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Business Model Design for Cathode Material Manufacturer Startup Case Study: PT Polimikro Berdikari Nusantara

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Startups often offer innovations in solving problems, but if these innovations have a business model, they will be protected from entering the valley of death. Polimikro Berdikari Nusantara (PBN) is one of the startups recently facing risk. PBN's main product, Lithium Nickel Manganese Cobalt Oxide (NMC), had Technological Readiness Level (TRL) 7 Demonstration System. However, the Market Readiness Level (MRL) is level MRL 4 Small Scale Early Adopter Campaign. Therefore, several activities need to be done to increase MRL to save PBN from the valley of death. This study aims to provide a design model and business strategy for PBN. This qualitative research uses analytical techniques using an interactive analysis model by Miles and Huberman. Data collection was done by observation, documentation, and interviews. The results obtained in this study are business models in the form of Business Model Canvas (BMC) and Lean Canvas (LC) integration.

Introduction

A startup is a new company with a business model based on innovation and technology [1]. Startup companies offer innovation as the main value. While they usually offer high scalability, they also have a high-risk failure during commercialization and fall into the valley of death [2]. To survive startup should have a business strategy to stand out in the crowd based on its capabilities [3]. For example, Tesla comes into the market as a high-end electric vehicle car, drawing the attention of high-income people to buy the product. Meanwhile, Rivian as an electric vehicle company come to market. As a company that relies on innovation and technology as selling points, startups need to pay attention to their Technology Readiness Level (TRL) and Market Readiness Level (MRL). TRL and MRL are defined as a method for evaluating a product's readiness for market. TRL measures the readiness or maturity of the technology developed in its products, while MRL measures the readiness of technology commercialization to the market [4]. TRL and MRL are necessary to identify because "no market need" is the second greatest reason why startups fail [5], with a failure percentage of 35%, the percentage comparison is quite thin with the first rank, which is "run out of cash or failed to raise new capital" with 38% rate of failure. To increase TRL, a startup needs product development. Meanwhile, to increase MR, startup needs a good business model.

This research takes a case study at the startup Polimikro Berdikari Nusantara (PBN), a lithium-ion battery cathode material manufacturer company. From the observation, PBN is at TRL 7 Demonstration System. PBN products have passed TRL level 6 because they have passed the specified standard tests, and test results can be seen in the product catalog. There has been a transaction on a laboratory production scale by a startup named Lectro to conduct research, and repeat orders have been made to conclude that the product has been demonstrated in the lab environment and is successful. To enter TRL 8, the test is still not enough to meet "Qualified" because the quantity is still very small, and there is no procedure for identifying product problems in trials in the actual ecosystem. Meanwhile, based on observation, PBN is at MRL 4 Small Scale Early Adopter Campaign. The first reason is that PBN has made sales transactions and has an early adopter, so the

Minimum Viable Product (MVP) has been validated to work well. PBN has explained its products in a pitch deck that can provide an overview of the company's product concept. The second reason is that PBN has customers but has yet to reach at least 50 transactions. There has been no massive marketing considering the production capacity. Current customers are startups that are early adopters and only one company, so currently, PBN is still at MRL 4. At least it requires a minimum of 100 successful transactions to reach MRL 5.

