

Promoting Road Safety Through the Adoption and the Regulation of Electric Two-Wheelers



Promoting Road Safety Through the Adoption and the Regulation of Two-Wheelers

December 2023

Published by:

Institute for Transportation and Development Policy (ITDP)

Copywriting and Editorial Design:

B/NDL Studios

This document is summarized from ITDP Indonesia reports and publications:

Recommendations of National Policies and Standards on Electric 2&3 Wheelers In Indonesia: Supporting E-Mobility Focusing on Electric Two- and Three-Wheelers and Policies on Urban Traffic Integration in Indonesia (2022)

Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Electric 2W Integration to Urban Traffic Guideline (2022)

Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Report of Broader Motorcycle Landscape in Greater Jakarta (2021)

Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Road Users' Perspectives and Concerns (2021)

Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Timetable and Roadmap for Ride-Hailing Fleet Electrification (2021)

Supporting E-mobility focusing on Electric Two- and Three-wheelers and Policies on Urban Traffic Integration in Indonesia: Baseline Assessment of 2&3W in Indonesia (2022)

Supporting E-mobility focusing on Electric Two- and Three-wheelers and Policies on Urban Traffic Integration in Indonesia: Guidelines on the Integration of Electric Two- and Three-Wheelers in Urban Traffic (2022)

Published in:

December 2023

Contact Person:

Fani Rachmita
Senior Communications & Partnership Manager
fani.rachmita@itdp.org

ITDP Indonesia
Jalan Johar No. 20, 5th Floor
Menteng, Jakarta 10340

TABLE OF CONTENT



TABLE OF CONTENT LIST OF TABLES AND FIGURES CORE POINTS

CHAPTER I – TWO-WHEELERS LANDSCAPE IN INDONESIA	9
1.1 Scope of Two-Wheelers	9
1.2 The Popularity of Two-Wheelers in Indonesia	10
1.3 Safety and Environmental Issues Surrounding Motorcycle Usage	15
1.4 The Urgency Toward Adoption and Regulation of Electric Two-Wheelers	18
CHAPTER II – THE ELECTRIC TWO-WHEELERS MARKET	22
2.1 Policy Overview to Support Electric Two-Wheelers in Indonesia	22
2.2 Initiatives from the Private Sector to Support Electric Two-Wheelers Adoption	26
2.3 Current Electric Two-Wheelers Uptake, Barriers, and Opportunities	28
CHAPTER III – PROMOTING ROAD SAFETY THROUGH THE ADOPTION AND REGULATION OF ELECTRIC TWO-WHEELERS	34
3.1 Road Users’ Perspective and Concerns Regarding Safety	34
3.2 Regulation of Electric Two-Wheelers to Improve Road Safety	36
CHAPTER IV – MOVING FORWARD	46
REFERENCE	

LIST OF TABLES AND FIGURES

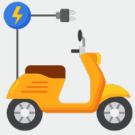
LIST OF TABLES

Table 1	Contribution of Each Type of Vehicle to Emission Based on a Traffic Volume Survey at Semanggi Intersection, Jakarta	17
Table 2	BEV Production Targets from the Ministry of Industry	25
Table 3	Drivers' Financial Capabilities for Purchasing Conventional Two-Wheelers..	29
Table 4	Safety Improvement Suggestions by Vulnerable Road Users for Regulating Electric Motorcycles	35
Table 5	Action Items and Prioritization	36
Table 6	Recommended Regulations for Motorized Vehicles and Micromobility Devices in the Two-Wheelers and PMD segments	41

LIST OF FIGURES

Figure 1	Mode Share in Greater Jakarta	11
Figure 2	Mode Preferences of Kampung Kota (Urban Neighborhood) Residents (Weekdays)	13
Figure 3	Speed vs. Pedestrian Fatality Risks	15
Figure 4	Example of Motorcycle Traffic Violations	16
Figure 5	Well-to-wheel Emission of Motorized Two-Wheelers in Indonesia, 2021	18
Figure 6	Motorized Two-Wheelers Fuel Economy in Indonesia, 2017-2021	19
Figure 7	Change in Electric Two-Wheelers Market Share as Compared to Two-Wheelers Sales	28
Figure 8	Estimated and Suggested Electric Two-Wheelers Price by Drivers	29
Figure 9	Factors Affecting Road Safety Perception Related to Motorcycles	34
Figure 10	Speed Restriction and Lane Assignments Modification	37
Figure 11	Through Traffic Restrictions in Residential Areas	38
Figure 12	Proposed Classification of Two- and Three-Wheelers in Indonesia	40
Figure 13	Illustration of Recommendations of Road Allocation for Two-Wheelers	43

CORE POINTS



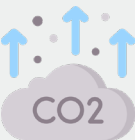
1. **Two-wheelers comprised two main types of vehicles: bicycles and motorcycles.** Bicycles do not have specific regulations for maximum speed, maximum vehicle weight, or any requirement for a type test. In comparison, motorcycles have different maximum design speeds and cylinder capacities. Unlike bicycles, motorcycles can generally operate in motorized vehicle lanes and have a higher maximum speed limit.



