Comparative Analysis of Combustion and Electric Motorcycle as an Alternative Online-Based Transportation in Indonesia

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Abstract

Due to demand for Indonesia to minimize pollution effect from transportation modes, the use of electric vehicle especially electric motorcycle is expected to reduce pollution to the environment in operational of online based transportation. For this reason, online based transportation needs information about how the electric motorcycle will reduce emissions and the impact on operational activity related to cost, quality and maintenance. This paper shows that relative to conventional motorcycles, electric motorcycles have more capital and operational cost than the conventional motorcycle, but electric motorcycle has better values on specification, energy consume, energy cost, carbon emission, purchase cost, and tax that give benefit to online-based transportation to accelerate the use of electric motorcycle in online-based transportation.

Keywords
Electric Motorcycle, Conventional Motorcycle, Carbon Emission, Energy Consumption, and Online-Based Transportation

1. Introduction

The demand for electric motorcycle is rising in Indonesia due to increased traffic congestion (Chong et al. 2018). Electric motorcycles are preferred by the Indonesian over other electric vehicles modes and other traditional ways of transportation. Electric motorcycle is an environmentally friendly transportation mode compared to the conventional motorcycle. According to the Ministry of Energy and Mineral Resources (ESDM), more electric motorcycle will be used in Indonesia in the next few years. Electric motorcycle production in the nation is projected to reach 1.34 million units in 2021. The quantity has grown to a maximum of 11.8 million units, which nearly achieves the 13 million electric motorcycles target in 2030 (Rizaty 2022).

Since electric motorcycle is more environmentally friendly for its operational use, online-based transportation company who has operate more than 2.5 million drivers in Indonesia, plan and implement little by little the conversion of conventional motorcycle in their operation to use the electric motorcycle. However, to implement this plan on a large scale, it is necessary to carry out further analysis related to the comparison of the use of electric motorbikes and conventional motorbikes in online based transportation activities, so that the implementation of changes in the type of vehicle does not only have a positive impact on the environment but still pays attention to aspects of efficiency and effectiveness of operations. This paper will discuss the comparison of energy consumption and carbon emission between conventional and electric motorcycles in online-based transportation.

1.1 Objectives
This study aims to analyze and compare energy consumption, carbon emission, maintenance cost, tax, between conventional and electric motorcycles in online based transportation.

2. Literature Review
2.1 Motorcycle use in Indonesia
Motorcycle has been an important transportation in Indonesia. It is a cheaper alternative compared to buying a car, and for most people it is easier to use and ideal transportation. As one of the cities with worst traffic in the world, Indonesian often opt to travel with motorcycle to travel to a destination. In big cities such as Jakarta, hailing rides not only happen to taxis but also for motorcycles, or as they called by *Ojek*. *Ojek* drivers use conventional motorcycles for their operational activity to help transport people from one place to another.

Along with the development of clean energy, electric motorcycles are also being developed to support this program. The number of electric motorcycles in Indonesia is estimated at 1.34 million units in 2021 (Carranza et al. 2022). This number is projected to increase to 13 million units in 2030 (Rizaty 2022). Electric motorcycles are increasingly in demand in Indonesia because of apart from being environmentally friendly, the price is also affordable for most people in Indonesia (Chang et al. 2022; Chong et al. 2018). Especially with the congested road in big cities in Indonesia, electric motorcycles have the potential to develop than electric cars and other conventional transportation.

2.2 Online-Based Transportation
While USA have Lyft and Uber as online-based Transportation, Indonesia have Go-Jek and Grab. Unlike Lyft and Uber, which only have cars to order via an application, Go-Jek and Grab have motorcycle and car options in their application. Go-Jek and Grab are companies that provide motorcycles and cars taxi services using online applications and can serve anyone who needs that service (Udiana and Yuliarmi 2022). Besides being able to take someone to their destination, Go-Jek and Grab also provide ordering services for goods, ordering foods, shopping, and so on. The number of online based transportation drivers in Indonesia is estimated 4 million (Mallo and Nugroho 2021).

