

Original Research Paper

Developing a Sustainable Business Model for Electric Motorcycle Conversion in Indonesia Using SBMC and PROMETHEE

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Abstract: The transportation sector accounts for approximately 37% of Indonesia's final energy consumption, with 99.9% still relying on fossil fuels. This dependency increases energy subsidy burdens and contributes significantly to greenhouse gas emissions. In response, the Indonesian government has introduced policies to promote battery electric vehicles, including incentives for converting internal combustion engine (ICE) motorcycles to electric. This study aims to develop a sustainable business model for motorcycle electrification in Indonesia using the Sustainable Business Model Canvas (SBMC) framework. To prioritize key business components, the PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations) method was applied. A mixed-methods approach was adopted, involving semi-structured interviews with 14 stakeholders and multi-criteria decision analysis. The findings highlight legality assurance, urban user targeting, and strategic partnerships as the most critical elements. The resulting SBMC provides actionable insights for policymakers and industry actors to accelerate electric motorcycle adoption and contribute to Indonesia's Net Zero Emission goals through more energy-efficient and low-carbon transport solutions.

Keywords: Business Model, ICE-to-EV Conversion, Net Zero Emission, PROMETHEE, Sustainability.



1. Introduction

Indonesia is currently facing a major transition toward sustainable energy amid rising fossil fuel consumption, particularly in the transportation sector. As of 2023, transportation accounted for 37% of the country's final energy consumption, with over 99% sourced from petroleum-based fuels [1]. This dependence exacerbates national energy subsidies and significantly contributes to greenhouse gas (GHG) emissions, thereby accelerating climate change. Motorcycles are a key contributor to this trend. With an average annual growth rate of 8.4% between 2010 and 2019 and a daily fuel use of approximately 1 liter per motorcycle, these vehicles alone emit around 90,000 tons of CO₂ per day [2]. The fiscal burden is also significant, with fuel compensation costs reaching Rp 302 billion per day. National energy supply remains dominated by fossil fuels, 42% coal, 32% oil, and 14% gas, while renewable energy comprises only 12% [3]. Under a business-as-usual (BAU) scenario, government energy subsidies are projected to rise from Rp 502 trillion in 2022 to Rp 1,628 trillion by 2060. In response, the Government of Indonesia has introduced regulatory and fiscal incentives to promote the adoption of battery electric vehicles (BEVs). Key policies include Presidential Regulation No. 55/2019 and its derivatives, which provide subsidies between Rp 7–10 million for new electric motorcycles and conversion programs [4] [5]. However, implementation has been limited. As of 2024, only 1,500 motorcycle conversions were realized, far below the annual target of 150,000 units [6] [7]. This discrepancy indicates a critical need for a comprehensive and context-sensitive business model to support the adoption of electric motorcycles in Indonesia.

To address this challenge, this study proposes the development of a Sustainable Business Model Canvas (SBMC) tailored for electric motorcycle conversion businesses. The SBMC, introduced by Osterwalder and Pigneur, is a strategic management framework used to describe, analyse, and innovate business models by integrating environmental, economic, and social dimensions. In this study, the SBMC is applied in the context of EV transition and adapted to local stakeholder conditions. To systematically prioritize the business model components, the PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations) method is employed, offering a structured multi-criteria decision-making approach based on stakeholder evaluations. This research contributes theoretically by contextualizing SBMC within the emerging market framework of EV conversion, and methodologically by integrating stakeholder analysis through PROMETHEE. Practically, it provides policy and industry actors with a structured model to guide decision-making, improve business readiness, and accelerate the transition to sustainable two-wheeled transportation.

2. Literature Review

The increasing number of motorcycles in Indonesia continues to raise fuel consumption and carbon emissions. From 2015 to 2024, motorcycle ownership rose steadily, reaching 137.35 million units in 2024, or 83.77% of all registered vehicles, with a cumulative growth rate of 35.45% over the past decade [8]. This trend reflects the vehicle's affordability, fuel efficiency, and convenience in urban congestion, further supported by reports showing that vehicle ownership outpaces population growth [9].

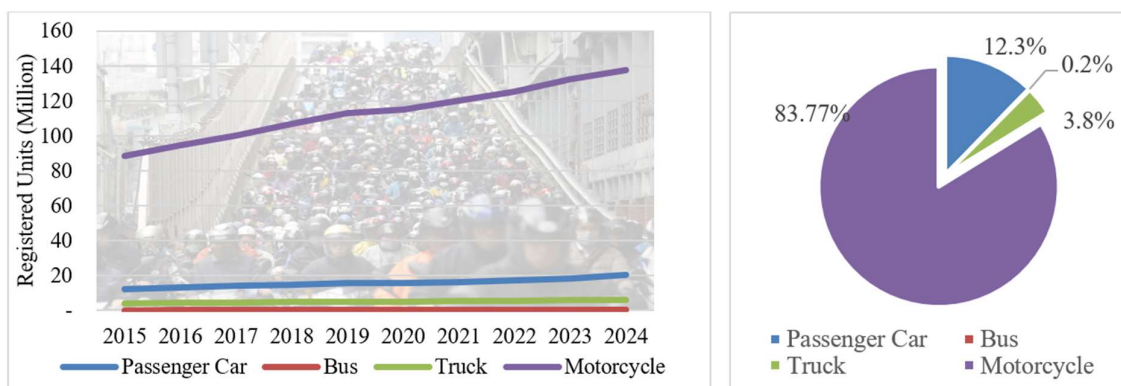


Figure 1. Vehicles Growth by Type 2015–2024 [8]

This surge in fuel-based vehicle usage has a direct impact on energy demand. The transport sector contributed 36.74% of total final energy consumption in 2023, second only to the industrial sector [1]. Alongside growing energy use, CO₂ emissions have also risen. In 2022, motorcycles contributed approximately 36.1% of transport-related CO₂ emissions, aligning with their high share in the total vehicle population [10]. This emission footprint affirms the critical need for mitigation through technological innovation. Recognizing this, the government launched several regulations to promote electric vehicle (EV) adoption, including Perpres 55/2019 and Permenhub 13/2023, which incentivize the conversion of internal combustion engine (ICE) motorcycles to electric ones [4]. These policies target both supply (via industrial stimulus) and demand (via direct subsidies), yet adoption remains sluggish due to high upfront costs, limited charging infrastructure, and public unfamiliarity.

The conversion process itself is governed by technical standards such as physical fitness of the donor motorcycle, valid documentation (STNK), and compliance with regulations under Permenhub 39/2023. According to a techno-economic study, the Total Cost of Ownership (TCO) for ICE motorcycles reaches IDR 8.2 million/year (IDR 370/km), while converted electric motorcycles require only IDR 4.2 million/year (IDR 192/km), demonstrating long-term user benefits [11].

