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Investment feasibility study of implementing electric conversion motorcycle in Indonesia: A sustainable development perspective

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ABSTRACT

The cause of global warming occurring in the world originates from the transportation sector, particularly Internal Combustion Engine (ICE) vehicles using fossil fuels. As a response, the Indonesian government has enacted regulations aimed at accelerating the adoption of electric vehicles. Electric vehicles developed in Indonesia encompass two-wheeled, three-wheeled, four-wheeled, and other types that operate by utilizing electrical energy stored in the vehicle's battery. One notable development involves the conversion of ICE motorcycles into electric motorcycles. This study seeks to assess the investment feasibility of implementing convertible motorcycles from economic, environmental, and social perspectives. The economic aspects are evaluated by calculating net present value (NPV) and payback period (PP), with the study's results demonstrating the economic viability of implementing convertible motorcycles. Furthermore, environmental considerations involve the comparison of chemical substances emitted as pollutants, with the results indicating the feasibility of this approach due to its potential to reduce air pollution. Lastly, the social aspect encompasses the review of potential impacts should converted electric motorcycles be produced on a large scale. The success of implementing convertible motorcycles necessitates the collaboration of various stakeholders, including the government, small and medium enterprises, electricity service providers, and the awareness of the public.

1. Introduction

The enhancement of vehicles in Indonesia increased by 5.7% in the previous year, with the number of vehicles reaching 143.8 million units [1]. The use of vehicles in Indonesia was dominated by motorcycles (41%) in 2018 [2]. The dominance of motorcycle usage is due to motorcycles offering faster travel times compared to other vehicles. Additionally, the inadequate state of public transportation in Indonesia leads people to favor private vehicles, particularly motorcycles.

Meanwhile, the transportation sector produces carbon emissions and is the main cause of air pollution, particularly from internal combustion engine vehicles using fossil fuels. Electric vehicles do not produce carbon emissions or air pollution. Therefore, motorcycles are currently transitioning to electric power due to government regulations [3]. Additionally, to support the acceleration of the transition to electric vehicles, the government has issued a regulation from the Minister of Transportation regarding the conversion of motorcycles with internal combustion engines (ICE) into battery-based electric motorcycles. Several conversion components are stipulated in the regulation, including batteries, battery management systems, DC to DC converters, electric motors, controllers/inverters, battery charging inlets, and other supporting equipment [4].

The regulation on electric motorcycle conversion provides people with the option to extend the lifespan of ICE motorcycles, contributing to the reduction of carbon gas emissions and air pollution. Moreover, if the usage of ICE motorcycles surpasses the average product lifespan, the motorcycle's performance will deteriorate, resulting in increased carbon emissions that impact the environment [5]. Environmental concerns are connected to the concept of sustainable development, which elucidates the interplay between social, economic, and environmental dimensions within the sustainable development framework, aiming to fulfill human interests in attaining prosperity [6].

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Converting ICE motorcycles into electric motorcycles can be conducted at a conversion workshop. However, the availability of these conversion workshops still needs to be increased in Indonesia [7]. Therefore, conducting research on the feasibility of investing in electric motorcycle conversion in Indonesia is essential. The analysis of the feasibility study is based on the sustainability pillar, encompassing economic, environmental, and social aspects [8].

This research aims to essentially implement the concept of sustainability in analyzing a feasibility study to positively impact human life. Previous feasibility studies have included the activation strategy for electric taxis in Jakarta [9], New York City [10], Rwanda [11], and Seoul [12]. Additionally, a feasibility analysis was conducted for an electric vehicle charging station at an International Airport in Chattogram, Bangladesh [13]. Based on the actual revenues and expenses of electric taxis in Seoul, this study assessed the potential implementation of electric taxis through a feasibility study and an environmental assessment, utilizing the Net Present Value and emission coefficient calculation methods [12].

