REDESIGNING LITHIUM BATTERY PRODUCTS AND APPLYING THE BUSINESS MODEL CANVAS WITH A LEAN STARTUP APPROACH (CASE STUDY: PT. BATEX ENERGI MANDIRI)

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ABSTRAK

Indonesia tengah mengalami pertumbuhan pesat dalam jumlah kendaraan bermotor, yang meningkatkan kebutuhan akan baterai lithium sebagai solusi penyimpanan energi yang efisien, di mana perusahaan rintisan seperti PT Batex perlu menghadapi tantangan inovasi dan pemahaman pasar melalui metode lean startup untuk meningkatkan produk dan daya saingnya di industri. Penelitian ini berfokus pada perancangan ulang baterai lithium untuk menciptakan produk inovatif yang sukses di pasar dengan mempertimbangkan kebutuhan pelanggan, kelayakan bisnis, dan penerapan metode lean startup sekaligus mengatasi tantangan kurangnya inovasi produk. Metode penelitian ini menggunakan pendekatan kualitatif dengan tahapan meliputi identifikasi masalah, pengumpulan data melalui observasi, wawancara, dan pengujian prototipe. Selanjutnya, analisis dilakukan untuk mengevaluasi hasil pengembangan produk dan mengintegrasikan umpan balik pelanggan ke dalam desain akhir. Perancangan ulang baterai lithium oleh PT Batex menunjukkan keberhasilan dengan daya tahan hingga 3.000 siklus pengisian, tingkat kepuasan pelanggan sebesar 90%, dan peningkatan pangsa pasar dari 5% menjadi 15% dalam satu tahun. Di masa mendatang, analisis pasar dan penelitian yang lebih mendalam tentang pengintegrasian baterai lithium dengan sistem energi terbarukan akan diperlukan untuk mendukung keberlanjutan dan pengembangan produk.

Kata kunci: *Baterai litium, analisis pasar, lean startup, business model canvas, inovasi produk.*

ABSTRACT

Indonesia is experiencing rapid growth in the number of motorized vehicles, which increases the need for lithium batteries as an efficient energy storage solution, where startups such as PT Batex need to face the challenges of innovation and market understanding through lean startup methods to improve their products and competitiveness in the industry. This research focuses on redesigning lithium battery batteries to create innovative products that are successful in the market by considering customer needs, business feasibility, and the application of lean startup methods while addressing the challenge of lack of product innovation. This research method uses a qualitative approach with stages including problem identification, data collection through observation, interviews, and prototype testing. Furthermore, analysis is carried out to evaluate product development results and integrate customer feedback into the final design. The redesign of lithium battery batteries by PT Batex shows success with a durability of up to 3,000 charging cycles, a customer satisfaction rate of 90%, and an increase in market share from 5% to 15% in one year. In the future, more in-depth market analysis and research on integrating lithium battery batteries with renewable energy systems will be needed to support sustainability and product development.

Keywords*: Lithium battery, market analysis, lean startup, business model canvas, product innovation.*

INTRODUCTION

Indonesia is one of the fastest-growing countries in the world, and the increasing number of motorized vehicles reflects this development. According to data from the Badan Pusat Statistik, the number of motorized vehicles, such as passenger cars, freight cars, and motorcycles, increased from 61,685,063 in 2008 to 146,858,759 in 2018 [1]. This rapid growth in motorized vehicles indicates a rise in people's mobility needs and a demand for more sophisticated and efficient technology in vehicle operations. Lithium batteries are essential in modern motor technology because they support various advanced features, such as the Start-Stop System that shuts off the engine when stopped and restarts it to save

fuel. Features like LED lighting, digital instrument panels, and Bluetooth connectivity require stable power. Kinetic Energy Recovery System (KERS) technology collects energy during braking for reuse, while the Ride-by-Wire system replaces the throttle cable with an electronic sensor for more precise throttle control. All these technologies rely on lithium batteries for their superior durability, charging efficiency, and energy capacity, enabling motors to operate more efficiently and environmentally friendly.

The importance of switching to lithium battery packs can be understood by observing the challenges faced by today's conventional energy storage systems. In the past decade, there has been a rapid increase in the use of electronic devices, electric vehicles, and the integration of renewable energy systems, all of which require efficient and sustainable energy storage solutions. Traditional energy storage systems, which often rely on older and less efficient technologies, such as lead- or nickel-based batteries, no longer meet the dynamic needs of modern energy. These limitations include lower storage capacity, shorter cycle life, long charging times, and greater environmental impact, highlighting the need for innovation in energy storage technology. A battery is an electric cell where a reversible electrochemical process occurs, allowing it to convert chemical energy into electrical energy (discharge process) and vice versa (charge process) through the regeneration of the electrodes. Thus, the battery generates electricity through a chemical process [2].

