	Roof Area (m^2)	Rooftop Solar Power Plant	
		Min (Wp)	Max (Wp)
Government Buildings in SARBAGITA	237,748	10,441,649	27,373,185
Universities in Bali	214,198	9,407,346	24,661,719
ITDC Tourism Area	409,586	17,725,052	46,466,906
Traditional Village SARBAGITA	245,520	10,782,968	28,267,966

4.2 Analysis of Solar Energy Market Conditions

4.2.1 Study on the perception of PLTS Atap in Bali

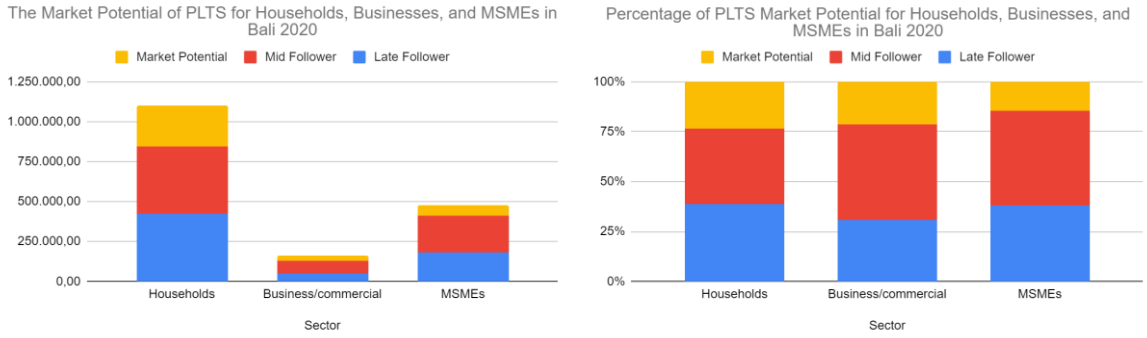


Figure 3. Study on the perception of PLTS rooftop in Bali **(**Citraningrum, 2021).

The Institute for Essential Services Reform (IESR) survey by Citraningrum, M (2021) reviewed the market conditions for rooftop solar PV based on three respondents: households, business/commercial and MSMEs. The survey results show that a potential market ecosystem has begun forming among stakeholders in Bali. Data shows that in the housing sector, there is already a 23.3% market potential in this case is willing to adopt from 1.1 million households in Bali in 2020, or equivalent to 256.000 households based on survey respondents in Bali. In addition, there is at least 21.1% market potential in the business and commercial sector from a total of 164.094 businesses and industries in Bali, equivalent to 35.000 companies. Lastly, in the MSME sector, there is a 14.7% market potential of 480.000 MSMEs in Bali, or equal to 71.000 MSMEs.

4.2.2 Investment Potential among Youth

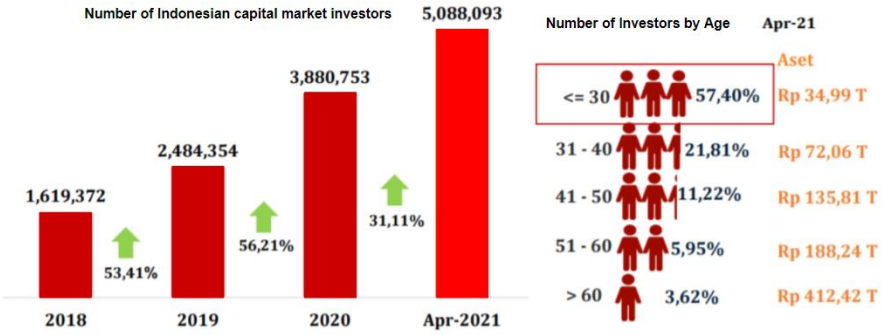


Figure 4. Number of Indonesian Capital Market Investors **(**KSEI, 2021).