Furthermore, the research on the deployment of electric taxis in Seoul examines the economic viability of replacing the current fossil fuel taxis in Seoul with electric vehicle taxis through a cost-benefit analysis. The parameters utilized in this research employ the cost-benefit analysis method for such a transition. The costs associated with purchasing vehicles, as well as building and maintaining charging infrastructure, are evaluated based on market prices and the characteristics of taxi transportation in Seoul. On the benefit side, the preventable environmental costs stemming from reduced air pollution and greenhouse gas emissions are assessed [14].

Moreover, research determined the feasibility of implementing an electric vehicle system in New York City with a high population density. Models are constructed and generated to simulate driver changes and examine system-level consequences of EVs on driver behavior, and the viability of integrating EVs in an urban context is heavily dependent on three parameters: vehicle range, charging location, and charging time [15].

Other research is related to the sustainable impact of implementing electric taxis in Indonesia using the cost-benefit analysis method. The parameters used in the cost-benefit analysis method include the Average Rate of Return, Net Present Value (NPV), Profitability Index (PI), and Internal Rate of Return (IRR) for both conventional taxis and electric taxis. Meanwhile, the social aspect is measured using parameters such as fuel price, fuel consumption, and distance traveled. In addition, the environmental aspect is assessed by calculating the emissions of hazardous pollutants produced by motorized vehicles [9].

Based on several previous studies, no research has discussed the feasibility of the electric conversion motorcycle business to support the accelerated transition to electric vehicles. This study was conducted to evaluate the potential for implementing convertible electric motorcycles through feasibility studies, analyzing social impacts, and assessing environmental aspects to measure sustainability in Indonesia.

2. Material and method

This research evaluates the sustainability impact of converted electric motorcycles in Indonesia. It is hoped that this research can assist the Indonesian government in reducing carbon emissions from ICE motorcycles. The research discusses the conversion of ICE motorcycles into electric motorbikes from a sustainability perspective, evaluating sustainability across economic, environmental, and social dimensions.

This research has converted an ICE motorcycle into an electric motorcycle. The conversion of ICE motorcycles into electric motorcycles has been carried out as shown in Fig. 1. The electric motorcycle conversion process involves replacing the internal combustion engine with a BLDC motor, controller, and battery.

Primary data is obtained from the conversion of ICE motorcycles into electric motorbikes. Several components need to be purchased for the electrical system and frame components. Meanwhile, the mounting and shaft components are manufactured and designed through a manufacturing process. As for the charger and battery swap components, it is assumed that they are acquired through leasing. According to the government's program, buying an electric motorcycle can be more cost-effective since it does not include a battery and only requires payment for leasing.

Secondary data was obtained from literature studies, previous research, and sources from internet websites. Some of the parameters and assumptions set in this study are listed in Table 1.

Figure 1. Electric conversion motorcycle

Table 1.
Parameters and assumptions

No	Parameter	Value	Source
1	Investment Planning Horizon	5 Year	Estimate if the conversion is mature
2	Minimum Attractive Rate of Return	4.25 %	Bank Indonesia
3	Demand of Electric Conversion Motorcycle	30 unit of month	CNN Indonesia
4	Value-added tax	10 %	Directorate General of Taxation
5	Selling Price of Electric Conversion Motorcycle	IDR 15,000,000	PLN
6	ICE Motorcycles: Honda Beat 110 CC Year 2013	IDR 8,200,000	Purchase Receipt

Table 2.
The investment cost of designing a conversion workshop

Item	Amount	Unit of Measure (UoM)	Cost per unit		Total cost		Source
Fixed Cost							
Rent a building	1	units/year	IDR	45,000,000	IDR	315,000,000	Building rental website
Raw Material Shelf	2	units	IDR	1,800,000	IDR	3,600,000	
Showcase	1	units	IDR	2,500,000	IDR	2,500,000	
Chair	1	units	IDR	1,250,000	IDR	1,250,000	Online shop website
Store name board	1	units	IDR	2,000,000	IDR	2,000,000	
Nut and Bolt Rack	5	units	IDR	670,000	IDR	3,350,000	
Total Fixed Costs					IDR	327,700,000	
Business Support Equipment							
Office stationery	1	set	IDR	300,000	IDR	300,000	
Dispensers	1	units	IDR	870,000	IDR	870,000	
Fan	2	units	IDR	250,000	IDR	500,000	Online shop website
Printer	1	units	IDR	2,000,000	IDR	2,000,000	
First aid kit	1	set	IDR	200,000	IDR	200,000	
Laptop	1	units	IDR	6,500,000	IDR	6,500,000	
Total Cost of Business Support Equipment					IDR	10,370,000	
The Investment Cost of Designing a Conversion Workshop					IDR	338,070,000	