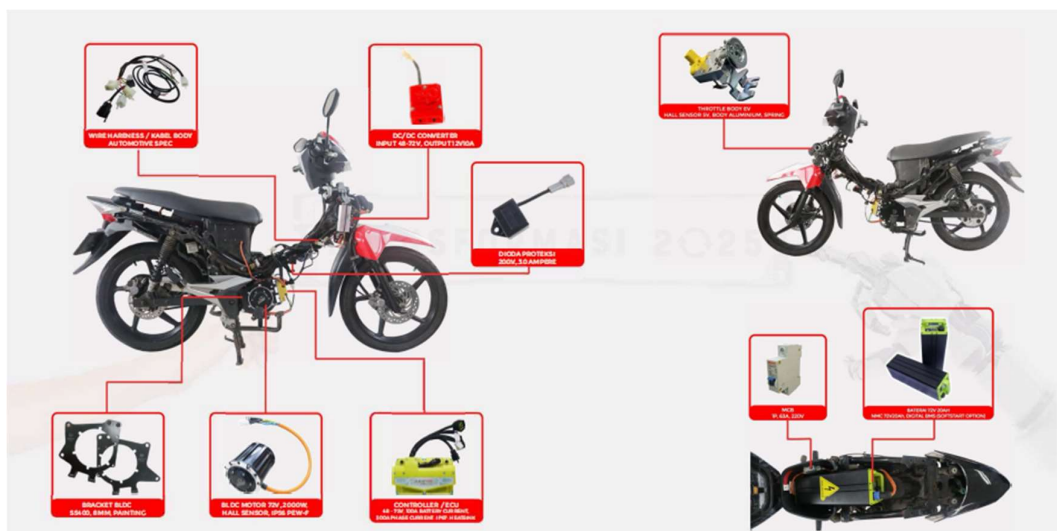


Figure 2. Conversion Motorcycle Components [12]

To develop a responsive and sustainable strategy, researchers and practitioners have increasingly adopted the Business Model Canvas (BMC) framework proposed by Osterwalder and Pigneur [13]. The BMC consists of nine building blocks to design and evaluate business models effectively. However, due to environmental and social pressures, the framework has evolved into the Sustainable Business Model Canvas (SBMC) by integrating components like eco-costs and eco-benefits, making it highly relevant for green mobility businesses [14]. Figure 3 shows the template sustainable business model canvas.

While SBMC provides a conceptual foundation, prioritizing components within the canvas often requires systematic stakeholder input. The Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) is a proven Multi-Criteria Decision-Making (MCDM) tool designed for such contexts [16]. PROMETHEE allows simultaneous evaluation of multiple business model components, considering both qualitative and quantitative inputs, essential for sustainability transitions where stakeholder interests frequently diverge [17]. Despite its relevance, few studies to date have combined SBMC and PROMETHEE in the context of motorcycle electrification in emerging economies. This paper addresses this gap by integrating both frameworks using empirical data from Indonesian stakeholders, offering novel contributions to the fields of sustainable transport and green business modelling.

A summary of past studies and research gaps is shown in Table 1.

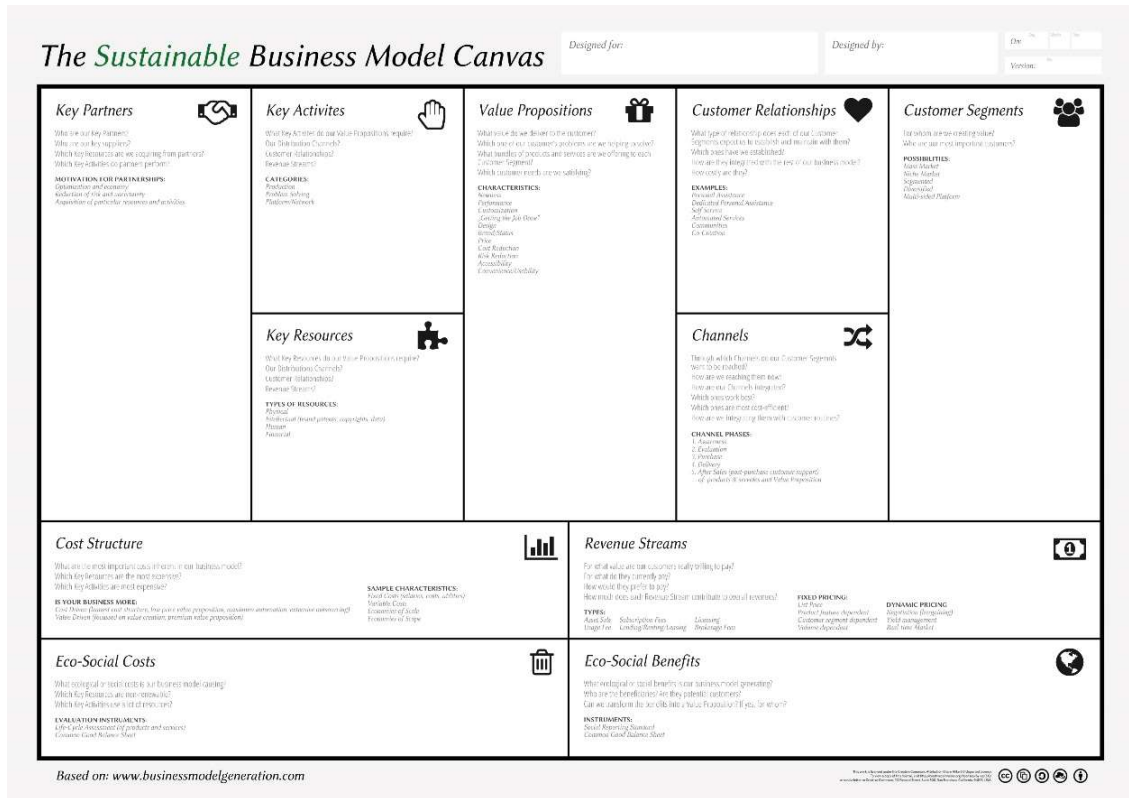


Figure 3. Template Sustainable Business Model Canvas [15]