The market for PBN can also be seen on the National Battery Research Institute (NBRI) website. NBRI is an independent Indonesian institution for electrochemical energy storage science and technology, supporting research, training, and education [6]. NBRI has 659 individual members, 62 institutional members, and 28 corporate members. This member of the NBRI can be a potential target market for PBN. Several business strategies need to be made to increase PBN's MRL to reach the existing target market. There are various ways to project a business strategy through a business model, and one that startups often use is the Business Model Canvas (BMC) by Osterwalder & Pigneur. Business Model Canvas (BMC) is a design model prepared to quickly present the company's conditions, capabilities, and targets in running its business [7]. Besides BMC, startups often use the business model framework Lean Canvas (LC) by Ash Maurya, with a lean principle. The lean principle can be described as a way for the company to release a product or service with limited capital as soon as possible [8]. Ash Maurya believes that BMC is suitable for large companies focusing on improving technology and innovation. However, it is still less efficient for newly formed companies and is still focused on validating and developing ideas for commercialization, so he developed BMC and proposed a business model framework called Lean Canvas (LC) [9]. BMC is focused on existing companies that want to innovate while LC is focused on new companies or companies that want to make radical innovations [10]. Unlike other business plans, lean startups do not focus on making perfect plans but rather implement learning by doing with improvements obtained from consumer feedback to get products or services that are ideal and needed by consumers [11]. Several previous researchers have integrated several business model frameworks to build the most suitable business model for the company, for example, BMC and SWOT (Strength, Weakness, Opportunity, Threat) [12], [13], BMC and BOS (Blue Ocean Strategy) [14], BMC and LC [15]. In the paper [15] researcher conduct interview without data validation, and choose one business model framework considered the best. In this paper, BMC and LC will be used simultaneously using interactive analysis and triangulation data validation. LC can be used when the company or startup does not have a mature product and market and is still at the idea validation stage, while BMC can be used when the company is mature enough but still wants to continue to develop through its technology and innovation.

Data Analysis Method

This study uses an interactive analysis model by Miles and Huberman [16] to perform data analysis. The previous researcher applied the interactive analysis model to determine the implementation of business strategy [17]. It was chosen because it is suitable for the business strategy that the researcher wants to design because of the interactive and continuous nature of the research. Moreover, if there still needs to be more data, the researcher can collect data again [18]. The interactive analysis model is one of the data analysis techniques in qualitative research. The interactive analysis model has four analysis components: data condensation, data display, and data verification. This process is carried out by a data collection process where the four components interact with each other. The interaction can be seen in the Figure 1 below. After the data has been obtained, the researcher can display the data directly. Examples of data that can be used are photos and observation notes, but if the data is too large, such as interview transcripts or company documents, the researcher condenses the data to make it easier to understand. One of the data condensation techniques that can be used is coding. After the data is successfully displayed and condensed, the next step is data verification or data drawing. If the data is valid then the data search is complete, if the data is not valid then the data search, data display and data condensation can be carried out again.

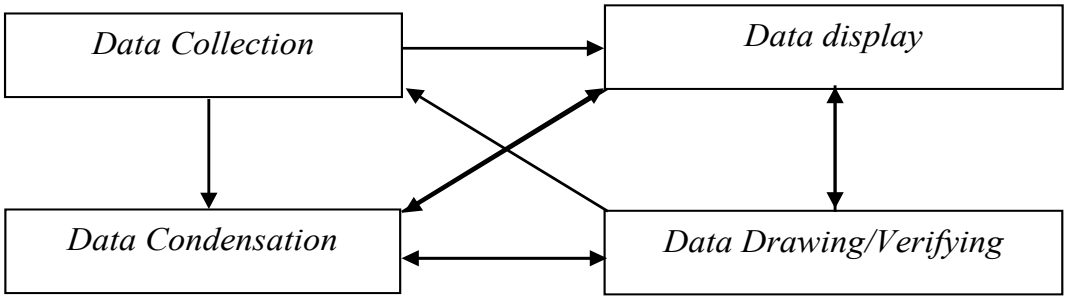

Fig. 1. Interactive Analysis Model

Data Collection

This research uses a qualitative research approach. Qualitative research has four procedures: literature study, interview, observation, and documentation [19]. To carry out business strategy planning at Polimikro Berdikari Nusantara (PBN), this study used three procedures: observation, interviews, and documentation for data collection. Data collection in this study was carried out in the period August 2021 – June 2022.

1. Observation

Observation is a data collection technique where researchers go to the field to observe everything related to space, place, actors, activities, objects, time, events, goals, and feelings. In this study, researchers made observations on the production floor and chatted with members of the company's directors to find facts that occurred in the field. Observations in this study aim to see the current conditions and test the data's validity to increase the research's credibility. The object of research observation can be seen in the Table 1, represent production site and distribution channel where the data collected.