Currently, youth is a potential asset in the investment world. Based on the data of KSEI (2021), youth less than 30 years old dominate the capital market with a percentage of 57.40%. Based on IDX data, the growth of retail investors in 2021 is supported by millennials (born 1981–1996) and Gen-Z (born 1997–2012). This investor growth is in line with the growing number of investors from youth in Indonesia; it can be a potential target market in developing Rooftop Solar Power Plants in Bali. Furthermore, youth is expected to be the first milestone in increasing public participation engagement. Therefore, a millennial-style strategy is needed to support the development of solar power plants in Bali.

4.2.3 The Success of Crowd Sale-based Rooftop Solar PV Abroad

A Solar Trade platform has implemented this crowd-sale-based rooftop solar power plant in Bantayan, Philippines. Solar Trade presents a feature in the form of providing crowdsourcing for information on the procurement of renewable energy projects, especially in the energy utility sector through solar PV, by utilizing people from all over the world to participate in the construction of this project through a crowd-sale. The community will benefit from purchasing solar panels from rental or leasing fees which are paid monthly/yearly with a certain amount of profit from the sale of electricity made by the party building the project. Solar Trade Based on the example that has been done by Solar Trade, which is located in Bantayan, the Philippines, with a complete installation for sales of 500 kW, these solar panels are sold through a crowd-sale mechanism at IDR 2,983,087 per panel with a power of 250 W. 2000 panels for a total capacity of 500 kW. This rental fee lasts for 12 years. You will expect to get a rental fee from 13,5% to 12,4% of rental yield each year (consider the time value of money by using a reduction in rental yield of 0,1% per year). Monthly income is calculated based on the electricity sales tariff to the electricity company. Thus the calculation for each panel with a power of 250 W is as follows (shown in Attachment' Table 4'). At the end of the leasing period, a profit of 65.4% will be obtained with the distribution of the residual sale at 10%. Then the initial capital of IDR 2,978,600 will be able to generate an income of IDR 4,626,604 with a profit of IDR 1,948,004 per panel. Investors will earn profits in the 8th year of investment and will continue to increase linearly in the following years until the end of the investment agreement period, which can be seen in the diagram below.

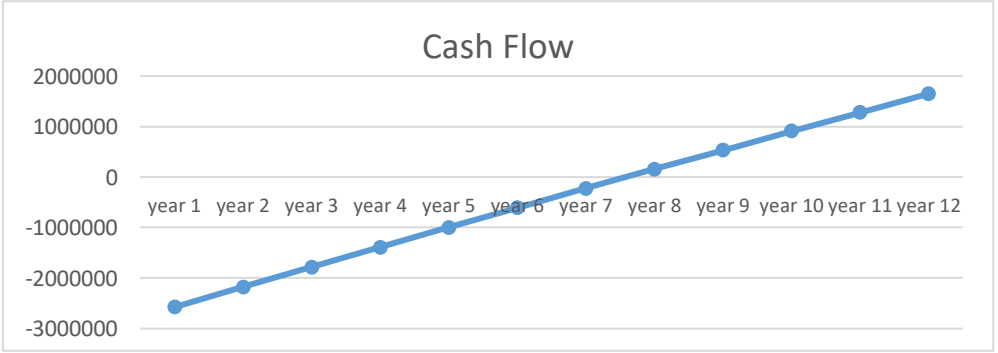


Figure 5. Estimated solar panel cash flow in Bantayan (Solar Trade, 2022).

This investment method can be implemented in Bali because Bantayan is an archipelago with beautiful natural attractions. Many tourists visit this area, so there are a lot of hospitality industries and other industries that support the tourism industry. Bantayan is similar to Bali, a tourist area visited by many tourists. It can create opportunities for marketing renewable energy investments to local and foreign tourists so that crowdfunding will get more excellent funding. In addition, the Balinese government has policy directions to accelerate the process of developing new and renewable energy.

4.3 Business Model Canvas

The business model canvas is carried out to map the components or business elements of the platform so that it can be seen as the interrelationships between elements to generate value for customers, the company, and the benefits obtained by both parties (a better version can be seen in Appendix' Figure 8').