2. **The motorcycle is a popular transportation and has become indispensable for many Indonesian households,** primarily due to its flexibility, accessibility, and affordability. Comprising about 85% of motorized vehicles, motorcycles are the backbone of Indonesia's transportation system, with nearly 130 million registered in 2023. Meanwhile, bicycle popularity is relatively lower because people may prefer faster and more convenient motorbikes for longer distances. However, it enjoys greater popularity among women and children when it comes to short-distance journeys within urban neighborhoods and smaller cities.



3. **However, motorcycles' rising popularity also contributes to a growing set of environmental and safety issues.** The Traffic Corps of Indonesian National Police or Korlantas Polri (2019) found that almost 73% of all land transport accidents involve motorcycles. Furthermore, according to Statistics Indonesia (2016), the most common victims of accidents involving motorcycles are children aged 12-16 years. The most substantial contributors are human factors, including motorcyclist behavior and lack of discipline. Vehicle and external factors, such as poor road infrastructure and maintenance, also significantly influence accident rates.



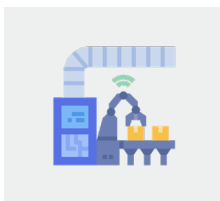
4. **Regarding the environment, the dominance of motorcycles in Jakarta (which made up almost 70% of the trips in the province) makes them the greatest contributor to air pollutant emissions from the transport sector, particularly CO and HC emissions.** This externality is also expected in other cities in Indonesia. With regard to greenhouse gas emissions, on average typical internal combustion engine (ICE) motorcycles in the <150 cc class in Indonesia contribute 57.9 gCO₂ greenhouse gases (GHG) emission per km driven, with 43.12 gCO₂ coming from tailpipe emissions.



5. **With the global trend towards electric vehicles (EVs), electrifying two-wheelers can potentially be the stepping stone to effectively tackle road safety and environmental issues.** To address these road safety concerns, and to help shape the future of electric two-wheelers, the Institute for Transportation and Development Policy (ITDP) and UK Partnering for Accelerated Climate Transitions (UK PACT) conducted a study to understand road users' perspectives and concerns about current motorcycle usage, and anticipate potential issues with future electric two-wheelers adoption. Moreover, a study from the UN Environment Programme (UNEP) and ITDP recommends that the combination of street design changes, management strategies, and user behavior adjustment can enhance road safety.

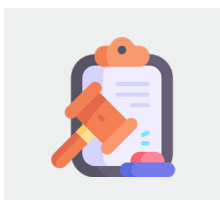


6. **Indonesia is taking significant steps to support the shift to EVs.** The Government of Indonesia offers various incentives to consumers and businesses, and allocated funds to research and development programs to jump-start the EV industry. Also, the involvement of ride-hailing companies and other private sector players have played a pivotal role in driving electric two-wheelers adoption across Jakarta and its broader metropolitan region. Nevertheless, unfortunately the efforts for the electric two-wheelers segments are still mostly focused on electric motorcycles (e-motorcycles) without significant support for electric bikes (e-bikes).



7. The current uptake of electric two-wheelers remains low due to barriers from the demand and supply side. To boost electric two-wheelers adoption, which ultimately should also include e-bikes, the government should consider these recommendations.

- Link clear electric two-wheelers adoption targets and roadmaps with national strategic documents and commit budgets.
- Achieve cost parity by providing fiscal incentives, including for e-bikes.
- Ensure safety by implementing technical and operational standards for vehicles, batteries, and charging infrastructure.
- Make riding electric two-wheelers, prioritizing e-bikes, more convenient than ICE two-wheelers by imposing stricter fuel economy, low emission zones, and other access restrictions.
- Incentivize industry players to provide high-performance models.
- Eliminate range anxiety by improving access to charging infrastructure.
- Establish public campaign programs to mainstream electric two-wheelers information.



8. Clear classification and regulations for two-wheelers are needed to streamline their integration into the existing transportation ecosystem, enhancing both safety and usability. ITDP proposed clearly classifying two- (and three) wheelers into motorized vehicles and micromobility devices. Motorized vehicles includes ICE and electric vehicles with a maximum design speed of more than 25 km/h, which includes ICE and electric motorcycles to ICE and electric three-wheelers comparable with Indonesia's current motorized two- and three-wheelers classification of L1, L2, L3, L4, and L5. On the other hand, micromobility devices vary from nonmotorized vehicles and electric vehicles with a maximum design speed of 25 km/h or less, such as pedal/electric bikes to manual or electric kick scooters.

Regarding regulation, ITDP advised the following general recommendation.

- All non-motorized micromobility devices, including conventional bicycles, should be permitted on cycling lanes and sidewalks (in the absence of a cycling lane), as long as they adhere to speed limits and prioritize pedestrian safety and mobility. Electric-powered vehicles, including electric micromobility, should not be allowed on sidewalks.
- The speed of electric micromobility¹ devices should be capped at 25 km/h with a weight restriction of 35 kg. For pedal-assisted bicycles, the additional electric drive should be deactivated once the speed reaches 25 km/h.
- Electric two-wheeler users, except for e-bikes and e-kick scooters, should ideally be 17 years or older.
- Vehicle registration and a plate number should be mandatory for vehicles capable of exceeding a speed of 25 km/h, as they should be categorized as motorized vehicles.

