Technological Innovation and Commercialization of Solar Tracker on Solar Cell: A Comparison Study

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Abstract

Renewable and environmentally friendly energy sources, such as solar cells that utilize solar radiation, are tools to produce environmentally friendly energy that are very suitable to be applied in tropical countries rich in sunlight such as Indonesia. Solar cells technology innovations have been widely applied in several fields such as the fishing industry, transportation, and agriculture. This shows that solar cells technology innovation is very needed because it has a wide reach and can be applied in almost all parts of Indonesia. One of the innovations needed to develop solar cells is a solar tracker that functions to direct the solar cells to sunlight so that the energy produced can be maximized. Solar tracker has a big impact because it can have an impact on economic growth in Indonesia. This study aims to determine the implementation of technopreneurship and the development of solar tracker innovations to optimize the electrical power generated in Delanggu by utilizing light sensors to follow the direction of the sun. This paper examines the challenges and obstacles faced in developing technopreneurship and contains a comparative study of solar track products from China that have almost the same features. Implementation technopreneurship needs a good and mature design and strategy, and choose effective and efficient steps by paying serious attention to designing the technology to be sold and how to use it and followed when there is a target market segment, and users already understand the technology.

Keywords
Energy, Solar Panel, Solar Tracker, Technopreneurship.

1. Introduction

In this modern era, the need for energy for humans is increasing rapidly. Every year the use of energy for household, industrial, transportation, and even agricultural purposes is increasing as well. Currently, energy in Indonesia depends on coal, natural gas, and oil, which are used less and less over time. If there is no alternative solution to replace energy sources in the next few years, it is very likely that we will no longer be able to consume electricity as it is now.

To prevent the depletion of energy sources, alternative sources of energy are needed as an innovation called renewable energy such as solar panels by utilizing sunlight as a source of electrical energy so we have an unlimited source of electrical energy for technological advancement and fulfillment of increasingly human. In the renewable energy industry, especially in solar panels, Indonesia is still far behind compared to several other countries in ASEAN such as Singapore, Malaysia and Thailand. Even though based on its geographic location, Indonesia has the potential to generate electric power of 4,8 kWh / m2. Based on calculations from the ESDM Research and Development Center, it is known that if Indonesia succeeds in developing a Solar Power Plant, Indonesia can produce 112.000 GWp of renewable electrical energy (Hasan, 2012).

There are several solar panel technology innovations that created to increase energy from solar panels from academia, government, and private companies. Innovation lies at the development stage, from the first stage of discovery to success as a business. In 2014, Institut Sepuluh Nopember (ITS) made a solar panel called the Smart Solar Panel System (SPS), which is able to absorb sunlight more optimally use a fresnel lens combined with a solar tracker. The solar tracker is a tool to automatically adjust the position of the solar panels, so it is able to follow sun's rays direction. With the real-time clock method, the solar tracker on the SPS will move nine degrees every 30 minutes. In addition to innovations in the solar tracker, the Solar Panel System (SPS) by students of the ITS Electrical Engineering Department also uses a fresnel lens on its solar cells. This fresnel lens has a high sunlight absorption capability and is thin and light. In the SPS assembly, the focal point of the fresnel lens is very calculated to place the lens on the solar panel so it can increase the intensity of the incoming sunlight (Saputra, 2014).

The success or failure of solar panel technology innovation is determined by the collaboration between the government, the business world, research laboratories, and universities. The efficiency can be achieved in production and trade by management and organizational structures. It is impossible for a company to make a breakthrough or technological innovation or develop something new unless new technology is used to make the business more competitive by increasing profits, reducing costs and similar changes in its economic results (Carayannis et al, 2015).

However, not all technological innovations can be present on the market. There are countless innovations that never come out, and fall into the "valley of death" because of the difference between scientific science and industrial marketing. This is a lost opportunity for economic and social growth and profitability of the company. For that we need an improvement by presenting technopreneurship and innovation systems in solar panel innovation management which will be discussed in this paper. This paper highlights the common challenges and barriers that inventors face in developing technology entrepreneurship and their benefits.

2. Literature Review

According to Edquist (1997), an innovation system is defined as: "important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovation." The goals of the innovation system can be in the form of creation, diffusion, and exploitation of innovation (Carayannis et al., 2015). Bauwhof argues that Hughes and Latour, taking into account the discovery-innovation process, identified communication (i.e. interactive learning) in which various forms of knowledge are integrated through a process of transformation, promoting new combinations of knowledge. In the early stages of this invention, the product (innovation) is an abstract concept which is then redefined and changed by actors seeking entry to the market. The 'discovery system' is 'open' because various options are being tested. In contrast to the discovery phase, mature products appear in a technological model with a fixed set of different forms of knowledge in a particular structure. In this sense, the internal complexity of the innovation system may be higher than the complexity during the discovery stage, but the prospects for 'weak ties' are not the same as before. In the learning economy, this occurs during new species (Carayannis et al., 2015).

