

ASSESSING THE PUBLIC PERCEPTION AND TARGETED IMPLEMENTATION OF ELECTRIC MOTORCYCLES IN DENPASAR CITY RELATED TO EMISSION REDUCTION

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ABSTRACT

Using an electric motorcycles can contribute to decreasing emissions in the transportation sector. Government policies and various socialization programs have supported the development of electric vehicles. This research was conducted to determine the public perception and implementation of electric motorcycles in Denpasar City. The public perception was obtained through questionnaires and in-depth interviews with related key persons. The statistical analysis of the questionnaire indicated a good category with a score of 3.43. The level of community acceptance was influenced by quieter and environmentally friendly technology, electricity tax subsidies, and lower electric fuel costs. The interview with community and government representatives reinforced the public acceptance finding affected by the intensive public outreach program and a vehicle installment payment scheme. As the result, The implementation target was rated optimistic, with a potential CO₂ emission reduction of up to 32,641 tons/year in 2026. All the efforts to implement electric motorcycles in Denpasar City by the governments have met the requirements to achieve acceptance of perceptions in the people of Denpasar City. This thing's very important to reaching out the scenario of reducing CO₂ emissions by 2026. In addition, it is important to have a more study regarding to the sustainability of the electric motorcycles ecosystem, such as the availability of data sources update from related agencies that show efforts to improve infrastructure by producers, the number of charging station and selling stations, as well as opportunities for domestic production and incentive policies.

Keywords: Electric Motorcycles; Emission; Implementation Targets; Level of Acceptance; Public Perception

1. INTRODUCTION

The drastic decline in air quality caused by the transportation sector in Indonesia deserves special attention (RCC UI Sustainable Solution, 2017). In 2015, Indonesia was the fourth largest emitter in the world (World Research Institute,

2015). For this reason, Indonesia must take mitigation actions on climate change drastically. According to projections by The Climate Action Tracker, Indonesia's total emissions are equivalent to 3.75 - 4% of total global emissions in 2030. To align with 1.5°C, the proportion of low-carbon fuels in the transportation fuel mix must increase to around 60% by 2050 (Dunne,

2019). The Integrated Vehicular Emissions Reduction Strategy (IVERS) states that many vehicle manufacturers are trying to create strategies to improve the technology and efficiency of the vehicle's internal combustion engine concerning fuel consumption and exhaust emissions. However, these efforts still cannot significantly change emissions' contribution to the surrounding air. Therefore, other types of technology proven to reduce emissions significantly are needed (Ziegler and Abdelkafi, 2022). The issue of air quality degradation is also responded to by the 2030 Sustainable Development Goals (SDGs). Air quality and climate issues are included as one of the goals in Sustainable Development Goals (SDGs) point 13 (UN-Habitat), which is Achieving Clean and Affordable Energy Through Low Emissions. The demands of the Republic of Indonesia as one of the countries that supports the Sustainable Development Goals (SDGs) program includes 17 essential points in maintaining environmental quality where at point 7, which discusses clean and affordable energy for the future, Indonesia must immediately improve and make massive innovations as a concrete manifestation of Indonesia's support for the sustainability of the SDGs program in Indonesia (Department of Economic and Social Affairs Sustainable Development, 2022). One of the concrete manifestations that Indonesia can achieve is to start providing policies regarding emission limits that apply to vehicles (Sidabutar, 2020, Nur and Kurniawan, 2021.).

Indonesia commits to making efforts to reduce the emission of greenhouse gases and actively prevent climate change. The Paris Agreement positions forests as the key to greenhouse gas reduction efforts. It is due to the ability of forests to absorb greenhouse gases. This position is implied by the provisions of Article 5 of the Paris Agreement, which encourages

state parties to implement and support a framework based on the agreement for activities related to Reducing Emissions from Deforestation and Forest Degradation, conservation, and forest management based on the principle of sustainability (Nur and Kurniawan, 2021). The Regulation of the Government of Indonesia Number 16 of 2016 on the Ratification of the Paris Agreement describes the nine actions of the National Development Priorities outlined in Nawacita, that are national commitments towards low-carbon and climate-resilient development, with adaptation and mitigation of climate change as an integrated and cross-sectoral priority in the National Development agenda. The commitments contained in Nawacita became the basis for preparing Indonesia's First Nationally Determined Contribution (NDC) document submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in November 2016. Indonesia's First NDC describes Indonesia's transition to a low-emission, climate-resilient future (Forestry and Environmental Ministry of Indonesia, 2017).

The government is active in accelerating the implementation of vehicles in Indonesia. One concrete manifestation of the central government is creating a policy or regulation that can regulate the implementation of electric vehicles. The policy of Regulation of the Government of Indonesia Number 73 of 2019 emphasizes luxury vehicle taxes, including electric motor vehicles. This regulation is also supported by Regulation of the President of Indonesia Number 55 of 2019 regarding the acceleration of electric vehicles in Indonesia. This regulation is evidence of the government's spirit in implementing electrification in Indonesia. It is also supported by five ministerial regulations, i.e., Regulation of

the Ministry of Energy and Mineral Resources Number 13 of 2020 regarding electric vehicle charging infrastructure, followed by Regulation of the Ministry of Transportation Number 45 of 2020 regarding certain electric motor vehicles, as well as Regulation of the Ministry of Home Affairs Number 8 of 2020 regarding electric vehicle tax regulation, and two ministerial regulations from Ministry of Industry Number 27 of 2020 and Number 28 of 2020 regarding electric battery industry regulations and electric vehicle roadmap in Indonesia. These nine regulations focus on the government's perspective and the electric vehicle industry. Regardless of the existence of the regulations, society still questions the infrastructure and durability of the electric vehicle in Indonesia (Andriani and Yuliasuti, 2013).