¹ There is a possible exception for Personal Mobility Aid (PMA) devices such as electric wheelchairs for older persons or people with disabilities, but it is beyond the scope of this current report.



Two-Wheelers Landscape in Indonesia

1

1.1. SCOPE OF TWO-WHEELERS

Two-wheelers comprised two main types of vehicles: bicycles and motorcycles (including both internal combustion engine models and electric ones). Each type serves a distinct role in the transportation ecosystem, with different specifications and standards.



Bicycles

Bicycles are the most basic form of two-wheeled transport, which can be further divided into conventional and electric bicycles. Conventional bicycles are non-motorized and rely entirely on human pedal power for movement. Bicycles are used globally for commuting, recreational activities, and even competitive sports. They offer numerous benefits, such as being zero emission, promoting physical activity, and allowing easy navigation through traffic.

Conventional bicycles do not have specific regulations for maximum speed, maximum vehicle weight, or any requirement for a type test. Bicycles must, however, conform to dimensions specified in regulations, which can vary by region. In Indonesia, a bicycle's maximum width and length are set at 550 mm and 2.100 mm, respectively. Bicycles are allowed to operate in cycle lanes and can also use the outermost (left) lane on motorized vehicle lanes.

Meanwhile, electric bicycles in Indonesia are currently regulated to have a speed limit of 25 km/h and are only allowed to operate on cycling lanes or designated areas, such as residential, office, tourism, and car-free day areas, and areas surrounding transit stations (if they are part of an integrated mobility system). No minimum age or driving license is required to operate a bicycle, both conventional or electric, and there is no need for registration or a license plate. Helmets, though not mandated, are strongly recommended for safety.

Several people enjoying a car-free day event, typically held every weekend, as they ride bicycles and stroll along the open streets.





Motorcycles

Motorcycles form a broad category that includes two-wheeled vehicles powered by internal combustion engines (ICE), electric motors, or hybrid systems. Motorcycles are divided into several classifications based on their power source, maximum design speed, cylinder capacity for ICE vehicles, and wheel configuration. In Indonesia, two-wheeler motorcycles are classified into L1 and L3 categories, where L1 includes motorized vehicles with maximum cylinder capacity of 50 cm³ or have a maximum design speed of 50 km/h and L3 includes those with cylinder capacity more than 50 cm³ or have maximum design speed more than 50 km/h².

Motorcycles can generally operate in motorized vehicle lanes and have a higher maximum speed limit than bicycles. Their maximum speeds can range from 50 km/h to 80 km/h, depending on the classification and the type of roads (urban, intercity, residential). Motorcycles are subject to mandatory type tests, which examine various factors, including electric accumulators, charging equipment, electrical safety, functional safety, hydrogen emissions, and others. Certain modifications, such as increasing motor power, are prohibited.

1.2 THE POPULARITY OF TWO-WHEELERS IN INDONESIA

Popularity of motorcycles

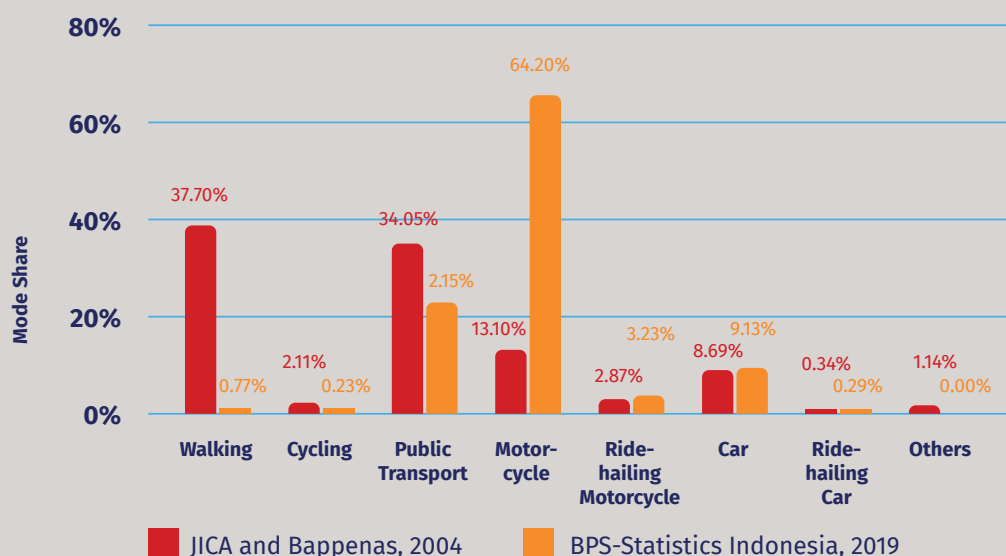
The motorcycle's presence is a vital part of the Indonesian streets as they have become deeply entrenched in the culture, economy, and lifestyle. Comprising about 85% of motorized vehicle population, motorcycles serve as the backbone of Indonesia's transportation system, with nearly 130 million of them registered in 2023. A wide array of socio-economic and infrastructural factors contribute to their unprecedented popularity in Indonesia.