Table 1. Observation Object

No.	Object
1	Production Floor PBN
2	Office PBN
3	Website polimikroid.com
4	Tokopedia PolimikroOfficial
5	Instagram @polimikroberdikarinusantara

2. Documentation

In this study, the researcher collected qualitative data by viewing and analyzing the documents made by the research subjects. Documentation aims to obtain information that can be used as an addition or validation to the information obtained through two other methods: interviews and observation. Documentation is also useful for testing the validity of the data to increase the credibility of the research. The documents used in this study can be seen in the Table 2 represent all the documents owned by PBN during research.

Table 2. Documentation Object

No.	Object
1	Operation Process Chart (OPC)
2	Sales Report
3	X-Ray Diffraction (XRD) test result
4	Scanning Electron Microscope (SEM) test result
5	Pitch Deck PBN

3. Interview

An interview is a data collection technique that involves verbal communication between researchers and research subjects [20]. Interviews were conducted using a semi-structured interview method. Semi-structured interviews or semi-structured interviews are interviews that involve open-

ended questions or open answers but are still on the topic area that the researcher wants to study. Researchers and research subjects can discuss a topic further to get more detailed information. Researchers can develop questions based on answers from subjects to previous questions. To validate data, informants are divided into three types: key informants, main informants and supporting informants. Key informants are informants who have various basic research information. The main informants are informants who are directly involved with the research topic. Supporting informants provide additional information that can complement researchers [21]. The subjects interviewed can be seen in the Table 3 below.

Table 3. Informants

No	Object	Position	Source Type
1	Muhammad Nur Ikhsanudin, S.T.	Chief Executive Officer	Key Informant
2	Mintarsih Rahmawati, S.T, M.T.	Chief Technology Officer	Main Informant
3	Shofirul Sholikhatun Nisa, S.T., M.T.	Chief Marketing Officer	Main Informant
4	Meidiana Arinawati, A.Md.	Chief Data Officer	Main Informant
5	Yulaikha Ariyani, A.Md	PUI-PT Electrical Energy Storage Technology UNS	Supporting Informant
6	Yazid Rijal Azinuddin, A.Md.T	Customer	Supporting Informant
7	Khikmah Nur Rikhy Stulasti, S.T.	Customer	Supporting Informant

Data Condensation

Data condensation is carried out to obtain clearly described data under the main idea and research theme. Data condensation can be interpreted as summarizing the important research points to find patterns. In this study, condensation is needed to interpret the results of interviews through the coding method. The data condensation carried out in this study was by coding each block containing questions. Furthermore, the answers of the informants in each block are summarized by referring to the BMC and LC frameworks in the Table 4. Apart from blocks from LC and BMC, each informant was also given a code to identify the source during the coding process of the interview results.

Table 4. Block Code

Code	Description
PT	Pertanyaan Tambahan (Additional Question)
U	Urutan (Order)
CS	Customer Segments
VP	Value Proposition
CH	Channels
CR	Customer Relationships
RS	Revenue Streams
KR	Key Resources
KA	Key Activities
KP	Key Partners
COS	Cost Structure
EA	Early adopters
P	Problems
S	Solutions
EXA	Existing Alternatives
HLC	High-Level Concept
KM	Key Metrics
IK	Muhammad Nur Ikhsanudin, S.T.
SH	Shofirul Sholikhatun Nisa, S.T. M.T.
MN	Mintarsih Rahmawati, S.T., M.T.
ME	Meidiana Arinawati, A.Md
YU	Yulaikha Ariyani, A.Md.
YZ	Yazid Rijal Azinuddin, A.Md.T.
KH	Khikmah Nur Rikhy Stulasti, S.T.

Data Display

The data that has been condensed is grouped with a certain pattern and then translated according to the pattern determined by the researcher. The data display carried out in this study was presented in the form of paragraphs, tables, graphics, and supplementary data as voice based on the research object from Table 1, Table 2, and Table 3. The list of data displays can be seen in the Table 5.