Denpasar City is one of the big cities in Indonesia, which is also an area for developing international tourism in Bali. Air pollution has been one of issues in the area due to its massive development as tourism destination (Sugiarta, 2019, Arwini, 2020). Active vehicle data in the Province of Bali in 2021 based on the data of Bali Provincial Revenue Agency, consisting of cars, buses, trucks, motorcycles, and special vehicles, has a total of 4,510,791 of which 63, 32% are motorcycles. This condition occurs in almost all cities, with the largest active vehicles in Denpasar City, with 1,470,570 vehicles and 82.85% motorcycles (Central Statistical Agency of Bali Province, 2023). In connection with the implementation of electric vehicles, the regional government in Bali Province has a policy of providing legal protection for the implementation of vehicle electrification. The Governor of Bali has established Governor Regulation Number 8 of 2007 regarding Environmental Quality Standards and New Criteria for Environmental Damage as a reference in

environmental maintenance in Bali. This Governor Regulation contains emission limits for vehicle exhaust gases that serve as a reference. This is expected to affect the development of electric vehicles, especially motorbikes used by most people in the Denpasar City area. In order to achieve the goal of building the Battery-Based Electric Motor Vehicle as part of the strategy to maintain environmental sustainability in Bali Province, the Bali Provincial Government has set two main measurable targets for a five-year period. These targets consist of (1) the target achievement of the use of Battery-Based Electric Motor Vehicle (KBLBB) for both motorcycles and passenger cars and (2) the target commitment to provide electric bus vehicles that are related to the target for reducing CO₂ emissions (Bali Provincial Transportation Agency, 2022). These targets are built considering the potential user preferences, both tourists and residents, as well as historical data on electric motorcycle ownership in Bali Province. Based on user preferences and interventions that influence the choice of electric motorcycles (Battery-Based Electric Motor Vehicle or Fossil-Fuel Vehicles or KBLBB), three target scenarios are developed: optimistic, moderate, and pessimistic (business as usual). Each scenario represents the probability of purchasing electric motorcycles under certain conditions. The optimistic scenario represents a situation where all-electric motorcycle interventions can be fully implemented, including subsidies for purchase and conversion (including taxes and loan interest), zoning implementation, and infrastructure development. The moderate scenario assumes the implementation of tax subsidies for electric motorcycles and conversion, as well as zoning implementation and infrastructure development. The pessimistic scenario

represents a situation where none of the electric motorcycle interventions can be implemented, so the increase only occurs naturally according to the current situation (business as usual) (Transportation Agency of Bali Province, 2022). By considering the public perception of electric motorbikes in the Denpasar City area, Bali Province, the level of acceptance of the development of this vehicle in the future can be determined. In addition, data on the conditions for implementing electric vehicles can provide an overview of target scenarios that can be achieved. The implementation of electric vehicles can be assessed from the public acceptance level, number of manufacturers, production capacity and Public Electric Vehicle Charging Stations (SPKLU), ownership of certified vehicles, domestic production opportunities related to price reductions, and incentives available to both consumers and manufacturers. For this reason, an assessment of public perceptions and implementation targets is carried out regarding the development of electric motorcycles in the City of Denpasar as an effort to reduce vehicle emissions.

2. METHODOLOGY

The research method used was descriptive research with a mixed-method approach combining quantitative and qualitative methods (Mix-Method). According to Sudaryana and Agusiady (2022), quantitative research emphasizes the analysis of numerical data processed using statistical methods. Principally, the quantitative approach was applied in inferential research (testing hypotheses) and relied on the conclusion of its results on a probability of rejecting the null hypothesis (nil). The quantitative method obtained the significance of differences between groups or relationships among the studied variables.

2.1. Assessment of Public Perception Level of Acceptance

In this analysis, the research method in the first stage used a quantitative method. The research used a quantitative descriptive method to describe the society's perception of electric motorcycle innovation in Denpasar City and the readiness of existing infrastructure provided by private and government sectors. Quantitative data were processed using software of Statistical Package for the Social Sciences (SPSS) tests. The correlation coefficient obtained was then compared with the applicable validation standards. To find the correlation coefficient, the researcher used the Pearson Product-Moment formula according to Sugiyono (2017) as follows:

$$R_{xy} = \frac{n(\sum x_i y_i) - (\sum x_i)(\sum y_i)}{\sqrt{\{n\sum x_i^2 - (\sum x_i)^2\}\{n\sum y_i^2 - (\sum y_i)^2\}}} \quad (1)$$

R_{xy} = The product moment r coefficient;

R = The validity coefficient of the item being sought;

x = The score obtained from the subject in each item;

y = The total score of the instrument;

n = The number of respondents in the instrument test;

$\sum x$ = The sum of the observations of variable x;

$\sum y$ = The sum of the observations of variable y;

$\sum xy$ = The sum of the products of the observations of variable x and variable y;

$\sum x^2$ = The sum of squares of each score of variable X;

$\sum y^2$ = The sum of squares of each score of variable Y

Decision basis:

- 1) If the calculated r-value > the table r-value, the instrument or questionnaire items significantly correlate with the total (considered valid) scores.
- 2) If the calculated r-value < the table r-value, then the instrument or questionnaire items are not significantly correlated with the total scores (considered invalid).

The qualitative method was then conducted using structured questions

with in-depth interview techniques for selected key informants who deeply understood electric vehicle issues in Denpasar City to obtain a different perspective from the respondents who answered the questionnaire using the quantitative method. This study took data samples from three points around Denpasar City, Bali Province. Divided into three locations: North Denpasar, East Denpasar, and South Denpasar. Which is The administration map of the Denpasar City is shown in Figure 1.