2.3 Energy Consumption
A significant increase of energy consumption is taking place in cities along with rapidly expanding populations. Economic development in all sectors contribute to large population and economic growth that leads to improvement in the overall living standard in Indonesia. The results of economic growth are increasing demand on energy consumption. Energy consumption in the transportation sector focused on two parts, private and public transportation (Sukarno et al. 2015). In Indonesia, the public transportations are bus, taxi, *angkot,* and *ojek.*

2.4 Carbon Emissions
Carbon monoxide emissions or CO emissions can be defined as emissions stemming from the burning of fossil fuels and the manufacture of cement; they include carbon dioxide produced during consumption of solid, liquid, and gas fuels as well as gas flaring. Human activities, such as the burning of fossil fuels and changes in land use, release large amounts of CO, causing concentrations in the atmosphere to rise (EPA 2022). The emissions of carbon dioxide have increased by almost 40% compared with pre-Industrial Revolution times. Consequently, because CO absorbs heat, more CO has increased the amount of the heat in for the Earth's heat balance (Jambor and Balogh 2018; Pechout et al. 2022).

3. Methods
The methods that are used for this research are by collecting the secondary data related to energy consumption, carbon emissions, maintenance cost, and tax between conventional vehicles and electric vehicles that is used in online based transportation activities. The vehicles that are used to represent the electric motorcycle that is used in online based transportation in Indonesia is Viar Q1 and the representation of conventional motorcycle in Indonesia is Honda BeAT 110cc PGM-FI.

All the data sourced from interview, National Power Plant, and Ministry Energy and Resource. The data that has been collected is carried out a comparative and feasibility analysis to see whether electric motorcycles are better implemented than conventional motorcycle in online based transportation. If there are deficiencies in the

implementation of electric motors in online-based transportation, an analysis and search for alternative solutions will be carried out to solve the existing problems.

4. Data Collection

The authors choose Honda BeAT 110cc PGM-FI as an example of conventional motorcycle, and Viar Q1 that Grab Bike has been using as an electric motorcycle (Astra Honda 2022; Viar 2022; Honda 2022). Below are the details about the product. The collected data related to product comparison adapted from each company website, can be shown in Table 1.

Table 1. Product Comparison Honda BeAT and Viar Q1

BeAT 110cc PGM-FI		**Viar Q1**	
Machine type	4 - Steps, SOHC, ESP	**Motor Type**	Brushless DC Motor 800 Watt
Step Volume	109.5 cc	**Step Volume**	-
Fuel System	Injection (PGM-FI)	**Fuel System**	Electric control system
Transmission Type	Automatic, V-Matic	**Transmission Type**	CVT Automatic transmission
Maximum Power	6.6 Kw (9.0 PS)/7,500 rpm	**Maximum Power**	0.8 kW
Maximum Torque	9.3 N.m (0,95 kgf.m)/5,500 rpm	**Maximum Torque**	100 Nm
Type of Starter	Electric and Kick Starter	**Type of Starter**	Electric
Fuel Tank Capacity	4.2 litre	**Battery Capacity**	2kWH
Maximum Speed	140 km/hour	**Maximum Speed**	60 km/hour

Based on interview, the authors find the energy consumption of each product. Honda BeAT spends 3.5 L for 100 km, while Viar Q1 use 3,3 kWh for 100 km. Energy cost Honda Beat spends Rp 229.37 per 1 km and Viar Q1 energy cost range from Rp 45.07 - Rp 56.65 per 1 km. Table 2 sums the comparison between the two products.

Table 2. Comparison energy consumption and energy cost between electric and gasoline motorcycle

Parameter	**Honda BeAT**	**Unit Conventional**	**Viar Q1**	**Unit Electric**
Energy Consumption	60.6	km/L	30.0	km/kWh
	3.5	L/100 km	3.33	kWh/100km
Energy Cost	10,000.00	Rupiah/L	1,352.00	Rupiah/kWh (min)
			1,699.53	Rupiah/kWh (max)
	229.37	Rupiah/km	45.07	Rupiah/km (min)
			56.65	Rupiah/km (max)

The vehicle emission testing method assesses the content of two hazardous substances, namely carbon monoxide (CO) and hydrocarbons (HC). Based on Governor Regulation Number 31 of 2008 concerning Motor Vehicle Exhaust Emission Thresholds, there are four categories of vehicles, M, N, O, and L. Honda BeAT include in L, motor vehicles less than four wheels, with year of manufacture≥ 2010. Christian writes on National Power Plant website, 1 litre fuel,

it is equal 1.2 kWh of electricity but can produce 2.4 kilograms of carbon emissions. Whereas 1.2 kWh of electricity in the electricity system in Indonesia now, the emission is only around 1.1 CO kg CO_{2E}.