Table 5. Data Display

No	Data Type	Data Collection	Data Display
1	Observation	Company Profile and History	Paragraph, Table, and Graphic
		Founder's background	Paragraph
		Intellectual property	Paragraph and Graphic
		Product list	Table
		Company's channels	Paragraph
2	Documentation	Company's sales report	Table
		Bill of Materials	Graphic
		Operation Process Chart	Graphic
		Product performance, efficiency, and capacity	Graphic
		Product specs and test result	Graphic
3	Interview	Interview recording	Voice
		Interview transcript	Table

Data Verification

There are four data validity tests, namely the credibility test, dependability test, transferability test, and confirmability test [22]. This study uses a credibility test to validate the data so that the data obtained is credible and can be accounted for. Six techniques can be used to test the credibility of the data, namely triangulation, observation extension, increasing persistence, negative case analysis, member check, and reference materials. This research uses the triangulation technique to test the credibility of the data. There are three triangulation techniques, namely source triangulation, technical triangulation, and time triangulation. This research uses the source triangulation technique and technique triangulation. These techniques were considered because the data were collected from various sources and techniques. Source triangulation was carried out based on three research subjects: key informants, main informants, and supporting informants Meanwhile, technical triangulation is carried out based on three data collection techniques: interviews, observation, and documentation. The component of the triangulation can be seen in the Figure 2. Researcher conduct observation, documentation, and interview to collect data. The results of the three different data collection techniques were compared to validate one another, if the researcher finds contradictions from the comparison of data, then data retrieval is carried out to clarify the actual data. Furthermore, the results of interviews with different sources, namely from key informant, main informants and supporting informants were compared.

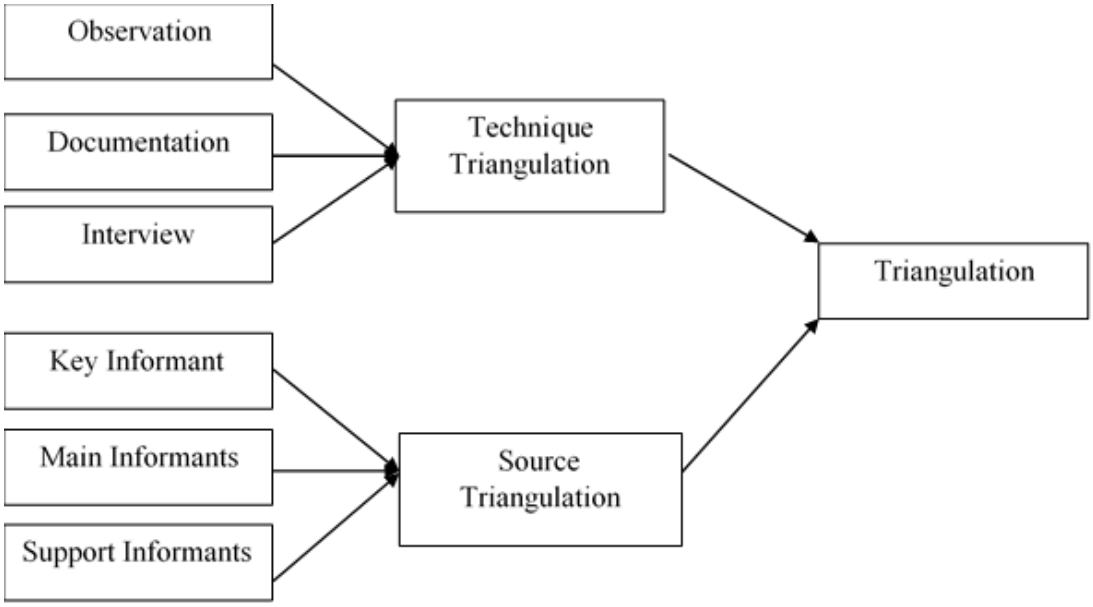

Fig. 2. Triangulation

Result

Data collection through observation, documentation, and interviews has been carried out. The data obtained is condensed and displayed in the form of paragraphs, tables, and graphs. Furthermore, the data is verified by triangulation technique and poured in the form of BMC and LC framework to represent the commercialization strategy.