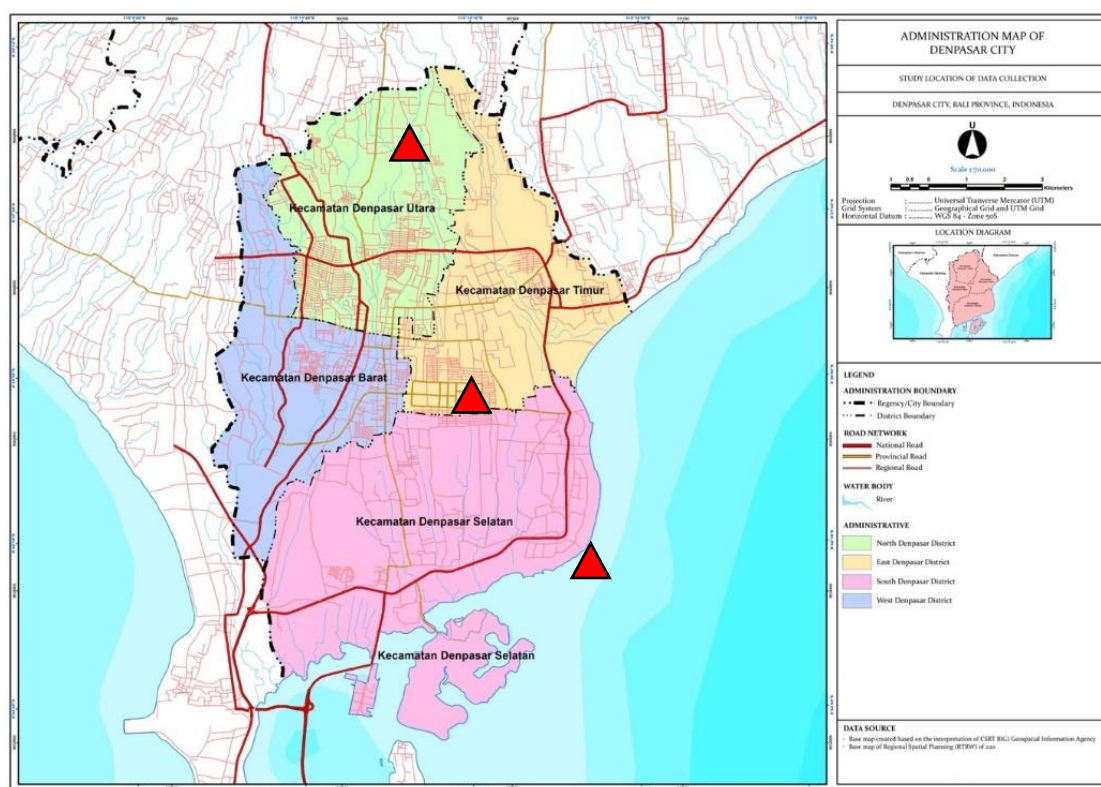


Figure 1
Administration map of the primary data collection of public perception in Denpasar City

2.2. Assessment of Targeted Implementation and the Emission Reduction.

The analysis was conducted by integrating primary data analysis result of the public perception level of acceptance and secondary collected data from related

institutions related to the the application of electric vehicles in Denpasar City, Bali Province, Indonesia, i.e., the number of manufacturers, production capacity, Public Electric Vehicle Charging Stations (SPKLU), certified ownership, opportunities for domestic production, and provision of incentives. Data analysis was

carried out using a qualitative descriptive method, namely through analysis, description, and various conditions and situations from various data collected in the form of interview results or observations regarding the problems studied that occurred in the field (Winartha, 2006). The implementation target was determined based on synthesizing data related to the electric motorcycle development in Denpasar City. There are three classifications of the target referring to the study conducted by the regional government of Transportation Agency of Bali Province, i.e., optimistic, moderate, and pessimistic.

Moreover, calculation of the CO₂ emission was performed considering the base condition as the base data that only take into account the number of conventional or Internal Combustion Engine (ICE) motorcycle and the condition that figure out the implementation of electric motorcycle in optimistic, moderate, and pessimistic scenario. The number of the conventional vehicle is projected according to the data in 2021 published by the Central Agency of Statistics of Bali Province. The number of the electric vehicle is based on the data published by Transportation Agency of Bali Province in Bali Province, where is the number of motorcycles in Denpasar City is assumed about 31.42% of the total motorcycles in Bali Province according to the ratio of the conventional motorcycle in 2021.

The projection of the number of vehicles refers to the geometric method that assumes that the number of vehicles will increase geometrically using a multiple calculation basis, such as the population (Adioetomo and Samosir, 2010). The vehicle growth rate is assumed to be the same for each year. The formula used in the geometry method is as follows:

$$F_n = F_o(1 + r)^t \tag{2}$$

F_n = the projected year number of vehicles;

F_o = the base year's number of vehicles;

r = the vehicle growth rate;

t = the period between projected years

The value of r is calculate using the following equation:

$$r = \frac{\left(\frac{F_n}{F_o}\right)}{t} - 1 \tag{3}$$

Calculation of CO₂ emissions from the specified conditions was carried out using the analysis of emissions from the transport sector with a Tier II approach, where local data is available that can be used. The formula used to measure the total emission in kg/year.km unit refers to the Intergovernmental Panel on Climate Change (IPCC) of 2006 (Nurdjanah, 2015) that takes into account the value of the number of internal combustion engine vehicles, emission factor, and fuel consumption. Hereafter, the CO₂ emission in ton/year unit can be calculated by multiplying the total emission value with the mileage and annual effective operation, as follows:

$$E = n \times EF \times K \times P \times \eta \tag{4}$$

E = Total emissions (kg/year.km);

n = Number of vehicles (unit);

EF = Emission factor (kg/liter);

K = Fuel consumption (liter/km);

P = Mileage (km/year);

η =Annual effective operation (%)

Eventually, the reduction of CO₂ emission was generated based on the subtraction of the base condition and the three different implementation conditions of electric motorcycle in Denpasar City, i.e., optimistic, moderate, and pessimistic.