This significant usage of motorcycles is shown in the actual mode share. A 2019 study found that the majority of trips within Greater Jakarta, accounting for 64.2% of all journeys, were undertaken using motorcycles. However, this trend has not always been prevalent. A 2004 study by the Japan International Cooperation Agency (JICA) and the Ministry of National Development Planning (Bappenas) revealed that motorcycles were used for only 13.1% of all commuting trips in Greater Jakarta. While the methodologies may vary, the stark contrast in the figures from these two studies underscores the need to examine the dramatic increase in motorcycle usage over that period.

² Minister of Transportation Regulation No. 30/2020

Figure 1 Mode Share in Greater Jakarta

Source: UK PACT and ITDP Indonesia. (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta.



Motorcycles have become indispensable for many Indonesian households, primarily due to their flexibility, accessibility, and affordability. To start with, they offer flexibility in terms of routes and schedules, providing the freedom of door-to-door mobility. This flexibility is a significant advantage in sprawling cities and towns in Indonesia. Furthermore, motorcycles are perfect for navigating the narrow streets often found within Indonesian cities, especially in residential areas. Their compact size and nimbleness provide an edge over larger, bulkier vehicles, ensuring easy access even in tight, constricted urban spaces.

Additionally, motorcycles are considered one of the most affordable modes. A motorcycle's purchase and running costs are considerably less compared to cars. An entry-level ICE motorcycle is purchasable for as low as around IDR17 million (~USD1,200). Add in the low gasoline price and minimal parking fees, motorcycles become a cost-effective mode of transport that is well within the financial reach of the average Indonesian. Furthermore, a recent survey by the Institute for Transportation and Development Policy (ITDP) Indonesia (2023) revealed that the average transportation cost of private vehicle users, including car and motorcycle users, in Greater Jakarta is 14% lower than the average transportation cost of public transport users. This further proves that motorcycles are currently one of the most affordable modes in the urban landscape.

The usage of motorcycles in Indonesia is not limited to personal use. Online ride-hailing services such as Go-Jek and Grab, along with e-commerce platforms like Tokopedia and Shopee and urban logistics services, have tapped into the motorcycle's potential to provide efficient delivery and transportation services. It is estimated that around 4 million motorcycle drivers are employed by online transportation app companies, significantly contributing to the nation's economy.

The rise of digital platforms has revolutionised the commercial use of motorcycles in Indonesia. The platform became a super app accelerating service transactions, including driver and customer payments. Coupled with the flexibility of the motorcycle in navigating congested streets and delivering goods door-to-door, it contributes to the economy by stimulating consumer spending and facilitating commerce.

The low popularity of bicycles and its reasons

Bicycles were once widely favored as a common means of transportation in various Indonesian cities. However, their popularity, particularly for daily commuting, has significantly declined in major cities like Jakarta and Surabaya and is also rapidly diminishing in secondary cities.



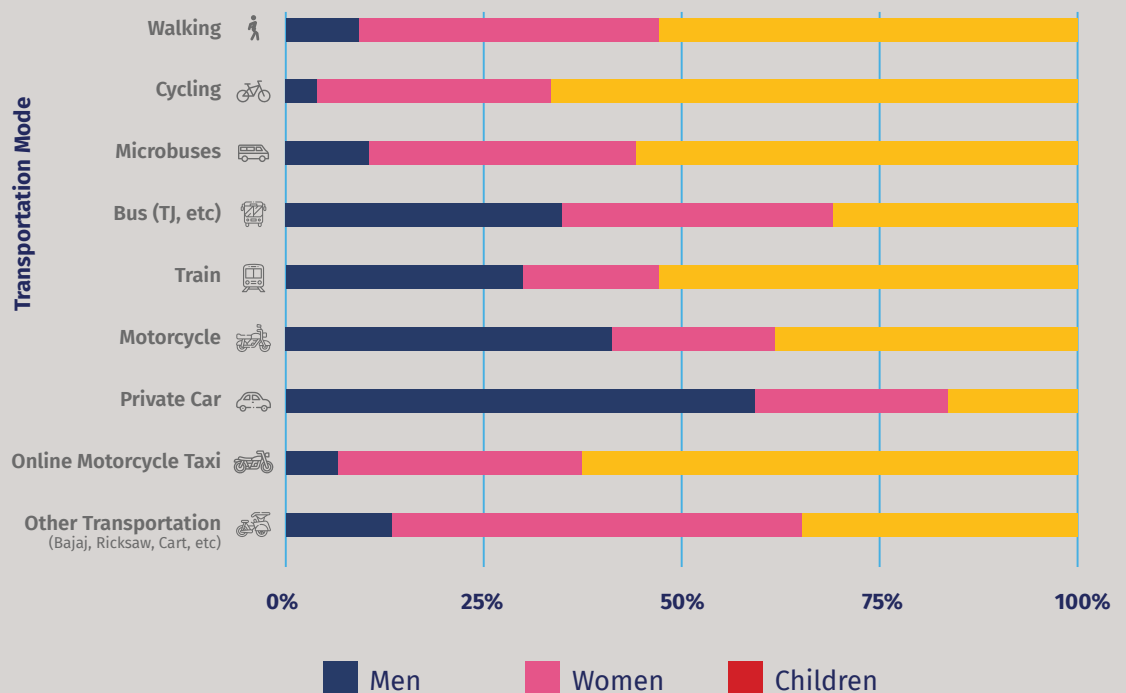
Green-painted bicycle lanes are not sufficient for proper bicycle infrastructure. Effective planning should prioritize the safety and comfort of cyclists.