Startups in Indonesia are gaining attention as solutions to various problems, but many fail to survive and make a profit, with a failure rate of 90% [3]. Startups can grow quickly, distinguishing them from small businesses, largely due to the internet, which has shifted from an industrial society to a digital or knowledge-based society [4]. The main goal of a startup is to find new markets and create high-value-added products. Initially, startups were low-cost projects often initiated by programmers and designers looking to generate significant profits. However, in more than 90% of cases, these endeavors are unsuccessful, with three out of five main problems being financial—mistakes in pricing, inaccurate cost estimation, or lack of capital for further development. A second significant problem is the lack of demand in the market, often caused by insufficient real-world product testing. Additionally, an ineffective team struggles to create an appropriate Minimum Viable Product (MVP) or business model [5].

PT Batex, a startup in the lithium battery industry for motor vehicles, faces significant challenges in an increasingly competitive environment. The decline in sales reflects fundamental issues, including a lack of necessary innovation, insufficient product differentiation, and an inaccurate understanding of market dynamics. Additionally, the marketing and competitive strategies have not achieved maximum effectiveness, hindering the company's efforts to maintain its position against established competitors. To address these challenges, PT Batex has adopted the lean startup framework as a key strategy in product development. This approach emphasizes rapid learning through iterative build-measure-learn cycles, allowing PT Batex to effectively verify market hypotheses and integrate customer input into the development process. With a vision to develop innovative and efficient lithium battery products, it is essential to design a suitable re-design of the lithium battery to ensure success.

The study examined risk management for the Internet of Things (IoT) lithium battery program and showed that risk analysis can reduce negative impacts in the future and that good risk management is essential for the convenience of public services in the digital era [6]. The study applied the lean startup method to develop the EVORIA application to increase efficiency and reduce the risk of product failure [7]. This method involves three stages: market validation, product validation, and business validation. The study's results showed the importance of consumer feedback in building startup ideas and formulating the right prototype. The study focused on innovation at Fore Coffee using the lean startup

method to improve consumer satisfaction [8]. This study identified consumer characteristics and explored the application of the lean startup methodology in providing better service. However, the satisfaction measurement stage has not been carried out optimally, which indicates that the lean startup cycle needs to be improved. The study discussed the development of a business model for the HealthyTips Startup product using the lean startup method [9]. Through the application of lean canvas, this study involved interviews with 10 informants, where 8 people provided validation according to the experimental stage on the javelin board. The results strengthen the design of the business model and provide added value for developing and improving the quality of the products produced.

This research is important to identify best practices and opportunities for improvement in applying lean startup methods, especially for startups in the lithium battery motorcycle battery industry that seek to increase their sales and competitive position in the market. Through this research, startups can gain strategic insights that can be applied to improve product development effectiveness, increase customer engagement, and ultimately drive sales growth.

RESEARCH METHOD

This research uses real observations and an information search process related to the problem to be solved. Observation and data collection were carried out at PT Batex. Data is collected through interviews and discussions to get ideas for designing lithium battery products. Interviews were conducted to obtain information about the conditions, capabilities, and goals of PT Batex Energi Mandiri in developing a business strategy based on Business Model Canvas (BMC) and Lean Canvas (LC). Interviews use a semi-structured interview method, where questions are open-ended but still focus on topics relevant to the research. The experiment Board approach tests and optimizes lithium battery motorcycle battery products. The Javelin board is a tool that supports hypothesis testing through experiments to validate an idea [10]. Quality dimension measurement is carried out to evaluate the quality of a product or service based on several important aspects. This data is then analyzed to assess the extent to which the product meets predetermined quality standards, considering comparisons with other products in the market and evaluation against industry standards. A cost-effectiveness analysis was then conducted to provide better support and evidence-based decision-making.

RESULTS & DISCUSSION

Empathy Map

A discussion was held involving the stakeholder perspective of PT Batex Energi Mandiri to produce an empathy map. An empathy map is an effective method for opening, visualizing, and understanding the emotional experiences of the target audience [11]. There are 4 important aspects of the empathy map: say, think, do, and feel. In the say aspect, users want a durable battery that can withstand extreme weather conditions. They also question the price and warranty offered and complain about unsatisfactory experiences related to battery products. In the think aspect, respondents consider the price and quality aspects of the product and hope that the battery has a long life and is more environmentally friendly. In the feel aspect, respondents complained about the lack of battery installation guides, interest in attractive designs, and concerns about purchasing mistakes regarding price and quality. In the do aspect, users conduct online research before purchasing a battery and pay attention to the services provided by the company. The empathy map is shown in Figure 1.