2.3. Incentives provision for electric vehicles.

An Associate Policy Analyst at the Fiscal Policy Agency of the Ministry of Finance stated that incentives are divided into two broad categories: incentives for consumers and incentives for manufacturers. Several incentives are

given to both consumers and other stakeholders (Institute for Essential Services Reform, 2022). Each group receives incentives from either the central government, local governments, or incentive scheme that applies nationally is described in Figure 3

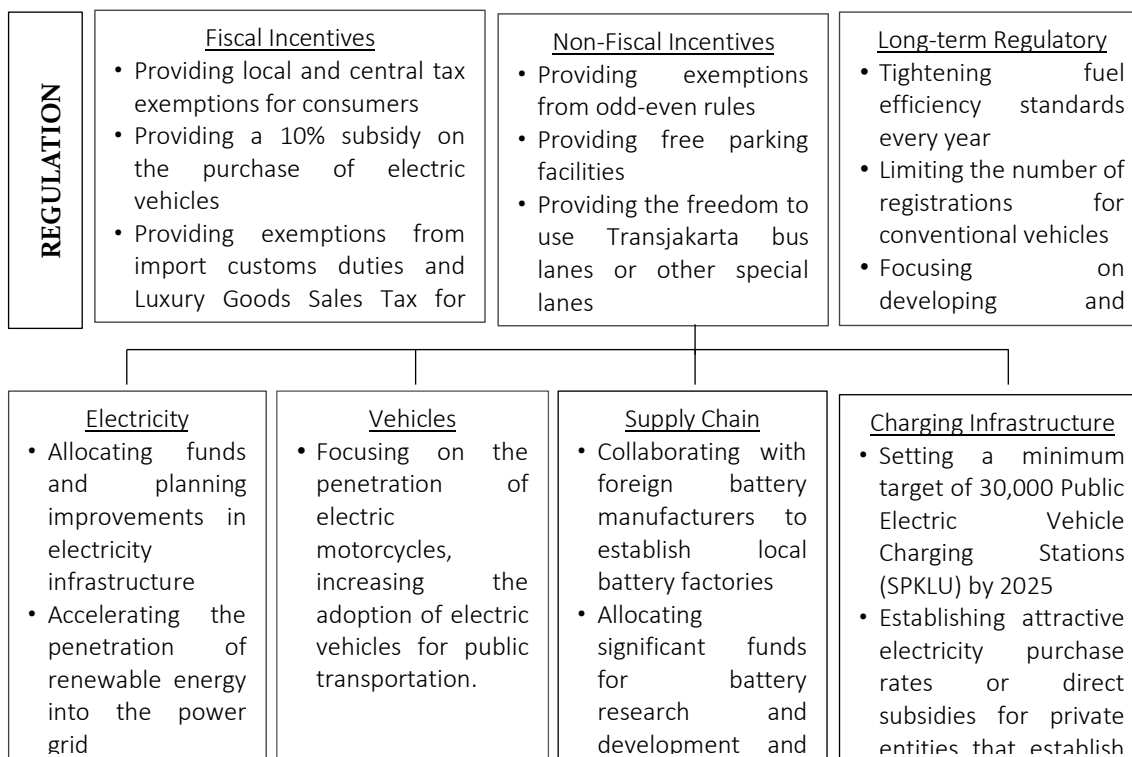


Figure 2
 Government Incentive Scheme
 Source: Institute for Essential Services Reform, 2022

3. RESULTS AND DISCUSSION

3.1 Public Perception of Electric Motorcycle in Denpasar City.

a. Quantitative result of questionnaire.

1) Characteristics of respondents.

The selected characteristics of 50 respondents were 80% male, most of whom live in North Denpasar (50%) and West Denpasar (26%). The respondents were highly educated, with 70% having an undergraduate degree,

and they worked as private employees (64%) and civil servants (27%). Their income ranged from 3 to 7 million rupiahs. 80% of the respondents own a motorcycle, which they have had for some time, while the remaining 20% were interested in owning one but were hindered by the price. In general, the sources of information about electric motorcycles come from electronic media (50%), socialization (30%), and public brochures (20%).

Table 1. Characteristics of Respondents Based on Questionnaire Results

No	Respondent Characteristics	Description
1	Gender	80% male
2	Residential area	dominated by those living in North Denpasar (50%) and West Denpasar (25%)
3	Highest education attainment	70% have a bachelor's degree
4	Occupation	dominated by private employees (64%) and government employees (27%)
5	Monthly income	dominated by people with monthly income between 3 to 7 million rupiahs
6	Vehicle ownership	80% are private vehicle owners
7	Vehicle interest	20% are interested but cannot afford to buy yet
8	Source of vehicle information	from electronic media (50%), socialization (30%), and public space brochures (20%)

2) Validity test of public perception variable.

The public perception was measured using 10 statement items arranged referring to Secinaro et al. (2022) and given to 50 respondents. The results of the questionnaire statements were deemed valid since the significance of the calculated r-value was greater than the table r-value,

which was 0.278 (Pearson’s method), as indicated in Table 2. The result demonstrated that all the statement items given to the 50 respondents were suitable for measuring the public perception variable. The validity test was conducted by calculating the correlation between the indicators and the total score of the variable.

Table 2. Correlation between the Indicators and the Total Score of the Variable

Item	Calculated r-value	Table r-value	Description
1	0,490	0,278	VALID
2	0,567	0,278	VALID
3	0,421	0,278	VALID
4	0,377	0,278	VALID
5	0,493	0,278	VALID
6	0,581	0,278	VALID
7	0,540	0,278	VALID
8	0,310	0,278	VALID
9	0,573	0,278	VALID
10	0,284	0,278	VALID

3) The public perception of the presence of electric motorcycles.

The results of the research on the public perception in Denpasar City about the presence of electric motorcycles, as shown in Table 3, were based on the understanding that subsidies for electricity and taxes on

electric motorcycles were very beneficial to society. Additionally, electric motorcycles were quieter and more environmentally friendly than conventional motorcycles, and the cost of electricity for electric motorcycles was cheaper than gasoline for conventional motorcycles.