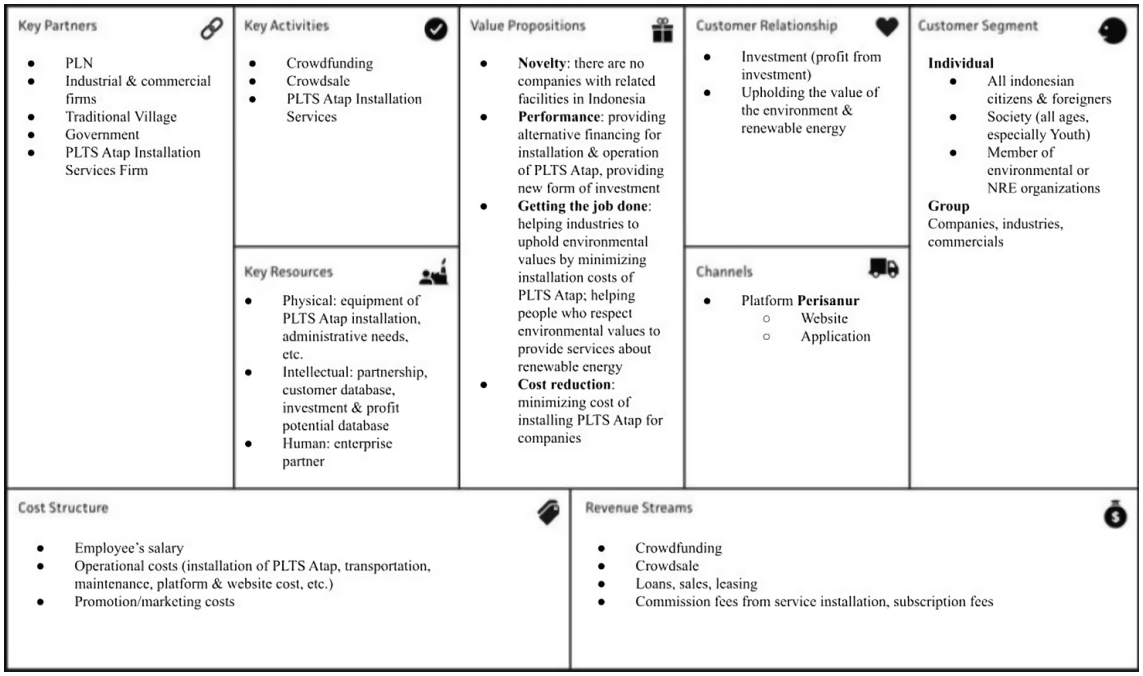


Figure 6. BMC of the product **(**Source: Analysis results).

This system is designed to accommodate stakeholders to support the use of solar energy in Indonesia, especially in Bali Province. Based on the BMC above, it is known that the customer segment of this system/application can be in the form of individuals or groups. Individual customers are targeted at all Indonesian citizens and foreign nationals who have met the requirements to invest, especially for youth and members of environmental or renewable energy organizations, while groups can come from companies, industries and commercials, especially as customers for installing *Rooftop Solar PV*. There are also critical partners in implementing the system, which is PLN as an electricity distribution company to transform heat energy into electricity, a rooftop-based solar energy installation company to facilitate the installation of *Rooftop Solar PV*, industries and companies as objects or subscribers that will utilize solar energy, the provincial government as a regulator and supervisor of related systems, and local governments who can utilize local people and existing resources in traditional villages that have the potential for producing solar energy. The partners are involved in supporting the crowd-based investment system so that each function can run so as to create an investment ecosystem. From the results of the analysis, it can be seen that the value proposition of this business model is that there is no company that accommodates the same thing in Indonesia that provides financing and investment services as well as installation and operational management of *Rooftop Solar PV*. With this system, the electricity costs that must be paid in the installation and operation of *Rooftop Solar PV* will be reduced because it will be distributed to investors according to the initial investment agreement. Meanwhile, by

relying on an investment system for crowdfunding and crowd sales, the money invested will circulate and return to investors as profits from commission fees for service, installation and subscription fees of *Rooftop Solar PV*. This system has been proven to reduce costs in mainstreaming the use of renewable energy, especially solar energy (*Rooftop Solar PV*), because there are many projects with similar ideas in America and Europe with promising benefits, such as Windcentrale, Abundance Generation, Mosaic, Trillion. Fund and Gen Community. With investment figures increasing in the past two years, it is hoped this system/application can support the energy transition and improve environmental quality through public and private participation (Yusgiantoro, 2021).