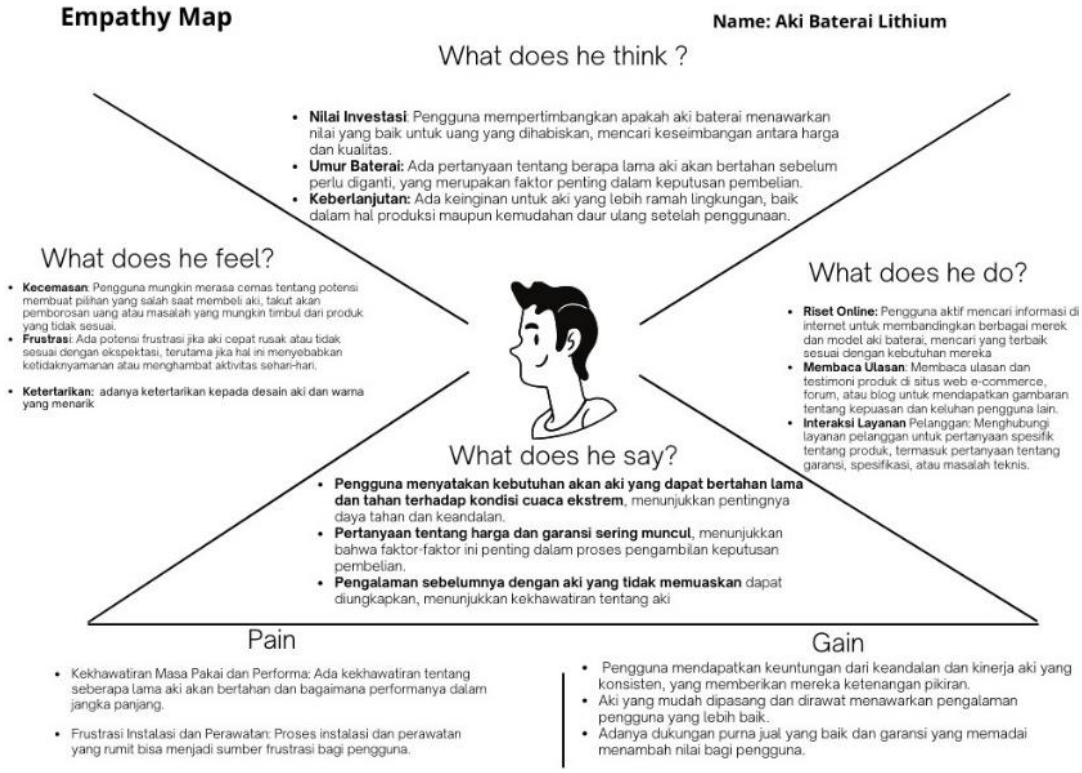


Figure 1. Empathy Map Lithium Battery

Experiment Board

The results of discussions with stakeholders on the empathy map form the basis for compiling an experiment board, including the stages of identifying customer problems, formulating hypotheses, and designing and implementing experiments. The first stage determines potential consumers with targets such as the general public (students and the Solo motorcycle community), mechanics, and workshop owners. The second step identifies the main problems: the need for a battery with a long life, durability in extreme conditions, an attractive design, and better warranty and maintenance services. Based on this problem, the solution is to redesign a lithium battery-based motorcycle battery.

In the next stage, the team made key risky assumptions, including that users consider the value offered by the battery and prioritize function over aesthetics. Testing was conducted using the interview method on seven respondents who had used the Lithium Motorcycle Battery prototype. The success criteria were 80% for the main idea and 60% for the design and service aspects. Face-to-face interviews provided direct feedback on the User Experiment of this battery product. The experiment board is shown in Figure 2.