Table 3. Recapitulation of Respondents' Responses Regarding Electric Motorcycles

Statement	Frequency						Total Score	Average
	1	2	3	4	5	N		
1 Electric motorcycles are quieter and more environmentally friendly than conventional motorcycles	2	8	11	11	18	50	185	3,7
2 The cost of electricity for electric motorcycles is cheaper than gasoline for conventional motorcycles	4	6	12	14	14	50	184	3,68
3 Electric motorcycles are guaranteed and more practical than conventional motorcycles	4	11	10	13	12	50	168	3,36
4 Electric motorcycles require less maintenance than conventional motorcycles	4	6	13	14	13	50	176	3,52
5 The range of electric motorcycles is sufficient for daily mobility	5	7	15	15	8	50	164	3,28
6 The design of electric motorcycles is a major selling point	2	9	14	16	9	50	171	3,42
7 The purchase and sale prices of electric motorcycles are good	5	11	13	14	7	50	157	3,14
8 The battery recharge system is very fast, practical, and facilitated	3	10	17	11	9	50	163	3,26
9 Electric subsidies and taxes for electric motorcycles are very beneficial for the community	1	5	14	15	15	50	188	3,76
10 Electric motorcycle battery charging stations are sufficient	6	8	15	11	10	50	161	3,22
Total (Public Perception of Electric Motorcycles)							1.717	3,43

Based on the table above, the respondents' assessment of the public perception of electric motorcycles resulted in a total score of 1.717 for the 10 statements, with an average of 3.43, as shown in Figure 3. In classifying the

number of respondents' response scores, the acceptance level of public perception regarding electric motorcycles in Denpasar City was generally in the good category.

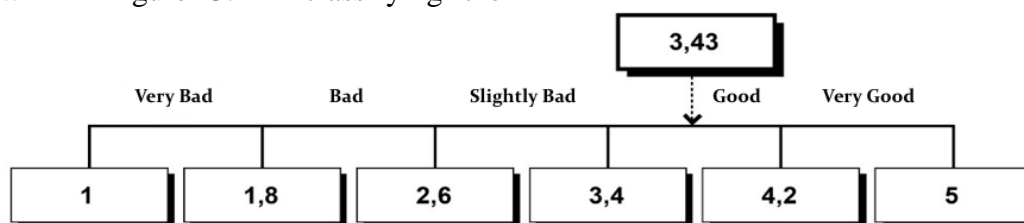


Figure 3. Results of respondents' assessment scores regarding Electric Vehicles

b. Qualitative result of in-depth interview with key person.

Qualitative research was conducted with in-depth interviews about the

perceptions of the society of Denpasar City regarding electric motorcycles given to society in the surrounding area of Denpasar City with several key

informants. The information helps prove the public perception of funding (Shanmugavel et al., 2022). The coordinator of the electric motorcycle community in Denpasar City believed that the society's perception regarding implementing electric motorcycles in Denpasar City is good enough and has been well received in society. The good condition could be seen from the enthusiasm of society in following the socialization of electric motorcycles that is conducted every month. This enthusiasm was also obtained in the increasing growth rate of electric motorcycle purchases in Denpasar City.

Moreover, representatives of Denpasar City's society believed electric motorcycles could change the community's perception of vehicles. In addition to being cheaper in operation, there was convenience in the charging method. In addition, the distance traveled by electric motorcycles was already sufficient to meet transportation needs from their residence from Gianyar Regency to the office around Denpasar City. Electric motorcycles also trained people to be more disciplined in replacing batteries according to predetermined locations.

Representatives of the Civil Service Apparatus (ASN) from the Forestry and Environmental Agency of Bali Province Environment believed that the implementation of electric motorcycles would continue to be carried out by various parties because, whether we like it or not, the electric vehicle trend will be the future of our transportation. The Forestry and Living Environment Department welcomed the growth of electric motorcycles with charging options that were well facilitated by various electric motorcycle manufacturers in Denpasar City.

One representative of the Transportation Department of Bali

Province believed that society's perception regarding the implementation of electric motorcycles has been very good and has begun to be accepted by society. The condition was evident from the socialization that the Transportation Department of Bali Province often conducted around Denpasar. It was also added by the impact of the G20 summit, where the use of electric vehicles was one of the points the government wanted to introduce to the Indonesian people. The ease of converting electric motorcycles was also adequate, with certified workshops to ensure the safety of electric motorcycles for the society of Denpasar City.

The qualitative research results found that the people of Denpasar City were generally able to accept the implementation of electric motorcycles in Denpasar City because there was frequent socialization about electric motorcycles held by many parties every week. In addition, the role of the banking sector in serving payment schemes in the form of installments for purchasing electric motorcycles helped the implementation of electric motorcycles in Denpasar City to be faster. The community of Denpasar City has been addressing its concerns about electric motorcycles.

3.2 Targeted Implementation of Electric Motorcycles in Denpasar City.

The electric vehicle industry in Indonesia has been continuously pushed for the acceleration of electrification by the central government. It can be seen from the target growth of electric vehicles in both assembly industries and infrastructure development and registration. Based on the Directorate General of Metal, Machinery, Transportation Equipment, and Electronics Industry of Indonesia Ministry of Industry in 2022, the government's

optimism in implementing electric vehicles, especially electric cars and electric motorcycles, is very visible from the growth targets set by the government until 2035. The sale of electric motorcycles in 2035 is targeted to reach 3.22 million units. This is accompanied by an increase in the number of electric motorcycle manufacturers by 35 companies with a total production capacity of 1.04 million units per year, bringing a total investment of IDR 0.45 trillion. The growth in the number of Public Electric Vehicle Charging Stations (SPKLU) from 572 units in 2021 is targeted to reach 31,859 units in 2030 (UN Department of Economic and Social Affairs Sustainable Development, 2022).

Based on information from electric vehicle providers in Bali area, electric bicycles and electric motorcycles are the most widely available types of vehicles in the area of Bali, including Denpasar City, both in terms of production, supply, conversion, and service. Providers of electric motorcycles are divided into three main types. The first type is pure distributors who only sell electric motorcycles without any other business activities. The second type is those who sell and provide other services, such as rental, service, tourism tours, and electric motorcycle conversion. The last type is electric motorcycle assemblers that produce, sell, and provide service (Transportation Agency of Bali Province, 2022).

a. Electric motorcycle manufacturers.

Public acceptance of electric motorcycles has increased the competition in the electric motorcycle market. The increasing number of manufacturers provides more options for society regarding models, price range, and quality. Table 4 indicated the detailed list of manufacturers, their products, and their business activities in Denpasar City.

b. Infrastructure of electric vehicle charging or battery swap stations.