Technology and Entrepreneurship are the two main factors in the early twentieth century (Joseph Schumpeter, 1934) where the role and dynamic nature of technological innovation and its interdependence are recognized as one of the greatest factors that develop and shape the future of the world economy. Entrepreneurs around the world are making technology one of the most influential tools in taking advantage of opportunities to grow economies. Thus, technology-based entrepreneurship or it can be called technopreneurship is one of the biggest innovations in the twenty-first century in the business world, through the facilities provided such as open access to local and global business networks, real and virtual infrastructure, and a network of incubators that can be utilized. in technopreneurship development.

3. Methods

The comparative study conducted by the author is based on selected case studies using observational data collection methods in examining the framework of technopreneurship approaches and innovation systems. The analysis takes a technopreneurship approach and innovation systems in the innovation management process and the technopreneurship model is applied by combining management theory, innovation process, and technopreneurship that can be seen in Figure 1. Start from new idea and discovery what do you want to study, after that the prototype of product will be subjected as feasibility study, and the last step is development of the prototype. From the prototype that has been developed, a new idea will be born which will form a technopreneurship development framework.

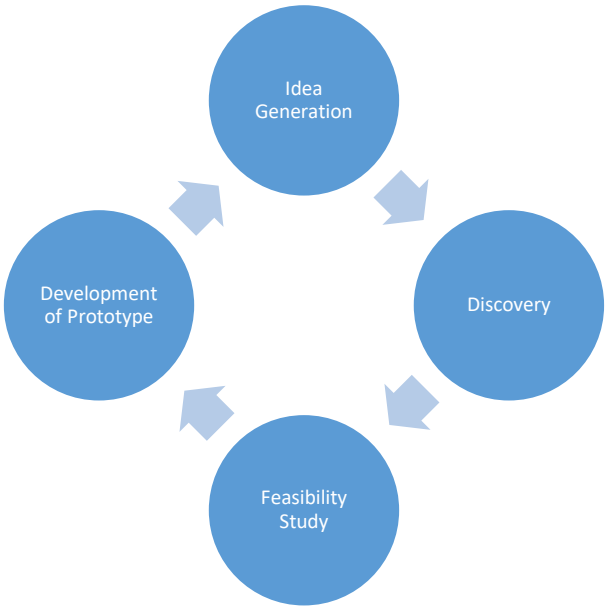

Figure 1. Framework for technological entrepreneurship development

Innovation management is a highly interactive process resulting from the ongoing transfer of knowledge between various points of the entity, where the participation of each team member can influence the outcome (Cooke et al., 1998). Innovations often seem to work in the short term, but not very much in the long term. The main reasons for this problem are unrealistic expectations in the future evolution of technology and a lack of insight into unexpected effects. The second observation is that only in a few cases the main obstacle is a scientific or technological problem. Usually, organizational, administrative, and institutional problems get in the way (Carayannis et al., 2015).

Innovation management is complex and risky. Analysis of company failures reveals, among other things, that many innovative companies fail to translate their technological creativity into profitable business operations. Therefore, the challenge is not just the creation of innovation, but the right management to generate profits in the company. Since the role of innovation management in company performance is clear, its management processes must be standardized and used to achieve sound business operations (Carayannis et al., 2015).

Many technological innovation products from research results fail to be released to the market and enter the valley of death. Universities are expected to take over from this process to accelerate the transfer of a technological innovation product to the market (Sutopo, 2015; Sutopo et al., 2019). With the strategy taken by TTO in taking measurements as an effort to measure performance when providing information efficiently to be used as a reference for other universities in formulating strategies. The university is also expected to help when a university plays a role such as providing facilities to support technology commercialization, mentoring, marketing and business networks, coaching, financial support, and internal regulations of the university (Sutopo, 2019).