Table 3. Comparison carbon emission between electric and gasoline

Type of Motorcycle	CO	Hydrocarbons (ppm)
Gasoline Motorcycle	4.50%	2,000
Electric Motorcycle	2.06%	916

Table 4. Total Cost Comparison

Cash					
Parameter	**Viar Q1**	**Unit Electric**	**Parameter**	**Honda BeAT**	**Unit Conventional**
Cost of Ownership	18,950,000	Rp/unit	Cost of Ownership	17,720,000	Rp/unit
Electricity Rate	1,700	Rp/kWh	Fuel Cost	10,000	Rp/L
Distance when Full Battery/day	120	km/day	Distance/day	120	km/day
Battery Capacity (A)	2	kWh	Fuel Tank Capacity	3.5	L
Total Capital Expenditure	**18,950,000**	**Rp/unit**	**Total Capital Expenditure**	**17,720,000**	**Rp/unit**
Total Operational Expenditure	**204,000**	**Rp/month**	**Total Operational Expenditure**	**1,028,571**	**Rp/month**

Table 5 . Rent cost comparison

Battery Rent		
Parameter	**Viar Q1**	**Unit Electric**
Cost of rental w/o battery	12,450,000	Rp/unit
Electricity Rate	1,700	Rp/kWh
Distance when full battery/day	120	km/day
Battery capacity (A)	2	kWh
Battery charging cost	204,000	Rp
Monthly rent cost	276,089	Rp/month
Total Capital Expenditure	**12,726,089**	**Rp/unit**
Total Operational Expenditure	**480,089**	**Rp/month**

Calculation tax between Viar Q1 and Honda BeAT, based on One-stop Administration Services Office *(Samsat PKB*) and Minister of Internal Affairs Regulation No. 82 Year 2022 (KARNAVIAN 2022). Resale value information can get from *Samsat PKB* website. Based on the regulation, weight coefficient for motorcycle is 1 and for electric motorcycle tax 10% from total motorcycle tax.

Table 6. Comparison Tax between Honda BeAT and Viar Q1

Variable	Viar Q1	Honda BeAT
Resale Value	11.900.000	12.100.000
Rate Tax	2%	2%
Weight Coefficient	1	1
Total	**23.800**	**242.000**

5. Results and Discussion

Based on the Table 1 shows the comparison between conventional and electric motorcycle. It shows that conventional motorcycles have more complex components to run the motorcycle compared to the electric one (Idaho National Laboratory 2013). This could lead to more component replacement during the maintenance phase. By looking at the maximum speed, conventional motorcycle has more maximum speed than the electric motorcycle, but from the torque

aspects, electric motorcycle has more torque compared to the conventional one. This could give advantage to electric motorcycle, since the traffic in Indonesia is stop and go traffic, so having more torque is more beneficial than having more top speed.

Based on Table 2 shows that conventional motorcycle has more durability in fuel consumption which conventional motorcycle can go farther using 1 liter of fuel than electric motorcycle using 1 kWH. But based on the cost, electric motorcycle has less cost compared to conventional motorcycle due to the fuel cost for the conventional motorcycle.

Based on Table 3 shows the comparison of carbon emission for conventional motorcycle and electric motorcycle. Electric motorcycle has less 2% carbon emissions than the conventional motorcycle and have a significant hydrocarbons emission than the conventional motorcycle.

The results of calculation of capital and operational expenditure of conventional and electric motorcycle on Table 4, shows that purchasing electric motorcycle cost more than conventional motorcycle, but operational expenditure electric motorcycle less than conventional motorcycle. Another option is to purchase an electric motorcycle without battery and rent the battery on Table 5.

Total capital expenditure costs less a lot than to purchase electric motorcycle, but the operational expenditure is twice as much as to purchase electric motorcycle along with battery. Based on the comparison tax between conventional and electric motorcycle on Table 6, electric motorcycle has less cost on tax due to Minister of Internal Affairs Regulation No. 82 Year 2022, which electric motorcycle only pay 10% of total tax to boost the use of electric motorcycle in Indonesia.

6. Conclusion

Electric motorcycle may cost more on total capital expenditure or total operational expenditure, with low production on carbon emissions. While conventional motorcycle cost more on several points, such as total capital expenditure, energy cost, and produce carbon emissions. It can be concluded that electric motorcycle has better values on specification, energy consume, energy cost, carbon emission, purchase cost, and tax. But there are still room for improvement for the regulation and the production of electric motorcycle in Indonesia to compress the cost of capital expenditure or operational expenditure to accelerate the adoption of electric motorcycle in online-based transportation.

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