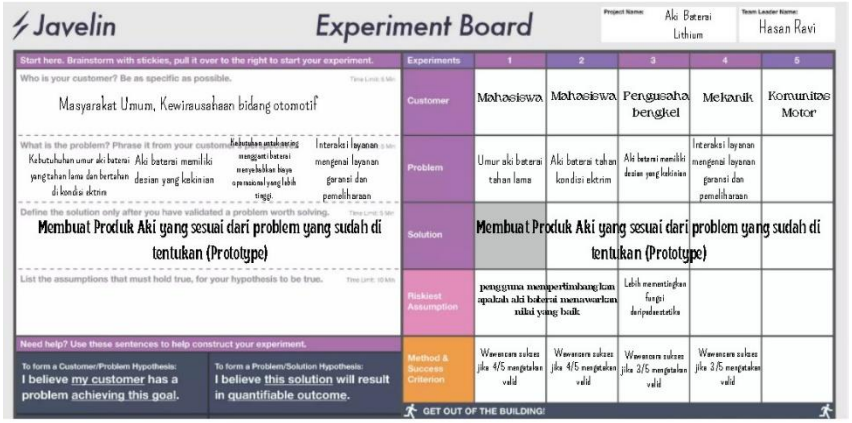
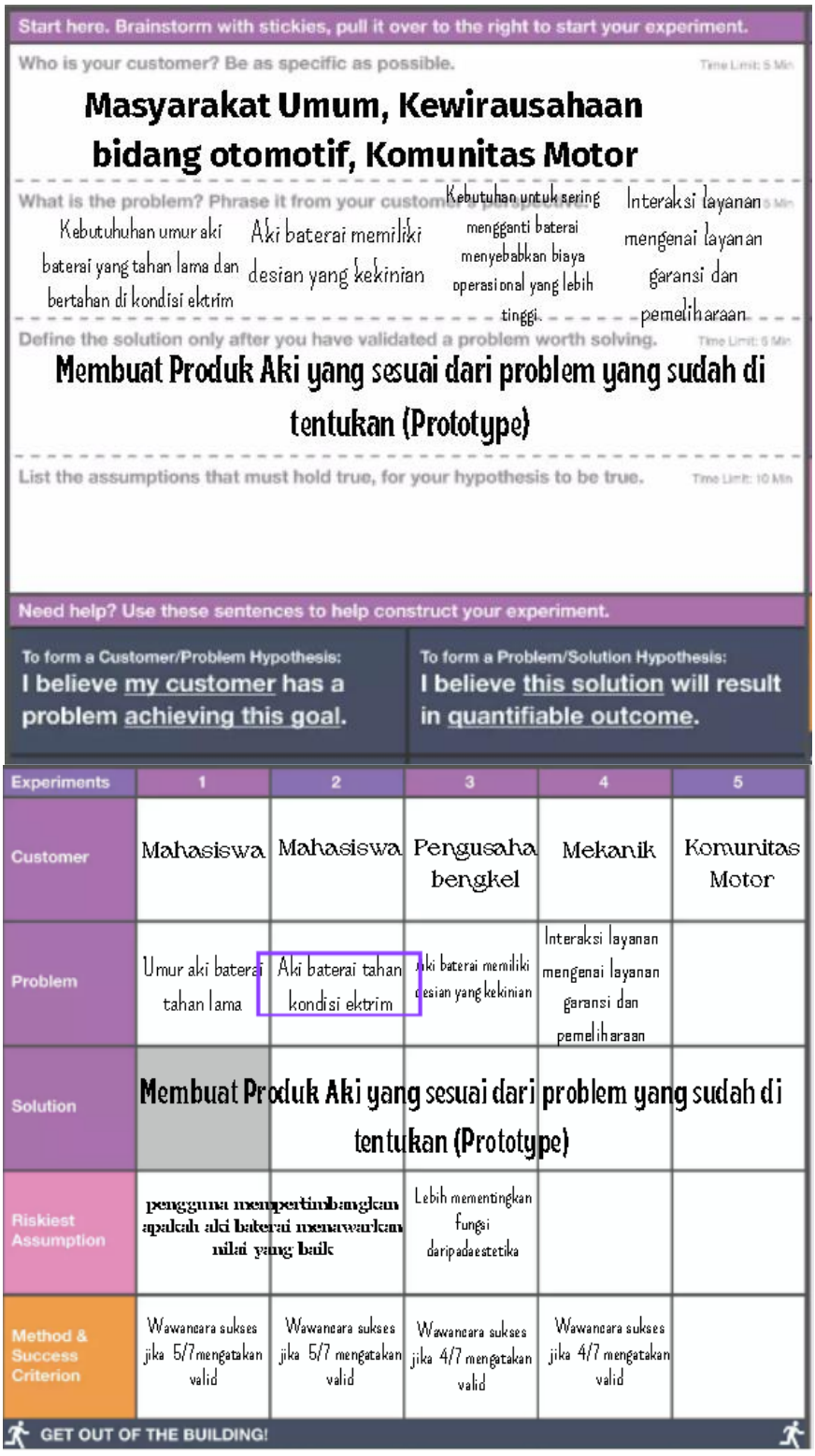


Figure 2. Experiment Board



Experiments	1	2	3	4	5
Customer	Mahasiswa	Mahasiswa	Pengusaha bengkel	Mekanik	Komunitas Motor
Problem	Umur aki baterai tahan lama	Aki baterai tahan kondisi ektrim	Aki baterai memiliki desian yang kekinian	Interaksi layanan mengenai layanan garansi dan pemeliharaan	
Solution	Membuat Produk Aki yang sesuai dari problem yang sudah di tentukan (Prototype)				
Riskiest Assumption	pengguna mempertimbangkan apakah aki baterai menawarkan nilai yang baik		Lebih mementingkan fungsi daripadaestetika		
Method & Success Criterion	Wawancara sukses jika 5/7 mengatakan valid	Wawancara sukses jika 5/7 mengatakan valid	Wawancara sukses jika 4/7 mengatakan valid	Wawancara sukses jika 4/7 mengatakan valid	