4.4 Flowchart Analysis

Based on the results of the analysis of potential energy use and analysis of the Business model canvas, it is concluded that the application must have several features and customers, as shown in the following diagram (in Attachment' Figure 7.'). Based on Figure 6, there are two divisions of customer segments, namely investors who are individual and group or in the form of companies. Each customer segment is served with different platform features. First, investors will be served with crowdsourcing marketing services, crowdfunding and investment profit estimation. Crowdsourcing and crowdfunding marketing services are features that serve the needs of investors in finding the right project to invest in based on the interests and background of the investor. With this service, it is hoped that investors will be able to find reviews related to projects that will be used as places of investment. Then the feature of calculating the estimated return on investment comes as a feature that complements this investment to make it even more attractive. Investors can see the estimated profit given according to the size and duration of the investment. This feature will make investors more confident to invest in rooftop solar power plants.

The next feature in the customer segment group is the installation of solar panels and complaints of damage. This feature is present in meeting the group's needs in terms of installing solar panels. In addition, the damage and maintenance complaints feature is a feature that makes it easier and maximizes investment returns so that the use of solar panels can run optimally at all times.

Then, after compiling the required features and customer segmentation, the next step is to develop a workflow for the application to maximize investment and transition to renewable energy, especially rooftop solar power plants, as follows (a better version can be seen in Appendix Figure 9')

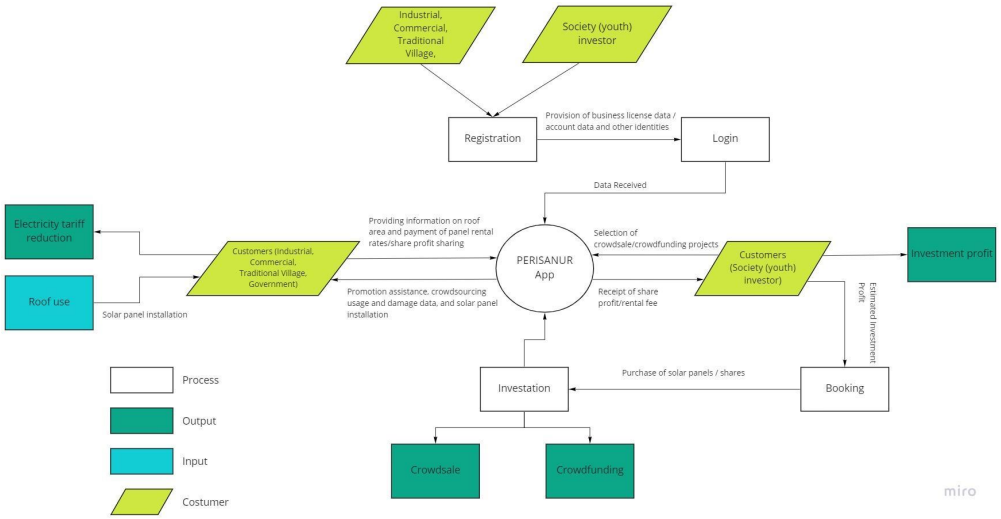


Figure 7. Workflow analysis of the application (Source: Analysis results).

In the results of the flowchart analysis, individual and group customers are required to register first and complete the data according to segmentation. After registering, individual and group customers can use the application. The group customer registers their group and calculates the potential roof that can be utilized; then, the information is passed on to the application. Next, individual customers use the

application to perform the selection of investment projects and the calculation of estimated profits. Then after getting the desired choice, an order is made for investment in crowd sale or crowdfunding. After that, the investor's money will be received for further installation of solar panels on the roof of the group customer. after use, the group customer will benefit from reduced electricity costs due to using rooftop solar power plants. Meanwhile, the society (youth) will benefit from the investment within the agreed period with the nominal profit that has also been agreed upon.