4. Data Collection

Solar tracker from Xiamen Mibet New Energy Co., Ltd. has been installed in several countries such as Japan, Australia and India where the placement of the solar tracker is placed in spacious locations such as roofs of buildings and fields with the aim of avoiding shadows and making it easier for the movement of the solar tracker to be able to obtain more optimal electricity when following the intensity of the sunshine per unit appointed time. Programmed automatic tracking can reach about 45 degrees from the original angle so that it can increase power generation 20% to 30% higher than fixed systems with good environmental adaptability without the influence of rainy and cloudy weather. Equipped with GPS, this solar tracker from Xiamen Mibet can guarantee the accuracy of the moving time of the solar panels with an excellent electromagnetic compatibility design to make the system stable and reliable at extreme temperatures at the same time. The remote communication feature can also be used to identify failures in an automatic system with an alarm notification on a mobile phone as a sign of interference with the automatic system so that it is hoped that there will be no bigger system damage. Xiamen Mibet has worked successfully in researching and developing, manufacturing and selling solar powered products with its intellectual property with innovative and first-class component mounting solutions that have been implemented in more than 100 countries. The product comparison beetwen Solar Tracker Xiamen Mibet and Solar Tracker Ecokarsa is shown in Table 1.

Table 1. Solar tracker product comparison

Solar Tracker Xiamen Mibet	**Solar Tracker Ecokarsa**
Can move 45^0 from center	Can move 30^0 from center
Light sensor with cable 2 m from center	Light sensor with cable 50 cm from center
Input 8 – 24V	Input 12V
5A	2,5A
Remote Controller	There is no Remote Controller yet
Database of sun's movement from the light sensor every hour	Data is not stored in real time
Automation system returns to center point at night	-
Maximum weight that can be lifted 30 kg	Maximum weight that can be lifted 10 kg
10 years warranty	There is no guarantee yet
Already have legality and license	There is no legality and license
Closed Source	Open source
Data accuracy above 90%	Data accuracy around 60% - 70%
Dimensions 20 cm x 10 cm x 5 cm	Dimensions 10 cm x 10 cm x 5 cm
Technology Readiness Level 9	Technology Readiness Level 5
Investor Xiamen Mibet, China	Investor UNS, Indonesia

By implementing a strategy of cooperation with various parties, Xiamen Mibet New Energy has successfully implemented and served the demand for innovative solar trackers on solar panels in several countries that are shown in Figure 3. This innovation has developed into several types that make people optimistic that the installation of solar panels for daily life, industry and applications in other fields can be fulfilled properly and optimally. It is important for Xiamen Mibet New Energy to have many relationships in developing this solar tracker because Xiamen Mibet New Energy can easily create its own market so that with the presence of a market that is sure to place an order for a solar tracker, the company can easily commercialize new technologies and innovations that will be developed by Xiamen Mibet New Energy. Figure 2 shows the prototype of Solar Tracker Xiamen Mibet. In addition, the gradual and constant development that can be seen from the innovation and technology that Xiamen

Mibet New Energy is able to execute is seen every year, so this is what makes the market even more daring to place orders directly.

Figure 2. Prototype Xiamen Solar Tracker System (Source: mbt-energy.com, 2021)

Figure 3. Deployment of The Xiamen Mibet New Energy Service (Source: mbt-energy.com, 2021)

Figure 4 shows the prototype of Solar tracker Ecokarsa that developed by Sebelas Maret University (UNS). UNS sent a group of students consisting of Gilang Titah Ramadhan, Fuad Fachrizal Achsan, Krisna Wahyu Wardhana, Nambang Rizal Saputra and Faishal Najib to conduct research related to Solar Power Plants (PLTS) to fulfill electricity needs for farmers in Delanggu village. This research is expected to be commercialized in the wider community, but the development of supporting technology such as programs and sensors is still in the research stage which results in the Ecokarsa solar tracker not being fully utilized by the community. The UNS Merdeka Belajar team is still conducting research on the application of the solar tracker for 4 months to collect sample data so that further analysis can be carried out to find optimal conditions from several aspects such as infrastructure, social and economic environment. This research is still being developed because the energy produced by solar panels is expected to help the Sanggar Rojolele farmer community in Delanggu to increase rice yields, reduce pests around the rice fields and as a public facility for farmers. And in the future, it can be expected to be commercialized in careful planning with the university also playing a role in developing research to support the commercialization of solar trackers and the concept of energy utilization for farmers which is being initiated by the UNS independent learning team.