Continued Figure 2. Experiment Board

Prototype Design Lithium Battery

The prototype in this study is the initial concept design of the battery based on the idea defined through the brainstorming process. This battery uses the LFP type of battery. The design of the battery design is made in the form of a three-dimensional model using Fusion software. The three-dimensional (3D) model allows for a digital design image that resembles the finished product. The product specifications for the lithium battery re-design

at PT. Batex Energi Mandiri is as follows: (Battery Type: LFP; Dimension: 114 x 70 x 118 mm; Voltage: 12 V; Capacity: 6 Ah; BMS: 4S 12V 100 A, Weight: ±0.88 Kg). This 3D model is expected to provide a visualization that is close to reality so that stakeholders can understand the shape and size of the product before entering the production stage. The prototype design of the product is shown in Figure 3.

Figure 3. Prototype Design Lithium Battery

Testing Prototype

During the test, the developer conducted direct interviews on re-designing the lithium motorcycle battery PT. Batex Energi Mandiri to prospective users. The interview was conducted to find out what the user's problems were regarding the lithium motorcycle battery product, then comparing the kin lithium motorcycle battery product with the re-

design of the lithium battery and explaining what value or benefits would be given to customers. to 5 prospective users.

Based on interviews with motorcycle battery users, several major problems were revealed. As many as 30% of respondents complained about the battery capacity decreasing over time, so power was not stored effectively. The problem of resistance to extreme weather was also expressed by 30% of respondents, which caused the battery performance to decrease drastically or be damaged in extreme temperature conditions. In addition, 20% of users stated that the battery ran out of power quickly even though it had just been recharged or replaced, adding to the inconvenience and additional costs. Corrosion on the battery terminals was experienced by 10% of respondents, which disrupted the electrical connection and charging efficiency. Finally, 10% of respondents felt that the lack of understanding about proper battery maintenance and installation was also a significant problem. These results indicate the need to improve battery quality and provide maintenance education to users. The customer problem infographic is shown in Figure 4.

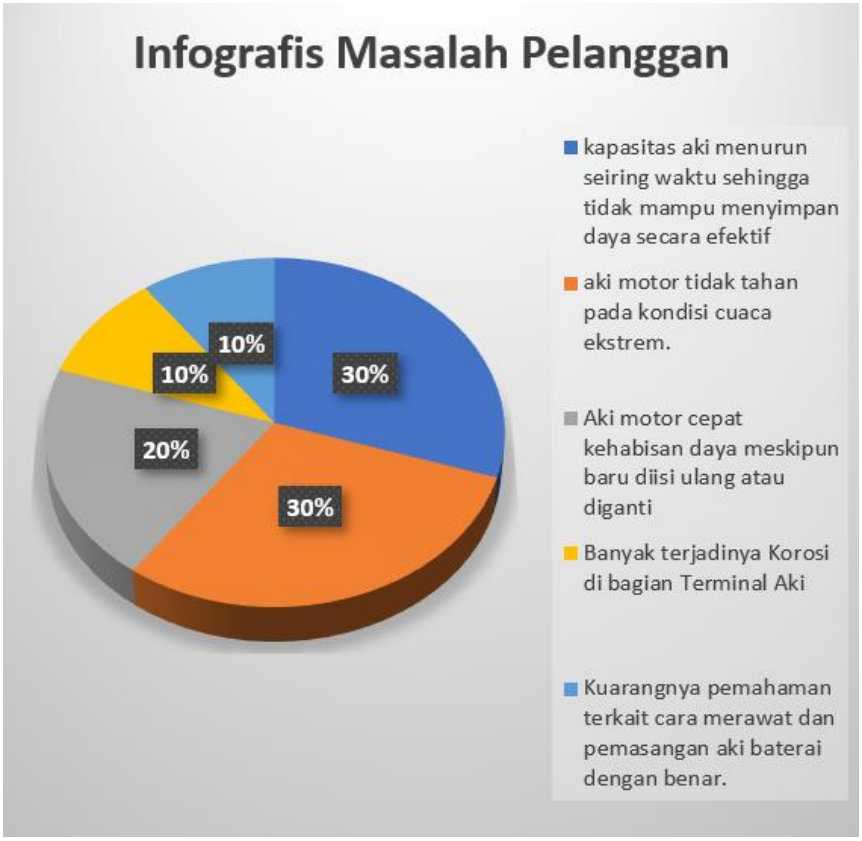


Figure 4. Customer Problem

Customer Problem and Solution Validation

Customer problems and solutions were validated using the experiment board to ensure the effectiveness of the solutions offered to customer needs. The results of interviews and product evaluations of lithium motorcycle batteries from PT Batex Energi Mandiri showed several important findings. First, all respondents validated that this product has a longer service life than conventional batteries. Consumers also acknowledged the ability of lithium batteries to function well in extreme conditions, including high and low temperatures, vibrations, and humidity. In addition, the majority of respondents appreciated the redesign of this product. The warranty and maintenance services offered by PT Batex Energi Mandiri were also considered significant added value,