Table 1. Research Gap in EV Business Model Literature

No	Ref.	Sector		Scope											Method
		2W	C2W	1 Vp	2 Cs	3 Ch	4 Cr	5 Rs	6 Kr	7 Ka	8 Kp	9 CS	10 Esc	11 Esb	
1	[18]	✓										✓			Markov chain, NPV, IRR, PP
2	[19]	✓		✓	✓								✓	✓	Stated preference surveys, SEM
3	[20]		✓		✓				✓	✓	✓			✓	Mixed Integer Linear Prog. (MILP)
4	[21]		✓	✓	✓				✓	✓	✓		✓	✓	Comparative analysis, tech. innovation process, technopreneur ship model
5	[22]		✓									✓	✓	✓	NPV, PP, carbon emissions simulation
6	[23]		✓									✓	✓	✓	Mixed Integer Linear Prog. (MILP)
7	[24]	✓		✓	✓								✓	✓	Survey and Partial-Least Squares
8	[25]		✓						✓	✓		✓	✓	✓	NPV, Payback Period
9	[26]	✓											✓	✓	SEM, Technology Acceptance Model
10	Mine		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	SBMC, PROMETHEE, Analisis SWOT

Note: Electric Motorcycle; C2W: Conversion Motorcycle; Vp: Value Propositions; Cs: Customer Segments; Ch: Channels; Cr: Customer Relationships; Rs: Revenue Streams; Kr: Key Resources; Ka: Key Activities; Kp: Key Partners; CS: Cost Structure; Esc: Ecology-Social Cost; Esb: Ecology-Social Benefit

3. Methodology

This study employs a mixed-methods approach, combining both qualitative and quantitative research methods to achieve a comprehensive understanding of the electric motorcycle conversion ecosystem in Indonesia. The research process is organized into four main stages: Research Design, Data Collection, Respondents, and Data Analysis.

3.1. Research Design and Flow

The research design integrates qualitative and quantitative techniques to provide a comprehensive analysis of the electric motorcycle conversion business model. The qualitative phase involved conducting semi-structured interviews with 14 key stakeholders from various sectors, including government agencies, conversion workshops, electric vehicle infrastructure providers, and industry associations. The goal was to explore their perspectives on key components of the Sustainable Business Model Canvas (SBMC), such as value propositions, customer segments, and key resources.

In parallel, a quantitative approach was employed, where a structured questionnaire was distributed to the same group of stakeholders. The questionnaire, based on the SBMC framework, aimed to capture stakeholders' views on the relative importance of each component of the business model. The responses were then analyzed using the PROMETHEE method, a multi-criteria decision-making tool, to rank the components and identify the most critical areas for business model development [27]. This dual approach ensured that the research would not only capture qualitative insights but also provide a structured, quantifiable analysis of stakeholder preferences.

To better understand the sequence of the research process, the following Research Flow Diagram summarizes the study's stages, from the initial data collection and stakeholder interviews to the final analysis using the PROMETHEE method.

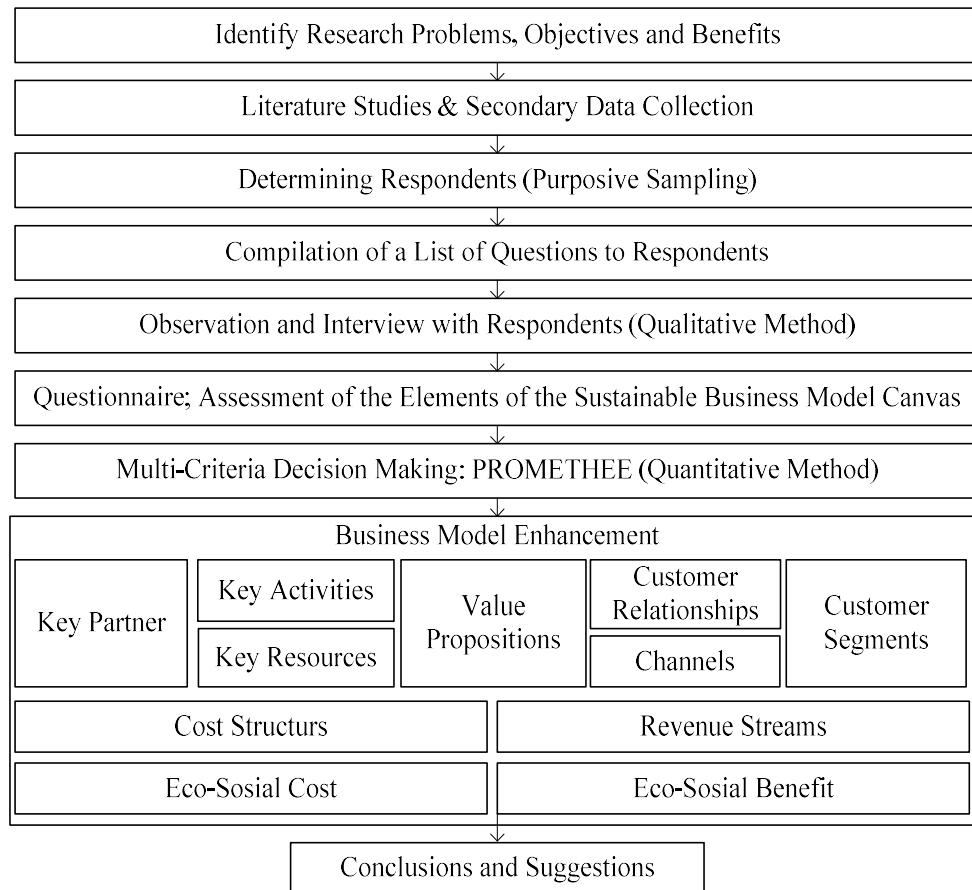


Figure 4. Research Flow Diagram

3.2. Data Collection

Data was collected in two phases:

1) Qualitative Data

Semi-structured interviews were conducted with 14 respondents who represented key actors in the electric motorcycle conversion ecosystem. These included government regulators, industry associations, conversion workshop operators, and infrastructure providers. The semi-structured nature of the interviews allowed flexibility, enabling the interviewer to probe deeper into specific areas of interest while also covering the core topics related to the SBMC components. The information collected from these interviews provided rich insights into the stakeholders' views on the feasibility, challenges, and potential of the electric motorcycle conversion program [28].