Several potential factors may influence this decline. People may prefer motorbikes that are faster and more convenient for longer distances compared to bicycles amid Indonesia's hot and humid climate. The lack of bike lanes may also mean that people are less likely to bike if there are no special paths for bikes, due to safety concerns since the vehicular lanes are already dominated by motorized vehicles. Based on a survey conducted by ITDP in Semarang in 2023, it showed that the existence of bike lane will influence directly to the proficiency level. The data showed a significant increase from 69.70% to 92.59% of people who acknowledge themselves as advanced cyclists if the bike lanes are installed and it will increase to 94.34% if the bike lanes are upgraded into protected bike lanes. Additional problems are also including the people's behaviour while driving the vehicles. People tend to not follow rules as motorized vehicles encroach upon the few existing lanes, further hindering the safety and convenience of cyclists.

Furthermore, due to the complex issues related to land use and spatial planning in Greater Jakarta, people tend to travel more than 20 kilometers per day which may not easy for people to ride bikes. The absence of proper facilities in accommodating mixed-commute behaviours also make cycling difficult. These reasons may also let cycling less popular as daily transport modes.

Nevertheless, based on ITDP survey, there has been an increase of cycling during and after the pandemic though predominantly for recreational purposes. In addition to that, cycling is considered popular for women and children even before the pandemic which can be seen from ITDP's study in 27 urban neighbourhood in Jakarta in 2018-2020. Bikes were chosen by women and children after walking and public transport in the neighborhood or for completing domestic roles and evenmore economic motives. In contrast, motorbikes were not predominantly chosen by these groups because in every household, motorcycles were given to adult men or to the main family breadwinner.

Figure 2 Mode Preferences of Kampung Kota (Urban Neighborhood) Residents (Weekdays)



Box 1 Surging Cycling Activity in Jakarta: ITDP Survey Findings

According to an ITDP survey in June 2020, there was a remarkable surge in cycling activity along Jl. Sudirman, a prominent central Jakarta thoroughfare, with an astounding 1,000 % increase in cyclists compared to the previous year. Similarly, other major roads in central Jakarta, such as the stretch between Bundaran Senayan and Sarinah, also witnessed significant increases ranging from 200% to 700%.

This surge in cycling activity was attributed to limited recreational options due to social distancing measures implemented since the first COVID-19 positive case announcement in March 2020. Factors such as physical health, avoiding crowds, and leisure were identified as key motivations for people to opt for bicycles.

Given the growing public interest in non-motorized transportation, the Governor of Jakarta has announced plans to add 101 km of bicycle lanes to the existing 63 km dedicated bike lanes in Jakarta by 2021. Additionally, a bike-sharing service operated by Gowes, a private operator, was being introduced on a pilot basis but is currently discontinued.

On a national level, the Government of Indonesia has shown its support for cycling by conducting a program to financially support subnational governments in developing cycling lanes in their regions, as the installation of bicycle paths and sidewalks is already mandated by Indonesia Law No. 22/2009 on Traffic and Road Transport and in the Ministerial Regulation No. 59/2020, which also instructs provision of bicycle parking facilities.



Despite the fact that the conventional bikes are considered good for health, but based on ITDP's survey to evaluate the former bike-sharing performance in Jakarta in 2021-2022, it demonstrated that there were 26.2% respondents wishing for the existence of e-bikes. In March 2021, e-bikes were dominantly used compared to available shared bikes. At least 3 (three) points were noted as the hallmarks of e-bikes compare to conventional bikes. They are considered faster, easier, and less tiring.

In conclusion, the decline in bicycle usage in Indonesian cities, especially major ones like Jakarta and Surabaya, is due to factors such as the preference for motorbikes, the lack of dedicated bike lanes, and safety concerns. However, there is optimism with ITDP surveys showing that bike lanes can boost cycling, and the emergence of e-bikes offering a faster, easier alternative shed a positive light that may bridge the potential shift from motorbikes to bikes. With the right infrastructure and policies, bicycles, both traditional and electric, could make a sustainable and efficient comeback in Indonesian cities, reducing congestion and promoting healthier urban mobility.