1. Business Model Canvas (BMC)

1.1 Customer Segment

In this block, the type of customer segment PBN focuses on is the niche market, namely researchers in the field of lithium-ion batteries and battery manufacturing companies with the main focus on selling advanced materials. However, by listing products on Tokopedia, PBN implements a marketing strategy for the mass market because it only does listings and does not carry out marketing strategies that focus on researchers. It is planned that PBN will send emails to lecturers who focus on lithium-ion batteries, but this still needs to be implemented. As for manufacturing batteries, PBN has not yet made an official offer to many manufactured batteries in Indonesia, only Batex, because they are in the same building. Batex accepts the offer of cooperation, but there is no official agreement that regulates it.

1.2 Value Proposition

PBN has 2 product categories that are sold, namely advanced and functional materials. Advanced materials are produced by PBN themselves, while functional materials are not, PBN acts as a reseller. The value that PBN wants to offer is a cheaper price because it eliminates shipping costs between countries and import taxes. In addition, because it is a domestic product, the advanced material produced by PBN can increase the Domestic Content Level (TKDN) required by lithium-ion battery manufacturing companies. As for researchers, PBN prioritizes the speed and ease of purchasing through the marketplace

1.3 Channel

PBN has six channels for distributing products and communicating with consumers. The channels in question are the polimikroid.com website, Tokopedia PolimikroOfficial, Instagram @polimikroberdikarinusantara, Whatsapp Business, Email polimikroberdikarinusantara@gmail.com, and the office at the UNS Pusbangnis Building, 1st floor.

1.4 Customer Relationship

Currently, PBN interacts with consumers through chat held by PBN members. However, chat is not automatic and is answered directly by personal (personal assistance) for consumers to ask questions and consult. In addition, PBN also relies on the Tokopedia marketplace to provide complete product listings that consumers can purchase independently without even contacting PBN (self-service).

1.5 Revenue Streams

PBN relies on product sales or asset sales as a source of income. Consulting services are currently consumer services and are not subject to tariffs, so they do not provide revenue. As for the patent, is owned by UNS so PBN cannot license the patent for production without UNS' approval. Even when the patent is ready, PBN must pay UNS's license fee. Some PBN members consider the investment as income, but it is an addition to capital and cannot be distributed as dividends, so it is not a revenue stream. PBN has three payment mechanism options: preorder, direct purchase, and negotiation. Preorders for advanced material products, direct purchases for functional material products, negotiations for purchases above 5 kg, and custom materials.

1.6 Key Resources

The main resources needed by PBN are production equipment (physical) owned by PUI-PT Electrical Energy Storage Technology UNS which is currently still free of charge because PBN is a manufacturing startup that does production. In addition, PBN requires experts who understand advanced and functional materials because only some have this knowledge. Another important resource is PBN's (intellectual) patents to differentiate itself from competitors.

1.7 Key Activities

As a manufacturing company, PBN's main activity is production. However, in addition to production, PBN also promotes its products because currently, sales of advanced materials are still far from production capacity, so promotion is still needed. In contrast, PBN is a reseller of functional materials, so its main activity is marketing. In addition, PBN is also developing new methods to improve the quality of its products because, currently, it still needs to catch up to Chinese companies.

1.8 Key Partners

PBN cooperates with PUI-PT Electrical Energy Storage Technology UNS and Batex to improve efficiency or Optimization and Economy of Scale. As a result, PBN and PUI-PT Electrical Energy Storage Technology UNS establish a mutually beneficial relationship, PBN does not need to purchase expensive material production equipment, and PUI PBN acts as a startup at the forefront of the commercialization of PUI technology. Meanwhile, Batex PBN acts as a supplier for making batteries that can increase the Domestic Content Level (TKDN).

1.9 Key Activities

Cost components that need to be considered by PBN are materials procurement for production and reselling, inventory cost for materials stock, equipment and office rental for business activity, marketing costs to promote the product, licensing fees for UNS patents, and salaries for experts. Identified costs are costs that are required in the current business can run.