Bali is one of the selected regions for the government's focus on the initial implementation of electric vehicles in Indonesia. The government's seriousness can be seen from the enthusiasm for using electric vehicles in the G20 Summit as a formal implementation of electric vehicles in Indonesia. (Suara, 2022). In addition, the government's seriousness in advancing the infrastructure of electric vehicles in Bali area continues to be developed. In order to welcome the G20 Summit in Bali, the Indonesian government has prepared three types of charging points, namely Fast Charging of Public Electric Vehicle Charging Stations (SPKLU), Ultra Fast Charging of SPKLU, and Home Charging. As of August 2022, there are 21 units of Fast Charging of SPKLU, 70 units of Ultra Fast Charging of SPKLU, and 200 units of Home Charging facilities available in Bali. (Indonesia State Electricity Corporation, 2022).

c. Sales of electric motorcycles.

The increasing intensity of socialization by various parties regarding electric vehicles in society shows quite positive results. This can be seen from the high societal interest in electric vehicles registered in the Bali Province, especially for electric motorcycles, which reached 94%, and electric cars reached 6%. This is related to the price and variety of electric motorcycles, which are more abundant and cheaper than electric cars. The development of electric motorcycle sales in Bali Province shows a significant number. The number of electric motorcycle sales in Bali Province from January to June 2022 has reached 802 units (Transportation Agency of Bali Province, 2022).

Table 4. Electric Vehicle Manufacturers and Their Business Activities in Denpasar City

No	Manufacturer's Name	Product	Business Activities
1.	Gesits	Electric motorcycle	Production, Dealership, Service
2.	United Motor	Electric motorcycle	Production, Dealership, Service
3.	Selis	Electric scooter, Electric moped, Electric bicycle, Electric motorcycle, Electric three-wheel car	Production, Dealership, Service
4.	Viar	Electric moped, Electric bicycle, Electric motorcycle	Production, Dealership, Service
5.	Electric Wheel	Electric moped, Electric motorcycle	Conversion, Dealership, Service
6.	Melotronic	Electric scooter, Electric bicycle, Electric unicycle, Electric go-kart, Electric segway, Electric skateboard	Dealership
7.	Skutis Corporation	Electric scooter	Production, Rental, Dealership, Service, Tour
8.	Pure Electra	Electric scooter, Electric bicycle, Electric motorcycle	Rental, Tour, Service, Conversion

Source: Transportation Agency of Bali Province, 2022

d. Domestic production opportunities for electric vehicles.

According to the Institute for Essential Services Reform (IESR) Special Report on Electric Vehicles in 2022, the price of electric vehicles in Indonesia is highly influenced by the process of importing raw materials from main manufacturers, most of which are located outside Indonesia. The condition certainly makes the basic price of the vehicle very high due to the additional costs for shipping and administration that take time and money. Therefore, President Ir. Joko Widodo has opened up a great opportunity for electric vehicle manufacturers to open production in Indonesia, of course, with local labor and an agreed Domestic Component Level. This makes the price of electric vehicles can be suppressed and supports the acceleration of electric

vehicle electrification in Indonesia (Institute for Essential Services Reform, 2022). Electric vehicles in Indonesia are classified based on price into three categories, i.e., lower medium, medium, and luxury.

e. Assessment flow of the electric motorcycle implementation

Considering the public perception level of acceptance and related agencies' secondary data that demonstrated an increase in manufacturers, infrastructures of charging stations, and sales, as well as domestic production opportunities and incentives provision, the implementation of electric vehicles, especially electric motorcycles, was considered following the optimistic scenario. The following diagram in Figure 4 illustrated the assessment flow of the electric motorcycle implementation.

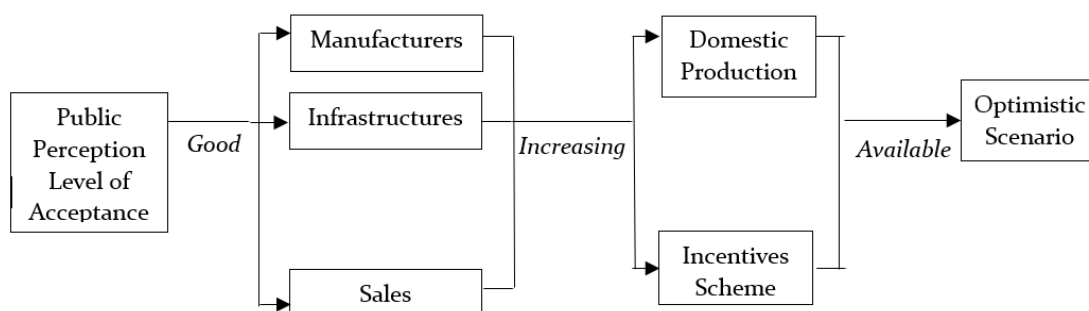


Figure 4.

Determination of Targeted Implementation of Electric Motorcycles in Denpasar City

Based on the targeted implementation scenarios of the electric vehicles, the CO₂ emission reduction was examined by utilizing the parameters mentioned in Table 5. The number of vehicles according to the projection result represents in Table 6. Eventually, the CO₂ emission and the emission reduction of the optimistic, moderate and pessimistic scenarios is defined in Table 7. According to the target implementation assessment, the target is considered to be in an optimistic category. The estimation revealed that the optimistic scenario is able to contribute to the CO₂ emission of about 32,641 tons/year. The estimation considered that motorcycles in the condition consist of a projected number of

petrol motorcycles and the projected number of electric motorcycles with 1,222,874 units and 90,199 units, respectively. The other scenarios have a lower ratio of projected petrol and electric motorcycles, resulting in less emission reduction than the optimistic scenario. Therefore, the optimistic condition is the most appropriate for emission reduction. Further studies engaging various development scenarios and other air pollutants with local impacts, i.e. carbon monoxide (CO), nitrogen oxides (NO_x), hydrocarbon (HC), sulfur dioxide (SO₂), and particulate matter (PM₁₀), are expected to acquire detailed examinations of emission reductions.