4.5 SWOT Analysis

The following are the results of identifying strengths, weaknesses, opportunities and threats of implementing the platform to support the use and investment of rooftop-based solar power plants using crowdfunding and crowd sale methods.

4.5.1 Strength

Strengths in this analysis describe the internal conditions of the platform in the form of capabilities it has as potential and alternatives to deal with threats. Crowd-based is a suitable financing method in mainstreaming the use of renewable energy, especially for solar energy & *Rooftop Solar PV*. It is considered quite effective in financing something that is being developed because it can reduce the cost of installing *Rooftop Solar PV* and has a low risk of overtaking investors (Golic, 2013). This can provide assurance to investors so that they can still uphold environmental values without the risk of losing large profits. With this system, all groups, including youth, can start a worthwhile investment. In addition, there has been no similar innovation in Indonesia in this field, so it has a high novelty level that will attract many investors and increase the number of profits. Furthermore, this system can provide benefits to entrepreneurs on an industrial and commercial scale by providing their electrical energy needs through the use of renewable energy, that is, *Rooftop Solar PV.*

4.5.2 Weakness

Weaknesses describe the internal conditions of the platform in the form of things that cannot be used to deal with threats. This system has the possibility of high-profit income with low risk. However, a large enough investment is required to run the system at the beginning of the operation of the business (Mostafaeipour et al., 2021). In addition, there has not been a comprehensive strategy formulation directly applied to the platform system related to problems in the construction and use of rooftop-based solar power plants, such as battery problems, installation & maintenance risks, intermittent energy conditions and after-sales service. Therefore, it is necessary to make the right strategy in the initial operation of the system in order to maximize profit returns and establish related regulations.

4.5.3 Opportunity

There are several external conditions that can support the implementation of the related system. First, the current level of investment from the youth group is relatively high compared to other groups, so it follows the selection of the target market. Around 54.7% of investors in Indonesia in 2021 are from 17 to 30 years old and have a turnover of IDR 34.99 trillion (KSEI, 2021). In addition, there are also several organizations that support the use of renewable energy in Indonesia, such as Masyarakat Energi Terbarukan Indonesia (METI), the Society of Renewable Energy (SRE) groups, Indonesia Green Energy, and others. A target market and a high probability of investment will support the implementation and movement of the system so that it can generate the expected profits and run smoothly.

4.5.4 Threat

There are several external conditions that can hinder the implementation of the *Rooftop Solar PV* development system through the crowd-based model. First is the lack of knowledge about the benefits and use of renewable energy, especially *Rooftop Solar PV.* Second, post-pandemic conditions allow for

an uncertain investment climate. In addition, there are also business competitors in the same field who will soon implement a crowd sale method to install *Rooftop Solar PV* in Indonesia. Under these conditions, there is a knowledge gap that reduces investment interest and disruptions in the investment climate of the system (Sopandi & Nazmulmunir, 2012).

5. Conclusions and Recommendation

Based on the study, the following conclusions are obtained to answer the problem formulation. In conclusion, rooftop-based solar power plants or *Rooftop Solar PV* in Bali have significant potential. Firstly is the theoretical potential, which is the highest potential in Bali for renewable energy, and the radiation has reached the solar power plants development target. Secondly, the potential locations of rooftop-based solar power plant development focus on developing green buildings by utilizing Bali's commercial, industrial, social and household sectors. Finally, this has also been supported by the market ecosystem from the sector and the youth as capital market dominators who can be approached to increase public engagement to participate. Afterward, to be able to develop a platform that can inform and attract youth to invest, it is done by reviewing the business model in application development. In this study, it can be seen that all elements in the business model canvas have been fulfilled and reviewed, indicating that this business is feasible to run. In addition, from the results of the BMC analysis, a study was conducted to produce attractive features for investors, then a workflow was made to guarantee the platform's feasibility to be operated on a crowd-based business model. This financing utilizes the role of the public in accelerating the development process of the renewable energy transition. This has been done in the Philippines, and it has been proven that this financing is profitable for investors. Through this financing scheme, it is hoped that it will be able to attract domestic and foreign investors to invest in solar PV in Bali. With its novelty value, it is hoped that this alternative method of financing can help the mainstreaming process of obtaining and using renewable energy to support sustainable development. In addition, it is also hoped that this strategy can increase public awareness and motivation to switch to the use of renewable energy with good accessibility.