Figure 4. Prototype Ecokarsa Solar Tracker System (Source: Blibli.com, 2021)

Table 2. Business Canvas Model Solar Tracker Ecokarsa

<table>
<tr>
<td rowspan="2">Key Partners

• Supplier Raw Material
• Shipping Services</td>
<td>Key Activities

• Procurement of goods
• Programming
• Production
• Branding
• Promotion
•</td>
<td rowspan="2">Value Propositions

• Environmentally Friendly
• Economical
• Energy Efficiency</td>
<td>Customer Relationships

• Using data analysis in determining which customers often order to be given rewards</td>
<td rowspan="2">Customer Segments

• Companies that use solar cell
• Elementary School
• University</td>
</tr>
<tr>
<td>Key Resources
• Man Power:
o Tool Assembly
o Admin
o Programmer
o Data Analysis
• Equipment
o Laptop
o Smartphone
o Internet
o IoT Sensors</td>
<td>Channels
• Online direct selling via website, Instagram, email and phone</td>
</tr>
<tr>
<td colspan="2">Cost Structure
• Labor costs
• Shipping costs
• Administration costs
• Raw material costs</td>
<td colspan="3">Revenue Streams
• Sales of products solar tracker
• Sales of products solar tracker and solar cell
• Installation solar tracker
• Workshop</td>
</tr>
</table>

The university is helping TTO research to determine the readiness of the solar tracker when it will be commercialized in the future. In order to assist this research, a 4 months study is needed to minimize risks, collect data and analyze factors that influence the commercialization of the solar tracker. The condition of the community is

also one of the big considerations in this study because the community will be one of the stakeholders who play a big role in the market for the demand for the solar tracker to be developed.

5. Results and Discussion

From the data that the author has collected, there are several similarities between the Xiamen Mibet solar tracker and the Ecokarsa solar tracker in terms of technopreneurship and innovation systems such as having a data set for calculating accuracy, sufficient readiness technology and the existence of sensors and programs. Judging from the process, commercialization is an important part of the innovation process which is complex, has high risk, requires high operational costs, and most innovations fail in this phase. The Xiamen Mibet solar tracker is superior in terms of commercialization compared to the Ecokarsa solar tracker when assessed from an entrepreneurial side because the Xiamen Mibet solar tracker product already has a license and legality and its closed source nature makes this technology safer and more exclusive because companies already network with each other to a greater extent than before with efforts to develop and commercialize technological innovations.

In finding new knowledge and innovations to help a product survive in a competitive market, a company should aim to seek new knowledge and applications. This is done through the collaboration of universities and industry just like Ecokarsa that collaboration with UNS. In particular, the technology transfer office (TTO) serves as an intermediary to enable collaboration between universities and companies. From this it can be proven that Indonesia can adopt strategies that have been taken by other countries to create a market for solar trackers on solar cells. In addition, cooperation with private companies, MSMEs, and also the government is also very much needed in an effort to increase the commercialization network of the new technology that will be launched, so that from this collaboration the government can ensure that the technology being developed can be used in various regions and at a wide and varied level of society.

Based on the analysis from TTO, it can be concluded that the TTO has a large enough role when it comes to developing the commercialization of technological innovations because TTO has the aim of increasing national economic development through increasing technological innovation. With the transfer of technology that contributes to the provision of new technology that has the potential to be commercialized. This program is conducted by universities and several private companies to develop, protect and control intellectual property by helping to obtain licenses or patents.

6. Conclusions

This study concludes that the analysis of the Technopreneurship & Innovation System framework for the development of the Solar Tracker Ecokarsa and the Xiamen Solar Tracker was carried to understand the innovation management process in the related Technology Transfer Office and how the technopreneurship model was applied. Based on the analysis that has been done, Technology Transfer Office is the key to success in managing Solar Tracker innovation so that the innovation system can be properly implicated for technology commercialization. Collaboration between technopreneurs and innovation systems, as well as the participation of government agencies, universities, and the private sector, is needed for the commercialization of technology, most of which have not been explored more deeply, so this has been in many products that are not ready to circulate on the market and fall into the valley of death so that This is very important for readers who are designing a product design with a technopreneurship and innovation system approach to avoid the product prototype avoiding the valley of death and being able to exist in the global markets.

This research is based on a comparative analysis based on case studies, so the conclusions drawn from these cases may be difficult to generalize. The findings of this study can be a lesson in the success of technology commercialization. The development stage consists of the Innovation Process and the Technology Transfer Office. This framework model follows the development framework of solar tracker technology. The weakness of this analysis is that there is no tactical strategy to achieve the success of the means to reach the market, so it is necessary to carry out more in-depth research and data collection related to product research.

The author's recommendation based on the results of this study is that if you want to be successful in commercializing technology, you need to have a good and mature design and strategy, and choose effective and efficient steps. The main strategy that can be chosen in doing technology business is by pay serious attention to designing the technology to be sold and how to use it and followed when there is a target market segment, and users already understand the technology. Implementing an open innovation strategy in doing technology business can also have a positive impact, where the technology created can quickly adapt to technology that comes from outside and can also increase product value.

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Biographies

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