2. Lean Canvas (LC)

Lean Canvas (LC) is a business model framework proposed by Ash Maurya [23] with the same purpose as Business Model Canvas (BMC), a single canvas that can describe business activities. Ash Maurya modified several blocks to fit the business model by adopting lean principles. The explanation of each block based on the data obtained is as follows:

2.1 Early Adopters

In this block, business people create a list of customers they feel are ideal to pay attention to and serve to get input. Customers who are used as early adopters are customers who place orders at the beginning of the establishment of a business and communicate intensely to get input on the products offered. Early adopters of PBN are Batex and Lectro researchers. Batex is an energy startup that sells lithium-ion batteries and their derivatives. Batex has built a partnership with PBN to increase TKDN in its products. Lectro chooses PBN's product because of its faster delivery and easier to access than alternatives.

2.2 Unique Value Proposition

This block emphasizes that startups have a differentiator from the alternatives already on the market. However, the existing differences must have advantages that can attract the attention of target consumers. In this block, PBN offers advantages foreign producers will find difficult to imitate, namely the increase in TKDN content. In addition, domestic production carried out by PBN can save shipping costs and delivery speed for the Indonesian market.

2.3 Unfair Advantage

There are two advantages of PBN that current competitors cannot easily imitate. The first is a simple patent entitled "Method of Making Lithium Nickel Cobalt Manganese Oxide Rich Nickel Cathode Material". The second is the production domicile in Indonesia to increase the Domestic Content Level (TKDN) for manufacturing companies that order PBN materials.

2.4 High-Level Concept

During the interview, PBN identified several companies for review, including Targray, NEI Corporation, and Gelon. At the time of documentation, the researcher found that Gelon is a company that can produce NMC, LFP, and NCA in China with product prices that are more expensive than in Indonesia and relatively long delivery (1-3 months). From this, it is concluded that the high-level concept of PBN is like Gelon with cheaper product prices with faster delivery and can increase TKDN.

2.5 Existing Alternatives

The alternative for purchasing advanced materials at this time is through distributors who make purchases from abroad, or some consumers buy products directly by importing. However, current alternatives present difficulties in the form of long delivery times and additional shipping and import taxes costs.

2.6 Problems

The problem that PBN has identified and wants to solve is the difficulty in purchasing materials for Indonesian consumers. The main seller of advanced materials is China, so consumers make purchases through distributors, or import directly. This causes large shipping costs and long waiting times, besides the aftersales offered need to be more satisfactory.

2.7 Solutions

To answer the identified problems, PBN offers several facilities that are features of its business model. The first is to do their production in the country. With the presence of PBN as a local producer, the price of shipping costs and delivery times can be cut. In addition, PBN provides free consultation as a consumer after-sales service.

2.8 Key Metrics

To provide competitive prices, PBN should consider the possible production cost. PBN can use lead time delivery as an evaluation benchmark for fast delivery times. In addition, to measure success in marketing, PBN can measure the number of new purchases (new orders) and repeat purchases (repeat orders). PBN sees reviews as a benchmark for overall performance to measure consumer satisfaction. As for product development, PBN can use the results of capacity and efficiency performance tests.

3. Business Model Canvas (BMC) and Lean Canvas (LC) Integration

After identifying each block on the Business Model Canvas (BMC) and Lean Canvas (LC), the author puts it on one canvas sheet representing a business model that is easy to understand. Each block canvas arranged by considering business process. First, company define problem occurred and determine solution that can be offered to solve the problem. Next, the company establish a business model by determining the target market that has problems identified by the company. Furthermore, the company determines what value is offered as a solution to turn the problem into a business opportunity that is difficult for competitors to imitate on a unique value proposition block. Then the company determines how to deliver that value to customers in the channel block, and how to establish communication in the customer relationship block. After that, the company determines how revenue is obtained from the value offered in the revenue stream block. Furthermore, on the product side, the company determines the resources in key resource block and activities in key activities block that needed to create the value that the company wants to offer as a solution to the problem. If there are resources or activities that cannot be carried out but are really needed by the company, then the company must identify partners in the block key partners so that value can be created. Finally, in the process of establishing a business model, the company determines what costs are needed by the company. The final stage is the process of evaluating and measuring ideas, in which the company determines ideal customers that can be surveyed and provides input in creating value in the early adopter block. This value is compared to current solutions offered by competitors in the existing alternatives block. The uniqueness that is obtained is expressed by a simple analogy to the high-level concept block so that it is as easy as possible to understand. Furthermore, the company determines key performance indicators in the key metrics block based on company activities and goals. Furthermore, the company determines key performance indicators in the key metrics block based on company activities and goals. Finally, as the business continues, the company can determine advantages that cannot be copied by competitors in the unfair advantage block, so that the company can dominate the market in business competition. BMC and LC Integration framework can be seen in Figure 3, while the results of this study on PBN can be seen in figure 4.