2) Quantitative Data

A structured questionnaire was developed based on the SBMC framework, and respondents were asked to rate the importance of various business model components using a Likert scale. This allowed for the collection of standardized data, which was then used in conjunction with the qualitative findings to provide a holistic view of the conversion business model. The responses were analyzed using the PROMETHEE method, which provided a systematic way to rank and prioritize the different components of the business model based on stakeholder preferences [29]. The Likert scale used in this study consists of five levels, each corresponding to a degree of importance, ranging from 1 (lowest) to 5 (highest). Respondents were asked to rate the importance of each component of the Sustainable Business Model Canvas (SBMC) based on their perspectives. The scale used for this study is summarized in the table below:

Table 2. Questionnaire Likert Scale

Scale	Impact Level
1	Irrelevant/Irrelevant
2	Very Small Impact
3	Medium Impact
4	Big Impact
5	Very Large/Critical Impact

3.3. Respondents

The respondents were selected using the purposive sampling technique, ensuring that the individuals chosen had significant expertise and experience in areas relevant to the electric motorcycle conversion ecosystem. Respondents were categorized into four main groups to ensure comprehensive coverage of all relevant perspectives. The first group consisted of government regulators, including representatives from ministries such as the Ministry of Energy and Mineral Resources as R1 and R2, the Ministry of Transportation as R3 and R4, the Ministry of Industry as R9 and R10, and the Indonesian Police as R13. These respondents play a crucial role in policy formulation, standardization, and the overall regulation of the conversion program. The second group included conversion workshop operators as R5, R6, R7, and R8, which are certified entities responsible for the actual conversion of internal combustion engine motorcycles to electric motorcycles.

The third group involved industry associations, such as the Electric Mobility Ecosystem Association (AEML) as R11 and the Indonesian Electric Motorcycle Industry Association (AISMOLI) as R12. These organizations focus on advocacy, industry development, and standardization efforts within the electric vehicle sector. Finally, the fourth group included infrastructure providers, notably PT PLN (Persero) as R14, which supplies the necessary charging infrastructure for electric motorcycles. This purposive sampling technique was carefully chosen to ensure that all relevant stakeholder perspectives were represented, providing a balanced and comprehensive view of the electric motorcycle conversion ecosystem.

3.4. Data Analysis

Data analysis in this study involved both qualitative and quantitative techniques:

1) Qualitative Analysis

Interview transcripts were carefully coded and analyzed thematically. This approach allowed for

the identification of recurring patterns and key insights related to the components of the SBMC, such as value propositions, customer segments, and key resources.

2) Quantitative Analysis

The responses from the structured questionnaire were processed using the PROMETHEE method to rank the importance of each SBMC component. The Visual PROMETHEE software generated outputs such as the preference flow, and ranking charts, which helped in visualizing stakeholder preferences and identifying which components should be prioritized in the business model. Each component of the SBMC was assigned a Phi value (net flow), which reflected the overall preference of the stakeholders. Additionally, the Phi+ (leaving flow) and Phi- (entering flow) values were considered to measure how each component dominated or was dominated by others. This allowed for a clear understanding of which components were most critical for the development of the business model.

4. Finding and Discussion

4.1. Finding

The electric motorcycle conversion program, initiated by the Indonesian government in 2022, aims to reduce fossil fuel dependence and greenhouse gas emissions in the transportation sector. However, as of December 2024, only about 1% of the national target, 150,000-unit conversions, had been achieved, with just 1,500 units converted. This highlights a significant gap between the target and actual implementation, signalling the need for a more effective business model to drive wider adoption of electric motorcycles [5].

To address these challenges, the government increased the conversion incentive from IDR 7 million to IDR 10 million per unit. This adjustment is expected to alleviate the high conversion costs, which typically range from IDR 15 million to IDR 17 million per motorcycle. Additionally, a free conversion program for 1,000 units was introduced to stimulate public interest [30]. Despite these efforts, obstacles such as low public awareness about the benefits of conversion and concerns over the performance of converted motorcycles remain significant barriers. Furthermore, the limited number of certified conversion workshops, only 34 as of April 2024, remains a significant barrier to scaling the program. The government has set a target of increasing the number of certified workshops to 1,020 by the end of 2023, which will require technical training, conversion standardization, and additional incentives for workshop operators [6] [31].

On the other hand, the sales of new electric motorcycles have shown very positive growth. According to data from the Primary Industrial Information System (Sisapira), subsidized electric motorcycle sales reached 63,146 units in 2024, marking a 447% increase compared to the previous year. This surge in sales reflects an increasing market awareness of electric vehicles, although the conversion program has not yet mirrored this trend. Despite these challenges, the electric motorcycle conversion program holds significant potential, provided there is strong synergy between adaptive regulations, improved industry readiness, and enhanced public literacy [32] [33].

4.2. Discussion

This discussion presents the results of field findings obtained through in-depth interviews with respondents related to the perception and practice of motorcycle electrification. The interview was conducted to explore first-hand views on the various elements that are the focus of the research. The data obtained from these interviews became the main foundation in the preparation and mapping of a sustainable business model framework in motorcycle conversion.

1) Value Propositions

The results of the interviews show that the main values offered from the fossil fuel motorcycle conversion program to electric motorcycles include operational cost efficiency, reduction of carbon emissions, and contribution to environmental sustainability. The pioneer of technology among the researchers, R1, emphasized, "One of the solution ideas to reduce the motorcycle population that has been circulating in the community is to carry out conversion activities from fuel-powered motorcycles to electric motorcycles." (R1, Personal Interview. 2025, January 2).

In line with that, regulators such as R2 and R10 state that the conversion of electric motors is a strategic step to reduce fossil energy consumption and increase national efficiency. R2 said, "Electric motor conversions offer up to 80% reduction in operating costs compared to oil-fueled vehicles." (R2, Personal Interview. 2025, January 5).

From the perspective of conversion workshops, R5 and R8 see conversion as providing direct economic benefits to the community. "By converting oil-fired motorcycles to electric motorcycles, we are making a positive contribution to reducing carbon emissions and air pollution." (R8, Personal Interview. 2025, February 14). Vehicle associations such as the R11 and R12 added that the conversion of electric motors strengthens the national electric-based vehicle ecosystem.

Meanwhile, on the side of EV infrastructure providers, R14 stated, "Conversion supports the development of public charging networks and accelerates the development of electric vehicle infrastructure." (R14, Personal Interview. 2025, March 17). The regulator's R9 added that "The conversion of fuel-to-electric motors is relevant to support the 2060 net zero emission roadmap." (R9, Personal Interview. 2025, January 19). Thus, all respondents agreed that the electric motor conversion program has strong value propositions in terms of economic efficiency, emission reduction, and supporting the acceleration of the national clean energy transition.

2) Customer Segments

In terms of customer segmentation, most respondents agreed that daily motorcycle users such as motorcycle taxis, informal sector workers, and urban communities with high mobility are the most potential targets. The vehicle association through R11 said, "The most potential customer segments are daily motorcycle users such as online motorcycle taxis, informal sector workers, and users in urban areas with high mobility intensity." (R11, Personal Interview. 2025, February 24). The government through R2 and R4 also directs that this program is suitable for operational vehicles of local government agencies or SOEs, as a showcase for the adoption of electric vehicles.