1.3 SAFETY AND ENVIRONMENTAL ISSUES SURROUNDING MOTORCYCLE USAGE

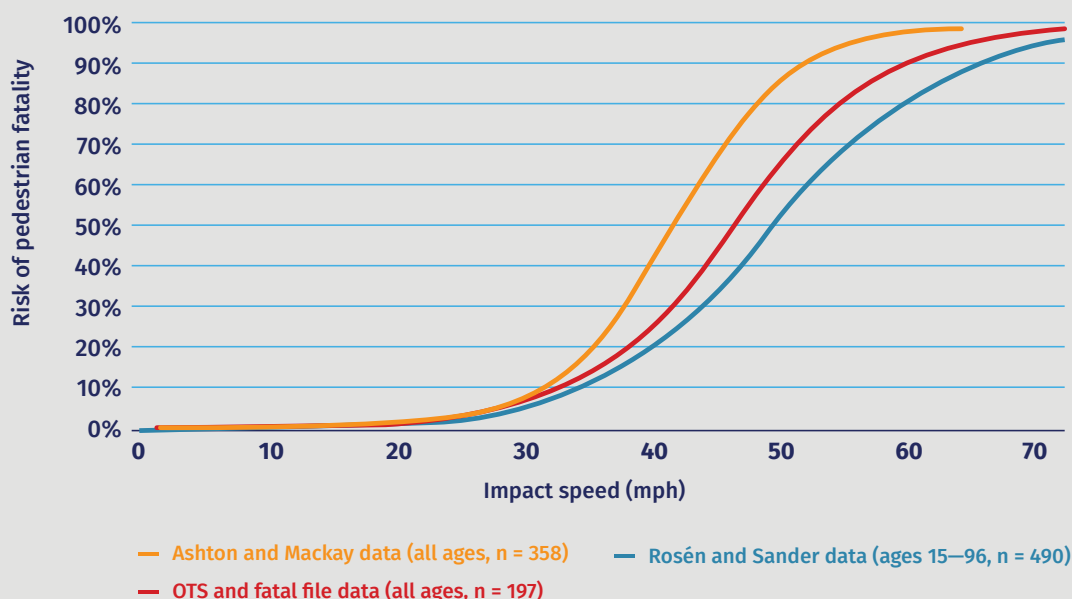
Unfortunately, motorcycles' rising popularity also contributes to a growing set of environmental and safety issues. It is a complex problem requiring comprehensive solutions that take into account not only the direct factors contributing to these issues but also the broader social and economic context in which they arise.

Road safety is the first significant concern associated with increased motorcycle usage. According to interviews with ride-hailing motorcycle drivers in Jakarta, safety risk is the most cited concern by the drivers, comprising 34% of overall concerns, followed by security risk³. The Traffic Corps of Indonesian National Police or Korlantas Polri (2019) found that almost 73% of all land transport accidents involve motorcycles.

A study by Richards (2010) found a significant correlation between speed and the fatality rate, showing that pedestrians involved in a car crash at 40 mph (64 km/h) are up to 5.5 times more likely to suffer fatal injuries than those in a 30 mph (48 km/h) crash. While further research may be needed to assess the speed and fatality rate correlation among motorcyclists, it is worth considering that pedestrians and two-wheeler users share a vulnerability due to the absence of enclosed protection, unlike four-wheeler users. Thus, the fatality rate between these two road user groups may be comparable.

Figure 3 Speed vs. Pedestrian Fatality Risks

Source: UK PACT and ITDP Indonesia (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta.



³ UK PACT and ITDP Indonesia (2022). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Output 3.1 Report of Current Perspectives on Ride Hailing Service and Electrification

Human factors, including motorcyclist behavior and lack of discipline, are the most substantial contributors. Vehicle and external factors, such as poor road infrastructure and maintenance, significantly influence accident rates. With the surge in the number of motorcycles - almost 6% Compound Annual Growth Rate (CAGR) between 2004 and 2019, according to the Indonesian Motorcycles Association (AIS) — the traffic density and propensity for accidents have also increased. On average, these accidents result in around 2-3 casualties per day, a rate that undoubtedly necessitates immediate action.

Poor adherence to current traffic regulations adds another layer. Common violations observed among motorcycles include disregarding traffic lights and signs, driving against traffic flow, and misusing pedestrian areas to bypass traffic or for parking purposes. It not only disrupts pedestrian mobility but also poses significant safety risks, exacerbating the already urgent issue of road accidents.

Figure 4 Example of Motorcycle Traffic Violations

Source: UK PACT and ITDP Indonesia (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta.



Motorcycle usage also poses a significant environmental issue. The dominance of motorcycles in Greater Jakarta (See Figure 1) makes them the greatest contributor of air pollutant emission from the transport sector, as suggested by a sampling survey shown in Table 1. With regard to greenhouse gas emissions, a regular (below 150 cc) ICE two-wheelers on average produces 43.12 gCO₂ tailpipe emission per kilometer driven⁴.

The table below indicates that motorcycles have a worse emissions performance compared to other types of vehicles, making them an environmentally damaging choice in the transport system. The current fuel quality worsens this problem, as only about 1% of the total gasoline on the market complies with Euro 4 standards. However, it is anticipated that the new refineries, expected to be commissioned in 2023, will produce Euro 5 quality fuel, which could help mitigate the pollution caused by motorcycles⁵.