Table 5. Parameters for CO₂ Emission Calculation of Motorcycles

Parameters	Unit	Petrol (Premium) Motorcycle	Electrical Motorcycles
CO ₂ Emission Factor	kg/liter	2.59786*	0**
Specific Energy (Fuel) Consumption (K)**	liter/km	0.031	0.010
Mileage (P)**	km/year	5000	5000
Annual Efective Operation (η)**	%	0.8915	89.15

Source: *) Nurdjanah, 2015; **) Fitriana et al, 2020

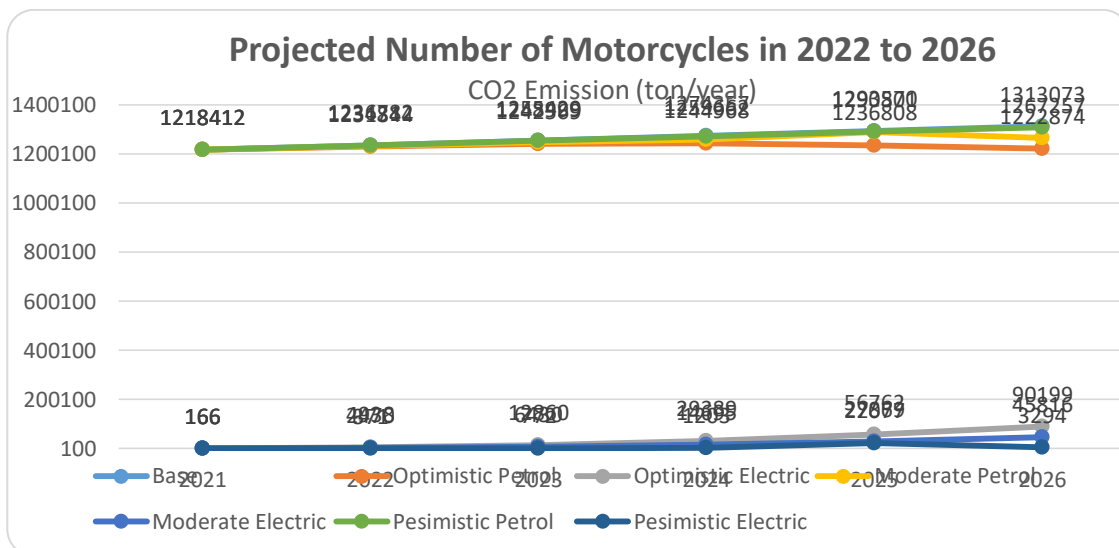


Figure 5.
Projected Number of Motorcycles in 2022 to 2026

The graph above illustrates the significant difference in projections between fossil fuel vehicles and electric vehicles over the period from 2021 to 2026. It highlights the trends and shifts in the adoption of these two types of

vehicles, emphasizing the increasing rise of electric vehicles. The data suggests a growing transition towards more sustainable transportation options as the years progress, with a marked decline in fossil fuel vehicle projections.

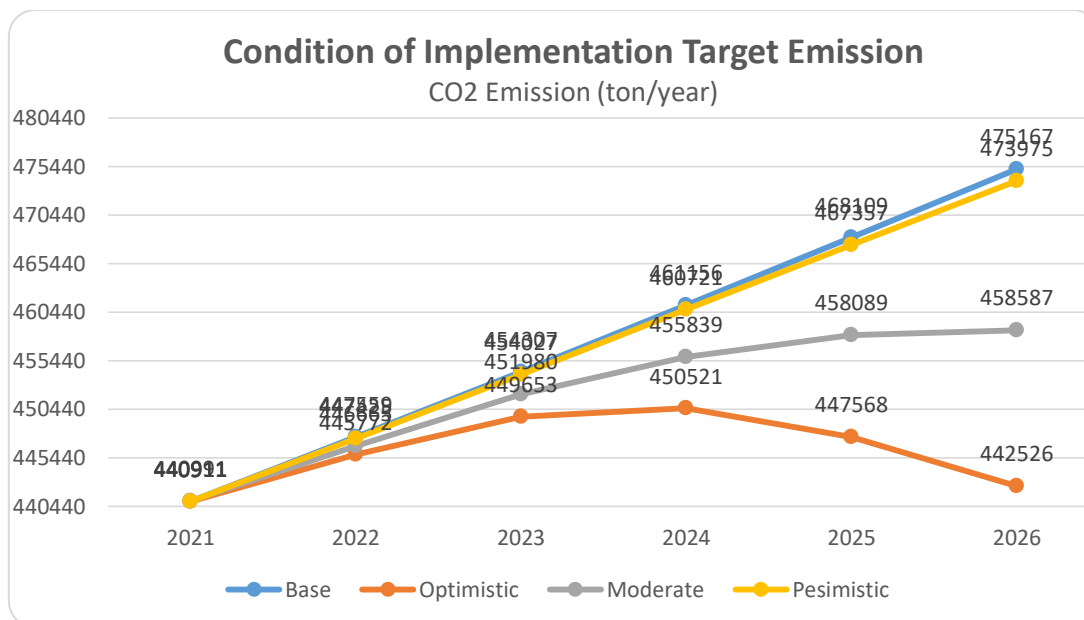


Figure 6.
CO₂ Emission and the Reduction for each Implementation Target

The data above shows the progress of the emission reduction targets, calculated in CO₂ per year. It is divided into four

scenarios: base, optimistic, moderate, and pessimistic. These scenarios illustrate different potential outcomes based on

varying levels of commitment and action goals.
towards achieving the emission reduction