especially since the company provides comprehensive education on proper battery installation. Overall, validation shows that this product has met consumers' main concerns regarding durability and practicality of use, indicating strong potential for market acceptance, especially if less valid design aspects continue to be improved. Experiment board validation is shown in Figure 5.

Success Criterion	Wawancara sukses 5/7 mengatakan Valid	Wawancara sukses 5/7 mengatakan Valid		Wawancara sukses 4/7 mengatakan Valid	Wawancara sukses 4/7 mengatakan Valid
GET OUT OF THE BUILDING!					
Result & Decision	Valid 7/7	Valid 7/7		Valid 4/7	Valid 6/7
Learning	Produk Aki Motor Baterai Lithium dari PT Batex Energi Mandiri akan menjawab solusi dari permasalahan tersebut karena Baterai lithium dari PT Batex Energi Mandiri memiliki umur pakai yang lebih lama dibandingkan baterai aki konvensional, Baterai lithium dari PT Batex Energi Mandiri mampu berfungsi dengan baik dalam kondisi ekstrem (suhu tinggi/rendah, getaran, dan kelembaban).			Dengan re-design aki motor Baterai Lithium dari PT Batex Energi Mandiri desain lebih kekinian dari desai produk sebelumnya	PT Batex Energi Mandiri menawarkan layanan garansi dan pemeliharaan yang menyeluruh serta edukasi pemasangan aki yang benar

Figure 5. Experiment Board Validation

Quality Measurement

Lithium battery product dimension measurements include physical size (length, width, height, and weight), energy storage capacity, life cycle durability, and safety features. For competitor product quality dimensions, measurements include performance, design and ergonomics, additional features, and price value. BATEX batteries excel with high safety features, such as leakage protection, anti-short circuit, overcharging prevention, ease of installation, availability of spare parts, and after-sales service supported by a one-year warranty from authorized dealers. This product is also resistant to extreme temperatures from -20°C to 60°C, with a service life of up to 3000 cycles or around eight years. Quality measurement for the BATEX and ABC battery is shown in Figures 6 and 7.

Dimensi Kualitas Aki BATEX		
Dimensi Kualitas	Indikator Pengukuran	Rincian Teknis
Kinerja (Performance)	Kapasitas Penyimpanan Energi	6 Ah
	Tegangan	12 V
	Output Daya Stabil	72W
	Durasi Pemakaian (Siklus Hidup)	72 Wh
Daya Tahan (Durability)	Ketahanan Terhadap Suhu Ekstrem:	(-20°C - 60°C)
	Umur Pakai Baterai:	3000 cycle (8 tahun)
Kemudahan Layanan (Serviceability)	Kemudahan Instalasi	Mur dan Baut
	Ketersediaan Suku Cadang dan Layanan Purna Jual:	1 Tahun (Dealer Resmi)
	Ukuran dan Berat	114 x 70 x 118 mm / ±0.88 Kg
Keamanan (Safety)	Perlindungan Terhadap Kebocoran dan Ledakan:	BMS: 4S 12V 100A
	Sistem Pengamanan Terhadap Korsleting dan Overcharging	BMS: 4S 12V 100A
Keterjangkauan (Affordability)	Harga Jual	Rp. 655.000

Figure 6. Quality Measurement BATEX Battery

Dimensi Kualitas Aki BATEX		
Dimensi Kualitas	Indikator Pengukuran	Rincian Teknis
Kinerja (Performance)	Kapasitas Penyimpanan Energi	6 Ah
	Tegangan	12 V
	Output Daya Stabil	36 W
	Durasi Pemakaian (Siklus Hidup)	72 Wh
Daya Tahan (Durability)	Ketahanan Terhadap Suhu Ekstrem:	(-20°C - 50°C)
	Umur Pakai Baterai:	2000 cycle (5 tahun)
Kemudahan Layanan (Serviceability)	Kemudahan Instalasi	Mur dan Baut
	Ketersediaan Suku Cadang dan Layanan Purna Jual:	Garansi Pabrik (5 Tahun)
	Ukuran dan Berat	112 x 69 x 88 mm / ±0.60 Kg
Keamanan (Safety)	Perlindungan Terhadap Kebocoran dan Ledakan:	BMS
	Sistem Pengamanan Terhadap Korsleting dan Overcharging	BMS
Keterjangkauan (Affordability)	Harga Jual	Rp. 869.000

Figure 7. Quality Measurement ABC Battery

A comparison of these two lithium battery motorcycle battery products shows that BATEX batteries excel in safety, temperature resistance, longer service life, and more competitive prices. In contrast, competitor products offer lighter weight and longer warranties, although their service life is shorter and their prices are higher. This comparison gives consumers an idea of each product's value and advantages in meeting their needs and budgets.