Economic aspects are measured by calculating the Net Present Value (NPV) and Payback Period (PP) [16], [17]. NPV represents the difference between the current value of cash inflows and the current value of cash outflows at a specific time. In general, NPV is a method that elucidates the present value of net income and cash flows [16]. The formula for calculating NPV is as follows [18]:

$$NPV = I_0 + A\left(\frac{P}{A}, i\%, N\right) \tag{1}$$

where NPV denotes net present value, I_0 denotes initial investment, A denotes end of period cash flow, P denotes present sum of money, $i\%$ denotes effective interest rate per interest period, and N denotes number of compounding (interest) periods.

The payback period is the length of time it takes to recover the costs of an investment or the length of time it takes for an investor to break even. The formula for calculating PP is as follows [17]:

$$\text{PP} = \frac{\text{initial investment}}{\text{net cash flow}} \tag{2}$$

Environmental aspects are assessed by comparing chemical substances as pollutants produced by ICE motorcycles and converted electric motorcycles [19]. The social aspect entails reviewing the impacts that would arise if converted electric motorcycles were produced on a large scale from the stakeholders' perspective, including the government, consumers, small and medium enterprises, and state-owned companies.

The disadvantage of using convertible electric motorcycles in Indonesia is that consumers heavily rely on batteries, and charging stations are not widely available in Indonesia [20]. Furthermore, there are a limited number of workshops available for electric motorbike conversions in Indonesia [7]. Consequently, this research will assess the economic, environmental, and social aspects of establishing a conversion electric motorcycle industry in Indonesia.

3. Results and discussions

Electric Conversion Motorcycles in Indonesia are the focus of this research. The objective of assessing the economic feasibility is to develop a financial model by determining the financial break-even point period resulting from business development.

First, expenditures and financial assumptions are identified. Subsequently, an investment feasibility analysis is conducted using the NPV and PP methods. Based on the calculation of total investment costs, the investment costs for designing a conversion workshop amount to IDR 338,070,000, with specific details available in Table 2.