These are some suggestions that can be considered for further research. First, it is necessary to map the potential economic study with the LCOE and NPV approach in measuring the average net present cost or value for rooftop solar power generation over the lifetime. Second, it is also essential to implement other innovations to overcome the problems of using the *Rooftop Solar PV*, such as intermittent energy sources and, depending on weather conditions, the need for ample space for installation, overheating problems and others. Third, designing the system is necessary to develop innovation as a solution and preventative action from weaknesses and related application threats because the strategy has not been provided in this study. Lastly, if the regulations related to Crowdfunding and crowd sale in the field of renewable energy production have been completed, it is required to adjust the application of innovation to these policies.

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Appendix

Table 4. Estimated profit on solar panel investment (Solar Trade, 2022).

Time	Outflow	Revenue	Rental Yield	Cash Flow	Benefit
year 1	**-2978600**	402111	13.50%	-2576489	-86.50%
year 2	0	399132	13.40%	-2177357	-73.10%
year 3	0	396154	13.30%	-1781203	-59.80%
year 4	0	393175	13.20%	-1388028	-46.60%
year 5	0	390197	13.10%	-997831	-33.50%
year 6	0	387218	13.00%	-610613	-20.50%
year 7	0	384239	12.90%	-226374	-7.60%
year 8	0	381261	12.80%	154887	5.20%
year 9	0	378282	12.70%	533169	17.90%
year 10	0	375304	12.60%	908473	30.50%
year 11	0	372325	12.50%	1280798	43.00%
year 12	0	369346	12.40%	1650144	55.40%
Residual Sale	0	297860		1948004	65.40%
Total Revenue	0	**4926604**			

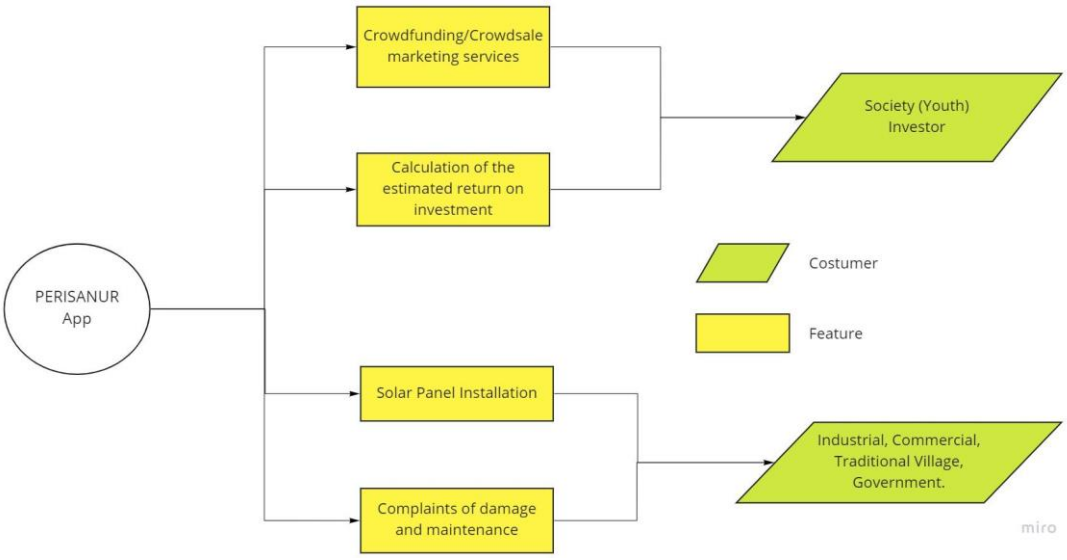

Figure 7. Feature Segmentation of Perinasur (Source: Analysis results).