⁴ UNEP dan ITDP Indonesia (2022). Supporting E-mobility focusing on Electric Two- and Three-wheelers and Policies on Urban Traffic Integration in Indonesia: Baseline Assessment of 2&3W in Indonesia

⁵ Shao, Z., Miller, J., and Jin, L. (2020). Soot-free road transport in Indonesia: A cost-benefit analysis and implications for fuel policy. International Council on Clean Transportation (ICCT). [Online]. [Accessed on April 2021]. Available from: <https://theicct.org/publications/soot-free-road-transport-indonesia-cost-benefit-analysis>

Table 1 Contribution of Each Type of Vehicle to Emission Based on a Traffic Volume Survey at Semanggi Intersection, Jakarta

Source: UK PACT and ITDP Indonesia (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater

Vehicle Types	CO	HC	Nox	PM	CO ₂	Shares in traffic volume
Cars	41%	19%	41%	0%	48%	47%
Truck	3%	4%	39%	81%	32%	11%
Bus	2%	2%	18%	19%	12%	3%
Motorcycle	55%	75%	2%	0%	9%	39%

The high use of motorcycles also has a significant impact on fuel consumption. In 2021, the ICE motorcycle fuel economy in Indonesia was 1.95 l/100 km⁶. On another word, on average, each ICE motorcycle in Indonesia consumes 1.95 litre fuel per 100 km driven. It is higher compared to Vietnam's 2020 two-wheelers fuel economy of 1.76 l/100 km and India's⁷ 2018 two-wheelers fuel economy of 1.74 l/100 km⁸. Nevertheless, when compared to the light-duty vehicle (LDV) fuel economy in Indonesia at 8.1 l/100 km in 2019, the two-wheelers' fuel economy still fares better.

The problem becomes even more complex when considering the inadequate public transport systems in most Indonesian cities. As motorcycles offer financial accessibility, flexibility, and ease of obtaining them, they have become a more attractive option to many people over public transport. The government's urgent challenge is to improve public transportation services because without any additional measures to provide alternative modes of transport, higher usage and reliance towards motorcycles will only escalate the safety and environmental issues that are already happening.

In the context of sustainable transportation, the advent of electric motorcycles presents another layer of complexity. On one hand, these vehicles could help decrease emissions and hence minimize the environmental externalities of motorcycles. On the other hand, they might deter the shift to public transport, thereby maintaining high traffic volumes and possibly road safety risks without any proper measures being taken.

⁶ Ibid.

⁷ Tran, D. S., Le, H., & Yang, Z. (2022). Two-wheelers in Vietnam: A baseline analysis of fleet characteristics and fuel consumption in 2019 and 2020. Working Paper, (2022-08)

⁸ Global Fuel Economy Initiative. (n.d.). Vehicle types. Global Fuel Economy Initiative; [www.globalfuelconomy.org](https://www.globalfuelconomy.org/toolkit/vehicle-types). Retrieved September 2, 2022, from <https://www.globalfuelconomy.org/toolkit/vehicle-types>

1.4 THE URGENCY TOWARD ADOPTION AND REGULATION OF ELECTRIC TWO-WHEELERS

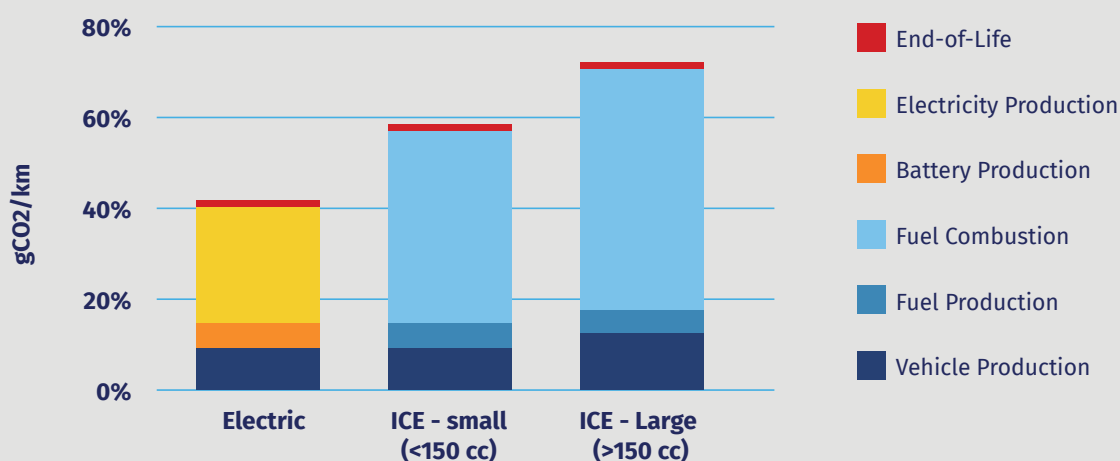
Environmental and safety benefits of two-wheelers electrification

Different solutions have been proposed to address the rise of motorcycle use, such as bans or access restrictions on certain road segments or zones. An alternate viewpoint is to minimize the externalities of motorcycles instead of eliminating the mode. With the global trend towards electric vehicles (EVs), electrifying two-wheelers can be an effective solution. Electric motorcycles could bring safety and environmental advantages but also present new challenges. Understanding these factors can help anticipate the effects of this transition.