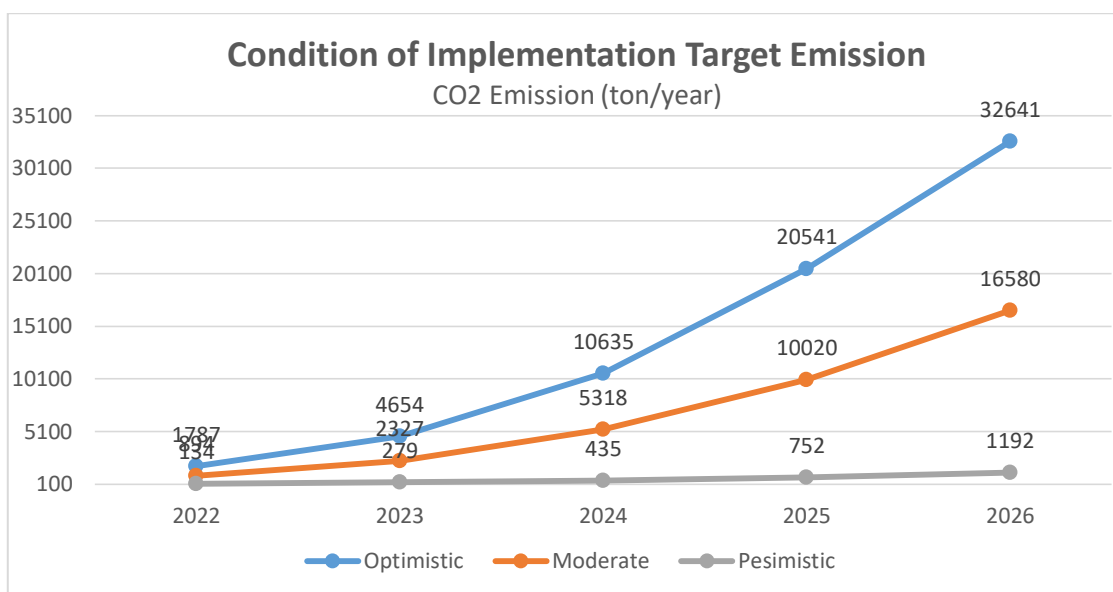


Figure 7.
The Reduction Scenarios related to CO₂ Emission and the Reduction

The regional policies in Bali Province, i.e., Regulation of the Government of Bali Province Number 9 of 2020 on the General Energy Plan for the Bali Province in 2020-2050, Regulation of the Governor of Bali Province Number 28 of 2019 on the Reduction or Elimination of Administrative Sanctions in the Form of Interest and Fines Against Motor Vehicle Taxes and Transfer Fees for Motorized Vehicles, Regulation of the Governor of Bali Province Number 48 of 2019 on the using Battery-Based Electric Motorized Vehicles, and Regulation of the Governor of Bali Province Number 1 of 2017 on the Environmental Protection And Management, play an essential role in supporting the implementation target.

Moreover, electric vehicle charging stations and battery swap stations must be built taking into account the location projection of movements of the electric vehicle and potential locations for the building of SPKLU, Public Electric Charging Station (SPLU), and Public

Electric Vehicle Battery Swap Station (SPBKLU) in Bali Province. The projection of Battery-Based Electric Motor Vehicle (KBLBB) movements and potential locations of KBLBB have been established by Transportation Agency of Bali Province using an analysis of Bali's economic activity, especially in the tourism sector, as an approach to the projection of KBLBB movements.

The tourism activity data that can be used to analyze the projecting of KBLBB movements and potential locations of SPKLU, SPLU, and SPBKLU include tourist locations, parking locations, hotel locations, shopping center locations, mini market locations, gas station locations, and hamlet (Banjar) locations. Based on a Multi-Criteria Decision Analysis (MCDA) analysis result, the projected number of SPKLU in Denpasar City for the optimistic, moderate, and pessimistic scenarios is 677 stations, 261 stations, and 22 stations, respectively. Compared to the total number in Bali Province, the distribution number of SPKLU

demonstrates that Denpasar City is one of the main focuses in implementing electric vehicles and infrastructure readiness in the Bali area (Transportation Agency of Bali Province, 2022).

The Indonesian Government Publicly launched Battery-Based Electric Motor Vehicles (KBLBB) on December 17, 2020. The Ministry of Energy and Mineral Resources aims to accelerate the KBLBB program to reduce pressure on Indonesia's balance of payments due to oil imports. The implication is an increase in national energy resilience. Therefore, using renewable energy and gas as the primary energy in power plants becomes necessary. Applying renewable energy will improve air quality and substantially reduce greenhouse gas emissions nationally. The Minister of Energy and Mineral Resources statement aligns with the target for using renewable energy in the national energy mix set out in Regulation of the President of Indonesia Number 22 of 2017 on the National Energy General Plan in the amount of 23%. However, the realization of renewable energy utilization in the national energy mix as of May 2020 was still far from the target, which was only 14.21% and dominated by geothermal energy. Using renewable energy as the primary energy in power plants is one of the prerequisites for the sustainability of electric vehicles. It has implications for climate change impact control in Indonesia.

4. CONCLUSION AND RECOMMENDATIONS

Public perception and targeted implementation of electric vehicles in Denpasar City, Bali Province, Indonesia, was assessed to acknowledge the potency of its development. The public perception of electric motorcycles in Denpasar City is good, with an average score of 3.43. The

community acceptance of electric vehicles, especially motorcycles, was affected by the quieter and environmentally friendly technology of electric motorcycles, electricity tax subsidies, and lower cost of electricity as fuel. The public perception was strengthened by the in-depth interview result with key persons, i.e., the coordinator of the electric motorbike community in Denpasar City, representatives of the Denpasar City community, representatives of the State Civil Apparatus (ASN) from the Forestry and Environmental Agency of Bali Province and Transportation Agency of Bali Province. Based on the interview, the community has been concerning electric vehicles due to the massive socialization activities that can outreach the community level and the provision of vehicle installment payment schemes from the banking sector. By integrating parameters of public perception level, manufacturers, charging station infrastructures, sales, domestic production opportunities, and incentives provision, the implementation target of electric vehicles in Denpasar City was determined optimally. Its influence is by the increasing number of electric vehicle manufacturers, Public Electric Vehicle Charging Stations (SPKLU) that has already been established in Denpasar City, and sales of electric motorcycles. The opportunity given to the manufacturer for conducting domestic production using local materials and human resources is also essential to lower the vehicle price. The government at the national and regional levels also provides incentive schemes that support both producers and consumers of electric vehicles. Based on the emission calculation from the transportation sector, the optimistic scenario can reduce CO₂ emissions by up to 32,641 tons/year in 2026. Furthermore, a more elaborated examination related to emission reduction is necessary to evaluate the sustainability of the electric vehicle ecosystem.

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