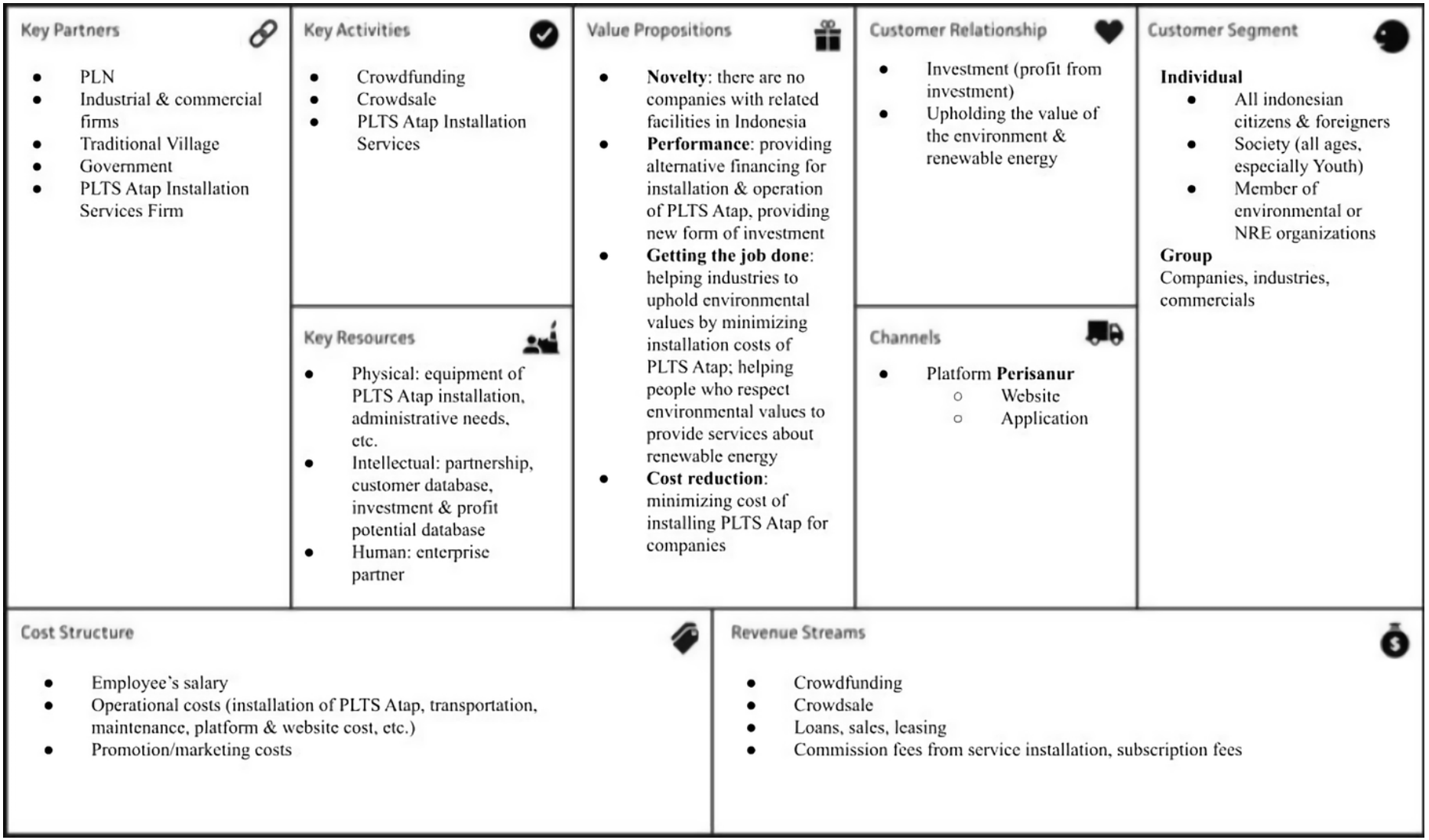

Figure 8. The BMC Application (Source: Analysis results).