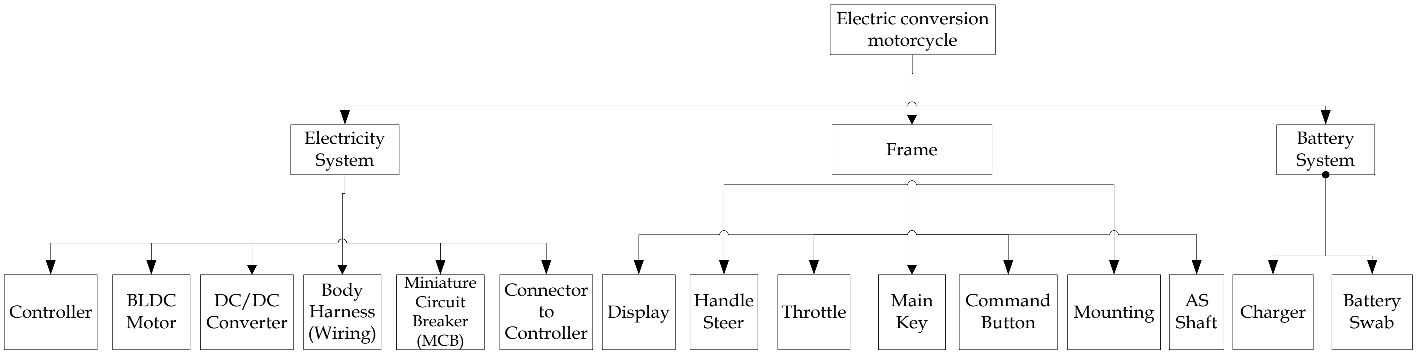

Figure 2. Product structure

Table 3.
Bill of material electric conversion motorcycles

No	Part name	Quantity	UoM	Decision
	Electricity System			
1	Controller	1	unit	Buy
2	BLDC Motor	1	unit	Buy
3	DC/DC Converter	1	unit	Buy
4	Body Harness (Wiring)	1	unit	Buy
5	MCB	1	unit	Buy
6	Connector to Controller	1	unit	Buy
	Frame			
7	Display	1	unit	Buy
8	Handle Steer	1	unit	Buy
9	Throttle	1	unit	Buy
10	Command Button	1	unit	Buy
11	Main Key	1	unit	Buy
12	Mounting	1	unit	Make
13	AS Shaft	1	unit	Make
	Battery System			
14	Charger	1	unit	Lease
15	Battery Swab	1	unit	lease

Table 4.
Cost of production

Type of Cost	Value
Fixed Cost	IDR 14,605,500
Variable Cost	IDR 3,744,091,200
Cost of production per year	IDR 3,758,696,700
Cost of production per unit	IDR 10,440,824

Each type of motor to be converted has distinct electrical system specifications. In this study, the motorcycles targeted for conversion from ICE to electric motorcycles are the 2013 Honda Beat 110 CC models. The product structure of this conversion electric motor is depicted in Fig. 2, and the bill of materials for electric conversion motorcycles is detailed in Table 3. Product costs are determined based on fixed costs and variable costs. Fixed costs encompass the fixed factory overhead costs, while variable costs comprise raw material expenses and factory overhead costs.

The cost calculation in Table 4 represents a one-year production calculation. Additionally, the annual cash flow for five years will be computed in Fig. 3. The NPV in Table 5 is a method that calculates the difference, using Eq. (1), between the present value of net cash receipts in the future.

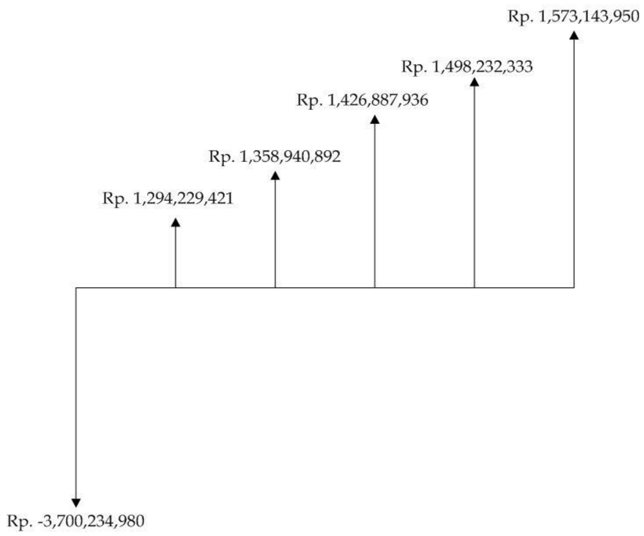

Figure 3. Cashflow

Based on Table 5, the NPV value is IDR 2,590,165,909 for an investment of IDR 338,070,000. Following the feasibility criteria, where the NPV value is greater than IDR 0, it can be concluded that the investment in the convertible electric motorcycle business unit meets the NPV feasibility criteria.