However, vehicle testers such as the R13 noted that from an economic point of view, "The conversion price is still high for the lower middle class, while the upper middle class tends to choose to buy a new electric motorcycle rather than convert." (R13, Personal Interview. 2025, February 29). The conversion workshop also provided an insight, as conveyed by R5, "Daily motorcycle users who want operational cost savings and ease of maintenance are a very potential segment for this conversion program." (R5, Personal Interview. 2025, February 12). Thus, potential customer segments include informal sector workers, motorcycle taxi drivers, agency operational vehicles, and daily motorcycle users who are looking for cost efficiency.

3) Channels

The distribution channel of the electric motor conversion program requires a combination of online and offline channels to maximize effectiveness. From the regulator's side, R13 proposed, "The integration of Electronic Registration in the distribution process of conversion vehicles is important, starting from physical checks to the issuance of TNKB specifically for electric vehicles." (R13, Personal Interview. 2025, February 29). Vehicle associations such as R11 and R12 encourage the strengthening of public information platforms, one of which is through Infomolis.co.id, to make it easier for the public to obtain information about electric vehicles and conversions.

The regulator from the Ministry of Energy and Mineral Resources, R2, added, "The distribution channels of conversion programs should be expanded with the integration of government digital platforms and collaboration with certified conversion workshops." (R2, Personal Interview. 2025, January 5). The conversion workshop, represented by R5, also emphasized the importance of direct education to potential users through exhibitions, seminars, and product demos to accelerate market understanding and acceptance. Thus, an integrated distribution channel approach between digital media, government support, and physical activities is the main strategy suggested by respondents.

4) Customer Relationship

Relationships with customers in the electric motorcycle conversion business are considered especially important to maintain business sustainability and increase public trust. R8 from the conversion workshop explained, "We maintain good communication with customers throughout the conversion process and afterwards, including providing training on the maintenance of electric motors." (R8, Personal Interview. 2025, February 14). Vehicle associations such as R11 emphasize the need to form a community of customers, "A community of battery-based electric vehicle customers can enhance the sharing experience and strengthen public trust in this technology." (R11, Personal Interview. 2025, February 24).

Meanwhile, R13 from Korlantas added the importance of assisting customers in the vehicle legalization process through physical check assistance and post-conversion document administration.

R4 from the government warned, "Customers need to get a guarantee of post-conversion services, including access to service and battery maintenance, so that trust in the converted electric motor increases." (R4, Personal Interview. 2025, January 17). Respondents agreed that intensive communication, after-sales service, customer community, and administrative assistance are crucial factors to build a sustainable relationship in the electric motor conversion business.

5) Revenue Streams

The sustainable revenue model of an electric motor conversion business requires a combination of financing schemes, government incentives, and additional services. EV provider Infrastructure R14 stated, "We support the sustainability of the revenue of the electric motor conversion business through the integration of government incentive programs and the development of the battery charging and swapping station ecosystem." (R14, Personal Interview. 2025, March 17). From the regulator's point of view, R2 and R10 emphasize the importance of the sustainability of the subsidy scheme, as well as the need for additional incentives such as regional tax exemptions for converted vehicles.

The conversion workshop, as conveyed by R5, added that a special financing scheme, like a new vehicle loan, is indispensable to expand the electric motorcycle conversion market in the community. R12 from the vehicle association said, "Expanding the source of income can be done by opening a subscription battery swap service, thereby increasing recurring revenue from conversion motorcycle users." (R12, Personal Interview. 2025, February 27). This is also emphasized by R11, which encourages cooperation with finance institutions and banks to make conversion financing more widely accessible. Thus, diversification of revenue sources, including from government programs, ancillary services, and financing schemes, is a key element of the sustainability of the electric motor conversion business.

6) Key Resources

The development of key resources is an important pillar to support a quality and sustainable electric motor conversion business. R10 from the regulator underlines the importance of using vehicles with good frames and quality components such as electric motors, battery packs, and controllers, "The selection of vehicles with good frame conditions and the quality of the main components greatly determine the conversion results." (R10, Personal Interview. 2025, February 24).

The conversion workshop, as conveyed by R5 and R6, identified that in addition to components, the existence of certified technician human resources and high-standard testing facilities was also a major need. The R3 of the testing institute adds the importance of technical certification and vehicle feasibility. Vehicle associations such as R11 emphasize the need for cross-sector collaboration in the provision of local components to increase TKDN. R4 also reminds about the importance of technical regulations, "The main components of conversion results such as electric motors and batteries must meet national standard certification in order to maintain vehicle quality." (R4, Personal Interview. 2025, January 17). All respondents agreed that quality human resources, adequate testing facilities, certified components, and cross-sector collaboration are key resources in the electric motor conversion program.

7) Key Activities

Key activities in the motorcycle conversion program must be aligned with the clean energy policy set by the government. R7 from the conversion workshop underlined the importance of improving the administrative process and the ease of document management of converted vehicles, "Document management for converted vehicles must be made simpler and faster." (R7, Personal Interview. 2025, February 17). Regulators such as R4 added that the safety aspect of converted vehicles must be the focus by ensuring that the entire test process conducted to strict standards. On the other hand, the R12 vehicle association recommends the need for massive public education about the benefits of conversion and its environmental impact. R14 from EV provider Infrastructure encourages the integration of conversion programs with the development of charging station infrastructure and battery swapping. The regulator's R2 added another focus on key activities, "The acceleration of charging infrastructure development should be integrated with the electric vehicle conversion roadmap." (R2, Personal Interview. 2025, January 5).

Thus, the key activities that are the focus are simplification of administrative processes, improvement of safety standards, public education, and the development of supporting infrastructure.

8) Key Partners

The success of the electric motor conversion program relies heavily on collaboration with strategic partners in various sectors. The R12 of the vehicle association mentions the importance of partnerships with local electric motorcycle and component manufacturers, as well as certified workshops, "Strategic partnerships are needed with local component manufacturers, certified workshops, type test institutes, energy and transportation regulators, and the Police for legality aspects." (R12, Personal Interview. 2025, February 27). R3 and R13 from the testing institute emphasized the key role of BPLJSKB in testing the type of vehicle results of the conversion to ensure safety. R2 and R4 from government regulators encourage cross-ministerial cooperation, while EV provider R14 Infrastructure adds the importance of corporate and financial institution support to expand access to financing and charging infrastructure. This cross-sector collaboration is the main key to accelerating the penetration of electric motorcycle conversion in Indonesia.