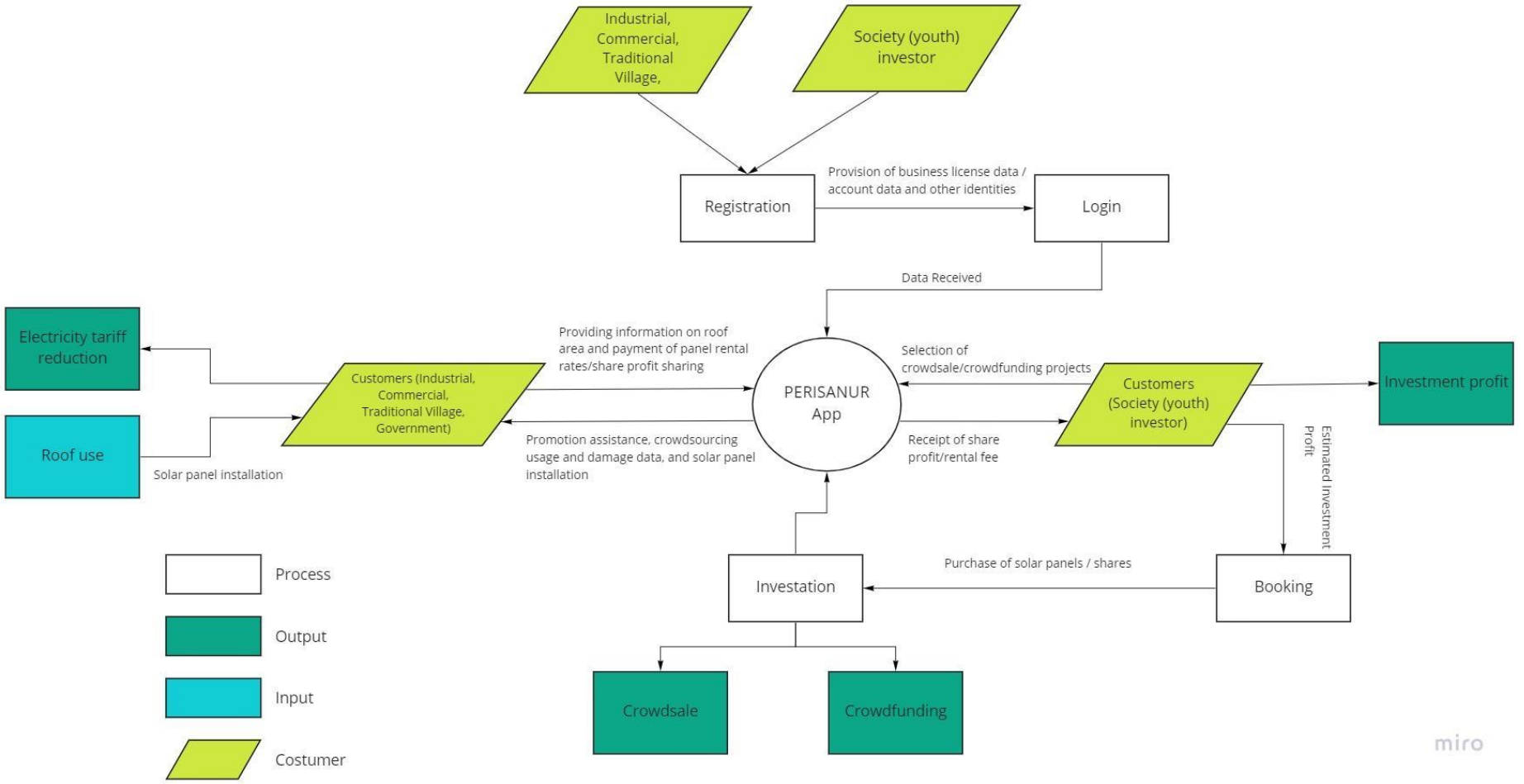

Figure 9. Workflow analysis of the application (Source: Analysis results).