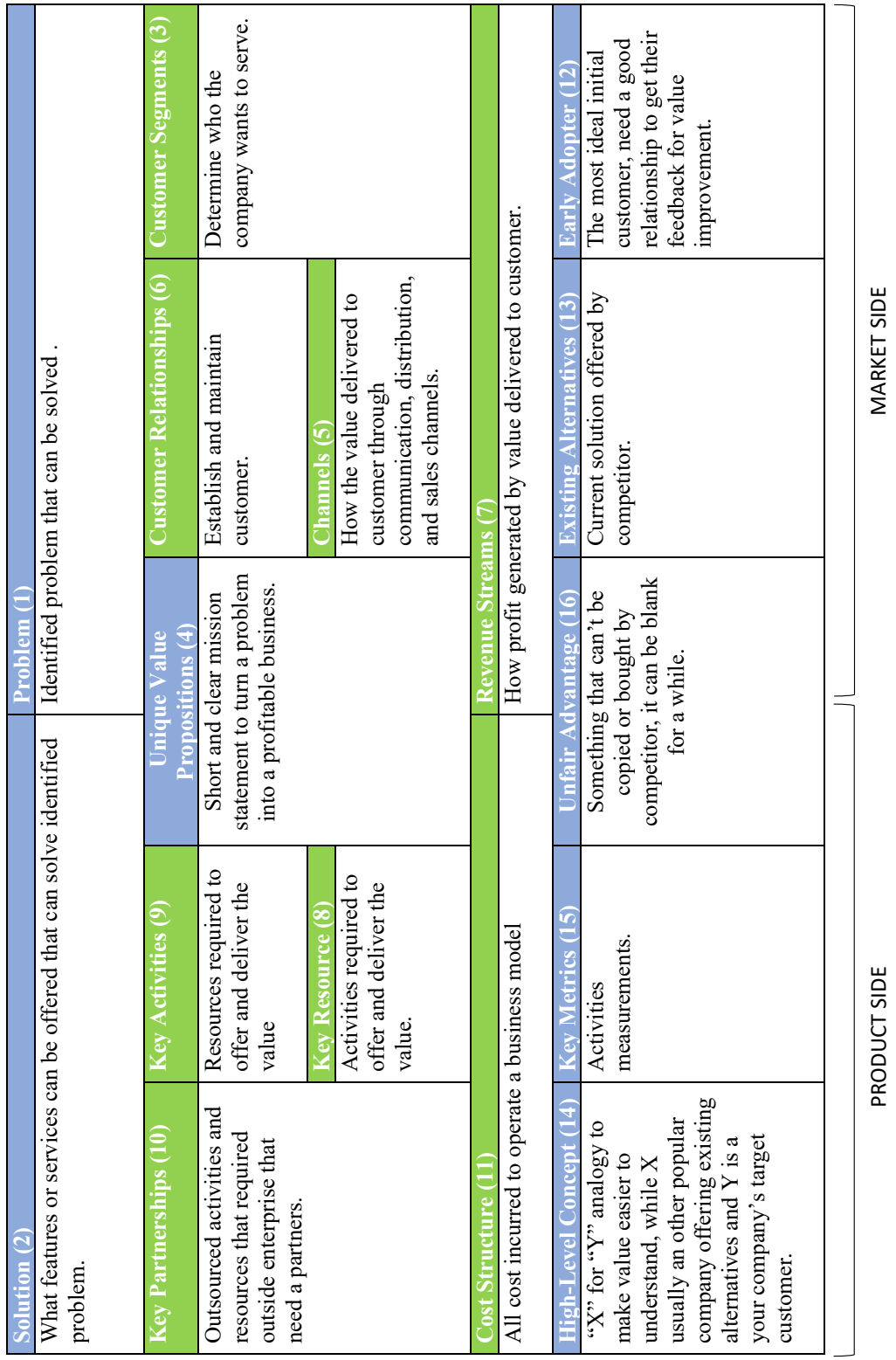

Fig. 3. BMC and LC Integration Framework

<table>
<tr><td colspan="2">Solution (2)
1. Local production
2. Delivery of goods from within the country
3. Free consultation</td><td colspan="3">Problem (1)
1. Difficult to purchase material needs (import)
2. Long delivery time with high price
3. Unclear aftersales service</td></tr>
<tr><td>Key Partners (10)
1. PUI UNS
2. Batex</td><td>Key Activities (9)
1. Material procurement and production
2. Product marketing
3. Product development
Key Resource (8)
1. Production needs
2. Experts
3. Intellectual properties</td><td>Unique Value Propositions (4)
A chemical material provider that offers an increase in TKDN</td><td>Customer Relationships (6)
1. Social media information
2. Marketplace product listing
3. Free consultation
Channels (5)
1. Website
2. Tokopedia
3. Instagram
4. Whatsapp Business
5. Email
6. Office</td><td>Customer Segments (3)
1. Small Local Battery Manufacturer
2. Battery Researcher</td></tr>
<tr><td colspan="2">Cost Structure (11)
1. Material procurement cost
2. Inventory cost
3. Equipment and office rent
4. Product marketing
5. Licensing
6. Payroll</td><td colspan="3">Revenue Streams (7)
Product Sales</td></tr>
<tr><td>High-Level Concept (14)
Gelon for Local Early Company</td><td>Key Metrics (15)
1. Production cost
2. Lead time delivery
3. New order
4. Repeat order
5. Reviews
6. Battery capacity
7. Battery efficiency</td><td>Unfair Advantage (16)
1. Patent ownership
2. Increase TKDN (Level of Domestic Content)</td><td>Existing Alternatives (13)
Third-party distributor
Direct import from global manufacturer</td><td>Early Adopter (12)
1. Batex
2. Lectro</td></tr>
</table>

Fig. 4. Business Model

Summary