Business Model Canvas

The business model canvas (BMC) is used for the product design of the lithium battery motorcycle designed for PT Batex Energi Mandiri. In this study, the BMC was designed to represent the business model currently being implemented by PT Batex Energi Mandiri. The BMC of PT Batex Energi Mandiri is shown in Figure 8.

Business Model Canvas

Designed for: PT Batex Energi Mandiri | *Designed by:* Hasan Ravi R | *Date:* 20 June 2024

Key Partners
- Supplier of BLDC and other spare parts: BRT, Elders Garage.
- Supplier of Lithium Motorcycle Battery Spare Parts.
- PUI UNS.
- Distribution and Logistics.

Key Activities
- Design and implement effective marketing strategies to reach customers and increase sales of lithium battery motorcycle batteries.
- Commitment to continue innovating by developing the latest technology to improve motorcycle batteries' efficiency, durability, and safety.
- Provide after-sales support services, including service, warranty, installation, and maintenance education, and collect feedback to improve service and product quality.
- Establish partnerships with suppliers, research institutions, governments, and other entities to support operations and expand networks to accelerate business growth.

Key Resources
- Focus on technology to produce lithium batteries.
- Own patents and advanced R&D facilities for lithium battery technology development.
- Capital available for operation and investment.
- Equipped with modern equipment for large-scale lithium battery production and testing, ensuring high-quality standards.

Value Propositions
- Lithium battery motorcycle batteries have a longer service life (5 years) with higher energy efficiency and storage capacity.
- Smaller and lighter design improves fuel efficiency and simplifies installation.
- Equipped with a battery management system (BMS) for user protection and safety.
- Sustainable with a low carbon footprint and recyclable, supporting sustainable practices.
- Despite a higher initial price, lithium battery motorcycle batteries offer lower overall operating costs.
- Withstands extreme temperatures and has a faster charging time, ensuring consistent performance and saving users time.

Customer Relationships
- Contact customers after service to ensure satisfaction and assist with any issues.
- Offering exclusive memberships with benefits such as special discounts, priority service, and early access to new products.
- Providing a comprehensive warranty for lithium battery motorcycle batteries, including maintenance and replacement, to ensure products remain optimal and customers are supported.
- Sending regular information via email or newsletter with maintenance tips, effective use, and product updates.
- Providing user guides, video tutorials, and informative articles to help customers understand and care for their lithium battery motorcycle batteries.

Channels
- Providing product-related information and content.
- Using Facebook, Instagram, Twitter, YouTube, and TikTok to build communities, promote services, and engage with customers.
- Building networks with local communities through events such as rides, workshops, and exhibitions.

Customer Segments
- Consumers interested in the latest technology and want to own an innovative and modern vehicle.
- Members of motorcycle clubs who gather and tour together need a battery with a larger energy storage capacity.
- Potential consumers with advanced security features, such as E-Lock or Immobilizer, need a battery with a larger storage capacity.
- Need a reliable and durable battery solution to ensure customer satisfaction and reduce the frequency of battery replacement.dan mengurangi frekuensi penggantian aki.

Cost Structure
- Raw material and production costs.
- Labor and operational costs.
- Marketing and promotion costs.
- Research and development costs.
- Logistics and distribution costs.

Revenue Streams
- PThe main revenue comes from direct retail sales of lithium battery motorcycle batteries to consumers and businesses.
- Revenue also comes from sales of chargers, cables, and accessories that support battery use.
- Providing after-sales services, including extended warranty packages and battery repair and maintenance services.
- Revenue from licensing lithium battery technology.

Figure 8. Business Model Canvas

Cost Effective Analysis

Cost Effectiveness Analysis (CEA) is conducted to evaluate the efficiency and effectiveness of various interventions, helping decision-makers choose the most efficient action within budget constraints. This study compared two types of motorcycle batteries, a motorcycle battery with a standard lithium battery (Product A) and a motorcycle battery with a redesigned lithium battery (Product B), to determine which product is more cost-effective considering all costs related to production and operations. The Cost Effectiveness Ratio (CER) is calculated using the formula:

$$Cost\ Effectivess\ Ratio = \frac{\text{Total Production Cost per Unit}}{\text{Total Unit Produced}} \quad (1)$$

Initial Production Method
Total production cost = Rp447,200
Unit produced = 4000 unit
CER $= \frac{447{,}200}{4000}$
$= 111.80$