9) Cost Structure

The cost aspect in the electric motor conversion business is a major concern, especially to increase the affordability of the program. R13 from the Korlantas Polri said, "The regulation on the whitening of motor vehicle names in accordance with Law No. 1 of 2022, which came into effect on January 5, 2025, allows vehicles that are converted to be free from name change duties, so that they only pay the administrative costs of STNK and BPKB." (R13, Personal Interview. 2025, February 29). Respondents from R11 vehicle associations also added that registration and licensing fees such as SUT and SRUT are still bottlenecks that need to simplify. R6 from the conversion workshop mentioned the need for incentives to reduce initial certification costs as well as strengthen local industries to reduce the cost of imported raw materials, especially for electric motor and battery components. With the implementation of bleaching regulations and the support of fiscal incentives, the cost structure of conversion programs is expected to become more efficient and competitive.

10) Eco-Social Costs

Electric motor conversion programs must still pay attention to the ecological impact of the conversion process itself. R13 expresses the need to use recycled batteries or old battery trade-in programs to reduce e-waste, "Certification of eco-friendly conversion workshops should be implemented, including waste management systems of batteries and used components." (R13, Personal Interview. 2025, February 29). Respondents from regulators such as R2 and R4 emphasized that the monitoring of the conversion process must ensure that used components are not misused or resold illegally.

The vehicle association's R11 also suggests a sustainable approach, "Conversion programs should consider the recycling of used components to reduce the environmental impact of automotive waste." (R11, Personal Interview. 2025, February 24). A sustainable approach to waste management and eco-friendly certification is the main strategy to minimize Eco-Social Costs in this program.

11) Eco-Social Benefits

The conversion of electric motorcycles has a positive impact both from an environmental and social perspective. R11 from the vehicle association stated, "The conversion program can help the region, especially in overcoming fuel scarcity and accelerating the adoption of electric vehicles outside Java." (R11, Personal Interview. 2025, February 24). R14 from infrastructure providers added that the conversion of electric motors contributes to the reduction of carbon emissions and supports government programs in the clean energy transition. On the social side, the R5 and R6 of the conversion workshop highlight that conversion opens new job opportunities in the technician and conversion workshop sector, as well as lowers the operational costs of vehicles for the community. With ecological benefits in the form of emission reductions and social benefits in the form of cost efficiency and the creation of new jobs, the electric motor conversion program provides significant added value in supporting sustainable development in Indonesia.

All interview results are then validated through a member check process using questionnaire media to ensure the interpretation of the data in accordance with the respondents' perception. With this approach, more accurate and comprehensive results are obtained in describing the actual conditions.

Table 3. Recapitulation of the Assessment of the Constituent Aspects of SBMC

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
VP1	5	5	4	4	5	4	5	5	4	5	5	5	5	4
VP2	5	5	4	4	5	4	5	5	4	4	5	5	4	5
VP3	5	4	3	5	5	3	5	5	4	5	5	5	5	5
VP4	5	5	2	5	5	3	5	5	5	5	5	5	5	4
VP5	5	5	4	5	5	4	5	4	4	5	4	5	4	5
VP6	5	5	3	4	5	3	5	4	5	5	5	5	4	3
VP7	5	4	5	4	5	4	5	5	4	5	4	5	5	4
VP8	5	5	4	4	5	4	5	5	5	4	5	5	5	5
VP9	5	5	4	3	5	4	5	5	5	3	5	5	5	5
VP10	5	5	2	5	5	4	5	4	4	3	5	5	5	4
VP11	5	4	4	3	5	3	5	4	4	5	3	5	5	5
VP12	5	3	4	5	5	4	5	4	4	5	4	5	5	4
CS1	5	5	5	4	5	4	5	4	5	5	5	5	4	5
CS2	3	2	2	4	5	3	5	4	4	3	4	5	3	3
CS3	5	4	3	5	5	4	3	4	4	4	4	3	3	5
CS4	5	4	3	5	5	4	3	4	4	4	4	5	3	5
CS5	4	5	4	3	5	2	5	4	5	5	5	5	4	3
CS6	5	4	4	4	5	5	5	4	4	5	5	5	5	5
CS7	5	4	2	4	5	3	5	4	4	4	5	5	5	5
CS8	4	3	3	4	4	4	5	4	5	4	5	5	5	5
CS9	5	3	3	4	5	4	5	4	5	4	4	5	4	4
CS10	4	4	3	5	4	4	5	4	5	4	4	5	3	3
CS11	4	5	2	5	5	4	5	4	5	5	5	5	5	4
CS12	5	4	3	5	5	4	5	4	5	5	4	5	5	5
CS13	5	3	4	5	5	4	4	4	4	5	5	5	5	4
C1	5	4	3	5	5	5	4	4	4	5	5	5	5	4
C2	5	4	4	5	5	5	4	4	5	5	5	5	4	4
C3	4	5	3	5	5	3	5	4	5	5	5	5	4	3
C4	3	5	2	5	5	4	5	4	4	3	5	5	3	4
C5	5	4	5	5	5	5	4	4	5	4	5	5	3	5
C6	4	3	5	5	4	4	5	5	4	5	5	5	5	3
CR1	5	5	4	5	5	4	5	4	4	4	5	5	5	4
CR2	5	3	4	4	5	4	4	4	5	4	4	5	5	5
CR3	5	5	4	5	5	4	4	4	5	5	5	5	5	3
CR4	5	4	5	5	5	5	5	4	4	4	5	5	5	5
CR5	3	5	4	5	5	4	5	4	5	3	5	5	5	4
RS1	5	5	4	4	5	4	4	4	4	3	3	5	4	4
RS2	5	5	3	4	5	4	5	4	4	3	3	5	5	4
RS3	5	5	4	3	5	4	4	4	5	3	3	5	4	3
RS4	5	3	4	3	5	3	5	4	4	4	3	5	5	4
RS5	5	4	3	3	5	4	5	4	4	4	3	5	5	4
RS6	5	5	5	3	5	4	3	4	5	3	3	5	4	4
KR1	5	3	4	5	5	4	5	4	4	3	5	5	5	5
KR2	5	3	3	4	5	4	5	4	5	3	3	5	5	3
KR3	5	5	4	3	5	4	4	4	4	5	5	5	5	5
KR4	5	5	5	5	5	4	5	4	4	5	5	5	4	4
KR5	5	3	4	5	5	4	5	4	4	5	5	5	4	5
KA1	3	5	4	5	5	4	5	4	4	5	5	5	4	3
KA2	3	5	4	5	5	4	5	4	5	5	5	5	5	5
KA3	4	5	4	5	5	4	4	4	4	5	5	5	5	5
KA4	4	3	4	5	5	4	4	5	4	5	5	5	5	3
KA5	4	4	5	3	5	4	4	5	5	5	4	5	5	4
KA6	3	4	5	5	5	4	4	4	5	5	4	5	4	4
KP1	5	5	3	5	5	5	5	4	5	5	5	5	5	4
KP2	5	3	4	5	5	5	5	4	5	5	5	5	5	4
KP3	5	5	5	3	5	4	2	4	3	5	5	5	5	4
KP4	5	4	5	3	5	4	5	4	4	5	5	5	5	4
KP5	5	5	3	5	5	5	5	3	4	5	5	5	4	3
KP6	4	5	3	2	5	4	3	4	5	4	5	5	4	4
KP7	4	4	3	3	5	4	5	4	4	3	5	5	5	5
KP8	4	5	3	3	5	4	5	4	5	5	5	5	5	5
KP9	5	5	2	3	5	4	4	5	4	5	5	5	5	5
KP10	5	5	3	3	5	4	4	4	4	5	5	5	5	5
KP11	5	5	3	5	5	4	5	4	4	5	5	5	4	5
KP12	5	4	4	5	5	4	3	4	4	5	5	5	4	3