The interactive analysis model was successful in creating a business model commercialization strategy. The business model framework used is Business Model Canvas (BMC) and Lean Canvas (LC). Conclusions were obtained that answered the formulation of the research problem and fulfilled the research objectives as follows:

1. The Interactive Analysis Model has been successfully used to develop a business model based on the Business Model Canvas (BMC) and Lean Canvas (LC) frameworks.
2. The value offered by PBN is material that is produced domestically which can provide a lower price, easy access, and faster delivery because it can eliminate shipping problems, besides that domestic production provides unfair advantages in being able to offer an increase in TKDN for battery manufacturing companies and PBN own intellectual property on one method of making the material.
3. In reaching target consumers, namely researchers and battery manufacturers, PBN distributes its products through the Tokopedia marketplace, which can be purchased directly at the office. Meanwhile, PBN utilizes Whatsapp Business, Tokopedia, Instagram, Email, website, and direct interaction in the office to connect and provide customer service.

4. PBN's main partners are PUI-PT Electrical Energy Storage Technology as a provider of equipment, Batex as a prospective company to be supplied by PBN, and Pertamina as an incubator, while the main activities of PBN are production, marketing, and product development with the main resources namely production tools, experts and intellectual property. Alternative solutions to current consumer problems are buying directly from distributors or importing. However, this causes several problems, such as difficulty in purchasing, expensive shipping costs, long waiting times, and minimal aftersales. Therefore, PBN presents solutions through an easy purchasing process, fast delivery, and after-sales service in free consultations.

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