Table 5.
NPV calculation

Year	Inflow	Outflow	Netto	Present Value
0	-	IDR 3,773,302,200	-IDR 3,773,302,200	-IDR 2,647,931,368
1	IDR 5,400,000,000	IDR 3,961,967,310	IDR 1,438,032,690	IDR 1,009,145,747
2	IDR 5,670,000,000	IDR 4,160,065,676	IDR 1,509,934,325	IDR 1,059,603,035
3	IDR 5.953,500,000	IDR 4,368,068,959	IDR 1,585,431,041	IDR 1,112,583,186
4	IDR 6.251,175,000	IDR 4,586,472,407	IDR 1,664,702,593	IDR 1,168,212,346
5	IDR 6,563,733,750	IDR 4,815,796,028	IDR 1,747,937,722	IDR 1,226,622,963
Total NPV				IDR 2,590,165,909

Table 6.
PP calculation

Year	Netto	Investment Difference
1	-	IDR 3,773,302,200
2	IDR 1,438,032,690	IDR 2,335,269,510
3	IDR 1,509,934,325	IDR 825,335,186
4	IDR 1,585,431,041	IDR (760,095,855)
5	IDR 1,664,702,593	IDR (2,424,798,448)
PP	3.2 years (38 months)	

Next, the PP analysis in Table 6 is performed to determine the duration required for the initial investment to be recouped. According to the results of the PP calculations, the initial investment return period is three years and two months.

If, within one month, 30 ICE motorcycles are converted into electric motorcycles, it will reduce the air pollution generated by ICE motorcycles. A single unit of an ICE motorcycle utilizing fossil fuels daily emits various pollutants, including CO (0.088 g/km), HC (0.037 g/km), NOx (0.77 g/km), CO2 (152.972 g/km), and SO2 (0.021 g/km) [11]. The CO2 emissions produced by ICE motorcycles running on fossil fuels over 19,000 km amount to 4,100 kg of CO_2. In contrast, electric vehicles powered by a steam power plant are estimated to generate 1,300 kg of CO_2. However, when employing renewable technology with solar cells, no CO_2 emissions occur. From an environmental perspective, electric conversion motorcycles are considered feasible to be adopted.

Social sustainability involves measuring human well-being, which includes the maintenance or improvement of welfare, security, health, food security, responsibility, and social justice. The conversion of electric vehicles in the transportation sector is deemed to have a significant impact due to its continued use of fossil energy. Furthermore, the conversion of electric vehicles can stimulate Small and Medium Enterprises to establish conversion workshops and supply electric vehicle components. The government will also promote the sustainability of the battery industry in Indonesia since the country possesses the mineral resources required for battery components. Additionally, a state-owned company plays a role in entering the market as a battery swap service provider. The battery swap service involves the exchange of a depleted electric motor battery for a new one. Therefore, from a social perspective, the implementation of electric conversion motorcycles is considered feasible in Indonesia.

4. Conclusions

This study assesses the feasibility of converting electric motorcycles from economic, environmental, and social perspectives. The economic aspect yields favorable results based on the NPV value and a payback period of 3.2 years within an investment planning horizon of 5 years. From an environmental standpoint, electric vehicles can produce CO_2 if the electricity source is derived from a steam power plant. However, when the electricity source is renewable energy, no CO_2 is emitted. The successful transition of electric vehicles to enhance environmental quality, quality of life, and social sustainability necessitates the involvement of the government, state-owned companies, electricity service providers, and Small and Medium Enterprises.

In this research, consumers have the option to extend the lifespan of motorcycles by converting ICE vehicles into electric motorcycles. For further research aimed at expediting the transition from ICE vehicles to electric vehicles in Indonesia, investigations can be conducted to determine the placement of charging stations, develop adoption intention models, create a standardization framework, and establish testing requirements for electric vehicle conversion.

Declaration statement

Febriza Imansuri: **Conceptualization, Methodology, Writing-Original Draft**. Mohammad Wirandi: **Design, Creating product prototypes**. Fredy Sumasto: **Resources, Validation, Formal analysis**. Siti Aisyah: **Resources, Visualization, Investigation**. Al Kautsar Permanaa: **Writing-Review & Editing.**

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Disclosure statement

The author declares that this manuscript is free from conflict of interest and is processed by applicable journal provisions and policies to avoid deviations from publication ethics in various forms.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article or its supplementary materials.

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