(Continue)

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
CS1	5	5	5	5	5	4	5	3	5	5	5	5	4	5
CS2	5	3	3	3	5	4	5	4	5	3	5	5	5	3
CS3	5	3	3	5	5	3	5	4	4	5	5	5	4	5
CS4	5	3	3	1	5	3	4	4	4	5	5	5	4	5
CS5	5	3	3	3	5	3	4	4	4	4	5	5	3	4
CS6	5	4	2	3	5	3	4	4	3	3	4	5	4	4
CS7	5	4	3	4	5	3	5	4	4	3	4	5	4	4
ESC1	4	3	2	4	5	3	3	4	4	3	4	5	5	3
ESC2	3	4	2	5	5	4	4	4	4	3	5	5	4	3
ESC3	4	5	4	3	5	4	5	4	4	3	5	5	4	5
ESC4	3	5	5	3	5	4	4	4	5	5	5	5	4	5
ESC5	3	4	4	3	5	4	3	4	4	3	4	5	4	4
ESC6	4	2	3	3	5	4	2	3	4	3	3	5	3	1
ESB1	5	5	4	5	5	4	5	4	4	5	5	5	5	3
ESB2	5	5	4	5	5	4	5	4	5	5	5	5	5	4
ESB3	5	5	4	5	5	4	5	4	3	5	4	5	4	4
ESB4	5	5	5	5	5	4	5	4	4	5	5	5	5	4
ESB5	5	4	4	3	5	4	5	4	4	5	5	5	5	5
ESB6	5	5	2	3	5	4	4	4	4	4	4	5	5	4

Each of these elements was evaluated through respondents' perceptions processed using the Visual PROMETHEE method, an approach in Multi-Criteria Decision Making (MCDM) that produces three measures: Phi (Φ) as a net flow value that describes overall preferences, Phi+ (Φ^+) as a leaving flow that indicates the dominance of an element over other elements, and Phi- (Φ^-) as an entering flow that indicates how much other elements dominate the element. In this analysis, the value of Phi (Φ) is the focus because it represents a balance between dominance and vulnerability, thus showing the extent to which, these elements are priorities in the development of business models. The higher the Phi value, the greater the respondent's preference for the element, which means it needs to get primary attention in the development of a sustainable business model.

Table 4. Table of Ranking Calculation Results with PROMETHEE Visual

Element	Rank	Aspect	Phi	Phi+	Phi-
VP	1	Vehicle Legality Guarantee	0.107	0.153	0.046
	2	Low Emission Transportation	0.068	0.120	0.052
	3	Low Operating Costs	0.033	0.136	0.104
	4	Sustainability Level	0.029	0.117	0.088
	4	User Convenience	0.029	0.123	0.094
	6	Energy Efficiency	0.029	0.123	0.094
	7	Standardization and Security	0.029	0.140	0.110
	8	Technological Innovation	0.023	0.123	0.101
	9	Improving Environmental Image	-0.049	0.097	0.146
	10	Vehicle Life Extension	-0.084	0.088	0.172
	11	Low Maintenance Costs	-0.088	0.091	0.179
	12	Energy Independence	-0.127	0.075	0.201
CS	1	Urban	0.223	0.262	0.039
	2	Red Plate	0.194	0.244	0.051
	3	MSME Actors	0.158	0.205	0.048
	4	Logistics and Couriers	0.119	0.208	0.089
	5	Local Health Agencies	0.080	0.194	0.113
	6	Company Operations	0.006	0.146	0.140
	7	Office Workers/Employees	0.003	0.149	0.146
	8	Educators	-0.036	0.113	0.149
	9	Motorcycle Taxi	-0.036	0.179	0.214
	10	Automotive Enthusiast	-0.074	0.119	0.194
	11	Student	-0.113	0.104	0.217
	12	Antique Motorcycle Community	-0.152	0.113	0.265
	13	Rural	-0.372	0.033	0.405

(Continue)