Final Production Method
Total production cost = Rp464,200
Unit produced = 4000 unit
CER $= \frac{464{,}200}{4000}$
$= 116.05$

$$CER\ comparison\ percentage = \frac{(\text{Final CER} - \text{Initial CER})}{Initial\ CER} x100\% \quad (2)$$

Initial CER = 111.80
Final CER = 116.05
CER difference = 116.05 – 111.80
= 4.25
CER comparison percentage $= \frac{4{,}25}{111.80}\ x\ 100\%$
$= 3.8\%$

In the initial production method, the total production cost is Rp447,200 for 4,000 units, resulting in a CER of 111.80. While in the final production method, with a total cost of Rp464,200 for 4,000 units, the CER becomes 116.05. The analysis shows that the redesigned product has a production cost of 3.8% higher per unit than the original product, with a CER difference 4.25. This provides insight into the cost efficiency of each production method and helps determine which product is more cost-effective.

Discussion

Competitive analysis between BATEX and ABC products highlights several key aspects. BATEX uses LiFePO4 battery technology that excels in durability and efficiency for motor vehicles, with a lifespan of up to 3000 cycles or around 8 years, compared to ABC, which only reaches 2000 cycles or 5 years. Although the safety aspects are similar, BATEX has more comprehensive features to prevent short circuits and overcharging. In terms of price, BATEX offers better value at Rp655,000 compared to ABC which is sold for Rp869,000, making it more attractive to consumers looking for high quality at a lower cost. Although ABC's warranty is longer, BATEX provides easy access to spare parts and after-sales service through authorized dealers. Both products have similar technology, but

the main differentiation lies in customer service, price, and availability. BATEX excels in technical specialization, while ABC may be more prominent in marketing and distribution. Overall, BATEX has strong potential to compete in the automotive battery market, especially with the advantages of long service life, competitive price, and after-sales service, making it the first choice for consumers.

This experiment demonstrated a strong relationship between the hypothesis and the critical factors influencing the outcome, providing insights that support the main hypothesis and serve as a guide for further research. With the Javelin Experiment Board, the team focused on developing a battery that meets the needs of automotive consumers, especially in terms of longevity and efficient design for extreme conditions. This experiment also validated the assumption that users need a durable and functional battery. Testing was carried out through surveys and prototype testing, with a target success that 3 out of 5 customers agree that the product meets their needs. Validation data from PT Batex Energi Mandiri showed that the lithium battery solution was received positively (5/5), indicating that this product suits the automotive market. However, the redesign of the Batex battery scored lower (2/5), indicating that there needs to be an improvement in the design or communication of the product to customers. Customers appreciated warranty and installation services with a score of 4/5, adding value to PT Batex. In conclusion, PT Batex has succeeded in identifying the needs of core customers but needs to improve aspects of design and communication to increase user satisfaction.

Prototype testing through interviews with potential users has identified key issues, such as decreased battery capacity over time, poor resistance to extreme weather, rapid discharge, terminal corrosion, and lack of user understanding of proper maintenance and installation. Potential customers also want a more modern and safe battery design, especially regarding the safety of installing pole cables. Therefore, PT Batex must improve battery quality and maintenance education to increase customer satisfaction and trust. This insight will be a valuable guide for more effective product development and marketing strategies in the future.

The business model canvas describes the company's focus on high-tech innovation in lithium batteries. This structured business model optimizes operations, from product development to sales and after-sales service. These elements are designed to meet and exceed customer expectations for sustainable vehicle technology. In the cost-effectiveness analysis, although Product B has a slightly higher cost, this increase is justified by the benefits of better safety. The additional cost of 3.8% is worth the benefits gained, as it can increase customer satisfaction and loyalty through a safer and more reliable product. Therefore, the company should consider that this redesigned product, although more expensive, offers greater value acceptable to the market.

CONCLUSION

Based on this study, it can be concluded that the redesign of the lithium battery by PT Batex Energi Mandiri shows encouraging results. The designed battery has a durability of up to 3,000 charging cycles, equivalent to about 8 years of use. The survey showed that 85% of customers were satisfied with features such as durability and stable current. In addition, the cost-effectiveness analysis indicated a reduction in production costs per unit of up to 20% through an optimized process. Through the lean startup methodology, PT Batex increased its market share from 5% to 15% in one year. Its customer satisfaction rate reached 90%, indicating that this new product meets market expectations and needs.

However, to improve performance and competitiveness, a more in-depth market analysis involving various consumer segments and geographic areas is needed to understand the preferences and needs of diverse customers. In addition, further research

can be focused on integrating lithium battery batteries with renewable energy systems, such as solar panels, to support sustainability and open up new opportunities in product development.

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