Element	Rank	Aspect	Phi	Phi+	Phi-
C	1	Exhibition	0.107	0.186	0.079
	2	Platform Digital	0.100	0.214	0.114
	3	Service Center/Information Center	0.064	0.171	0.107
	4	SPLU/Swap Battery	0.014	0.200	0.186
	5	Regional Community	-0.021	0.150	0.171
	6	Used Motorcycle Dealer Partnership	-0.264	0.086	0.350
CR	1	Warranty	0.116	0.179	0.063
	2	Direct Interaction	0.027	0.098	0.071
	2	Community Empowerment	0.027	0.125	0.098
	4	Installation Scheme	-0.063	0.089	0.152
	5	Integrated Platform	-0.107	0.080	0.188
RS	1	Repair Services	0.050	0.114	0.064
	2	Workshop	0.007	0.086	0.079
	3	Conversion Plans	0.007	0.100	0.093
	4	Rent/Swap Batteries	0.007	0.114	0.107
	5	Spare parts	-0.036	0.079	0.114
	6	Conversion/Certification Consulting	-0.036	0.100	0.136
KR	1	Key Components of Conversion	0.134	0.196	0.063
	2	Construction Workshop	0.045	0.161	0.116
	3	Conversion Equipment	0.045	0.125	0.080
	4	Certified Technician	0.000	0.107	0.107
	5	Administration Team	-0.223	0.071	0.295
KA	1	Campaign	0.114	0.164	0.050
	2	Education	0.071	0.136	0.064
	3	Research & Development	-0.014	0.136	0.150
	4	Marketing	-0.057	0.086	0.143
	5	Component Recycling	-0.057	0.086	0.143
	6	Workshop Certification	-0.057	0.093	0.150
KP	1	Ministry of Transportation	0.153	0.192	0.039
	2	Ministry of Energy & Mineral Resources	0.114	0.201	0.088
	3	Electric Vehicle Association	0.075	0.146	0.071
	4	Government	0.039	0.133	0.094
	5	PT PLN (Persero)	0.036	0.136	0.101
	6	Community	0.010	0.136	0.127
	7	Motorcycle Community	0.003	0.104	0.101
	8	Indonesian Police	-0.003	0.143	0.146
	9	Ministry of Industry	-0.055	0.120	0.175
	10	National Standards Agency	-0.078	0.107	0.185
	11	Bank/Koperasi	-0.117	0.084	0.201
	12	BSN	-0.175	0.065	0.240
CS	1	Key Components of Conversion	0.333	0.375	0.042
	2	Technician Skill Development	0.131	0.196	0.066
	3	Legality of Conversion Vehicles	-0.018	0.161	0.179
	4	Workshop Certification	-0.036	0.125	0.161
	5	Workshop Operations	-0.060	0.107	0.167
	6	Modification Services	-0.137	0.071	0.208
	7	Used Component Management	-0.214	0.060	0.274
ESC	1	High Conversion Costs	0.279	0.336	0.057
	2	Incentive Uncertainty	0.200	0.257	0.057
	3	Community Resistance	0.021	0.179	0.157
	4	Risks of Non-Systemic Machinery Waste Management	-0.036	0.121	0.157
	5	Inequality of Access to Technology	-0.107	0.136	0.243
	6	Impact of Electricity from Non-Renewable Sources	-0.357	0.043	0.400
ESB	1	Environmentally friendly	0.121	0.136	0.014
	2	Environmental Awareness	0.114	0.129	0.014
	3	Emission Reduction	0.036	0.093	0.057
	4	Reduction of the National Fiscal Burden	-0.007	0.100	0.107
	5	Green Job	-0.050	0.071	0.121
	6	Strengthening the Local Economy	-0.214	0.029	0.243

Figure 5 shows the sustainable business model canvas for motorcycle conversion.

The Sustainable Business Model Canvas					Designed by:	Date:	Version:
Motorcycle Conversion From ICE to EV					Silvia	18-May-25	2
Key Partner 1. Ministry of Transportation 2. Ministry of Energy and Mine 3. Electric Vehicle Association 4. Local Government 5. PT PLN (Persero) 6. Community 7. Motorcycle Community 8. Indonesian Police 9. Ministry of Industry 10. Trademark Agent 11. Bank/Koperasi 12. National Standards Agency 13. Infrastructure Providers Electric Charging	Key Activities 1. Socialization (Campaign) 2. Education 3. Research and Development 5. Marketing 4. Component Recycling Management 6. Workshop Certification	Value Proposition 1. Vehicle Legality Guarantee 2. Low Emission Transportation 3. Low Operating Costs 4. Sustainability Level 5. Ease of Use 6. Energy Efficiency 7. Standardization & Guaranteed Security 8. Latest Innovations 9. Improving Environmental Image (Green Branding) 10. Vehicle Life Extension 11. Low Maintenance Costs 12. Energy Independence 13. Quality of Conversion Results	Cus to mer Relations hip 1. Warranty and Guarantee 2. Direct Interaction 3. Community Empowerment 4. Installment Scheme 5. Integrated Platform 6. Customer Satisfaction Survey	Customer Segments 1. Urban Segment 2. Red Plate Vehicles 3. MSME Actors 4. Logistics and Courier Companies 5. Local Health Agencies (Health Centers, Clinics) 6. Company Operational Vehicles 7. Office Worker / Employee 8. Educators 9. Motorcycle Taxi Vehicles 10. Automotive Enthusiast 11. Student 12. Antique Motorcycle Community 13. Rural Segment 14. Used Motorcycles Are Suitable for Use			
Cost Structure 1. Key Components of Conversion 2. Technician Skill Development Cost 3. Legality Cost of Conversion Vehicles 4. Workshop Certification Fee 5. Workshop Operational Costs 6. Modification Services	Key Resources 1. Key Components of Conversion 2. Construction Workshop 3. Conversion Equipment 4. Certified Technician 5. Administration Team	Revenue Streams 1. Repair Services 2. Physical Workshop 3. Conversion Plan Sales 4. Battery Rental and Exchange Services 5. Parts Sales 6. Conversion / Certification Consulting Services	Ecology-Social Benefits 1. Eco-Friendly Vehicles 2. Community Environmental Awareness 3. Carbon Emission Reduction 4. Reducing the National Fiscal Burden on Fuel Subsidy 5. Creation of New Jobs (Green Jobs) 6. Strengthening the Local Economy				
Ecology-Social Cost 1. Initial Conversion Costs Still High 2. Uncertainty of Incentives or Policies 3. Community Resistance to New Technologies 4. Risks of Non-Systemic Machinery Waste Management 5. Inequality of Access to Technology 6. Impact of Electricity from Non-Renewable Sources 7. Increase in E-Waste							
Business Model Development							

Figure 5. Sustainable Business Model Canvas for Motorcycle Conversion

Based on the results of the calculation (as shows in Table 4), a preference rating for each element obtained. For example. for the Value Proposition (VP) element, the Vehicle Legality Assurance aspect has the highest Phi value. which is 0.107. placing it first as the most crucial factor according to respondents' perceptions. Similarly for the other elements, the ranking results used to determine the priority of the aspects of concern in each SBMC block. Thus, the results of the Phi value ranking became the basis for compiling the SBMC. where the elements with the highest Phi value from each block prioritized to include in the design of the business model. This process ensures that the developed model is not only theoretically based but also reflects the real needs and preferences of the players in the field.

Building on the previously outlined process for creating the Sustainable Business Model Canvas (SBMC) for electric motorcycle conversion, this section integrates insights from interviews, questionnaires, and alternative rankings using the PROMETHEE method, as shown in Figure 5. By integrating both qualitative insights and quantitative analysis. this SBMC aims to outline the critical components necessary for a successful transition to electric motorcycles. The canvas serves as a strategic tool for navigating the complexities of this conversion, ensuring a sustainable business model that can drive long-term adoption and market success.

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