One of the most significant environmental benefits of EVs is the absence of tailpipe emissions, a primary source of local air pollution. This effectively eliminates pollution resulting from fuel combustion in our cities. However, it has to be noted that while EVs do not have tailpipe emissions, other types of pollution, such as those caused by brake, tire, and road wear, will continue to be a challenge. There is also indirect pollution from coal power plants, which largely supply the electricity for the charging infrastructure.

Figure 5 Well-to-wheel Emission of Motorized Two-Wheelers in Indonesia, 2021

Source: UK PACT and ITDP Indonesia (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta.

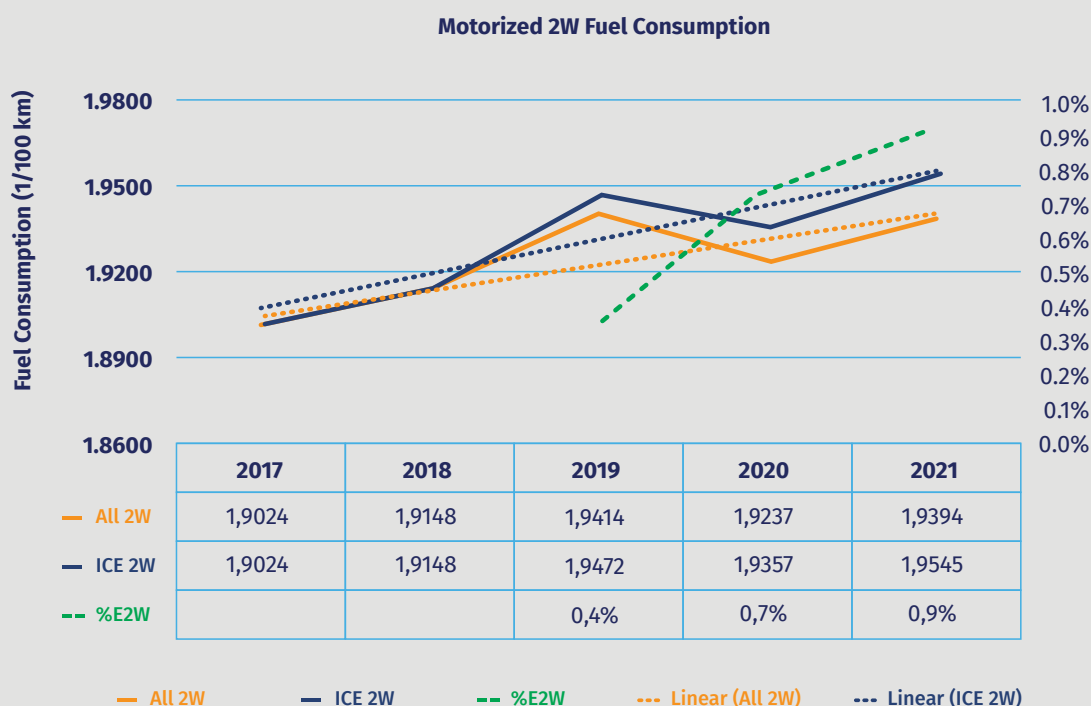


Nevertheless, despite the Indonesian carbon-intensive grid, the estimated life cycle emissions analysis of currently available electric motorcycle models has the lowest well-to-wheel emissions at 40.8 gCO₂/km on average⁹. In comparison, as shown in Figure 5 above, regular ICE two-wheelers have a 57.9 gCO₂/km emission level, while large ICE two-wheelers (>150cc) have the worst emissions level at 82.4 gCO₂/km. In other words, a typical electric motorcycle can achieve almost 30% greenhouse gas emissions reduction compared to conventional regular motorcycles on a well-to-wheel basis, assuming the existing grid emission factor. Looking ahead, if the power sector's decarbonization proves successful, the impact of electric motorcycles on emission reduction could be more evident.

⁹ Assuming a 10-year lifetime, with a total of 106,200 km driven.

Figure 6 Motorized Two-Wheelers Fuel Economy in Indonesia, 2017-2021

Source: UNEP and ITDP Indonesia (2022). Supporting E-mobility focusing on Electric Two- and Three-wheelers and Policies on Urban Traffic Integration in Indonesia: Baseline Assessment of 2&3W in Indonesia



The adoption of electric vehicles can also reduce fuel consumption rate and hence improve fuel economy. The national motorcycle fleet fuel consumption, as in the weighted average of the fuel consumption of various motorcycle models, from 2017 to 2021 is presented above. Overall, the fuel consumption of the ICE motorcycles continued to increase each year and only decreased in 2020. From 1.9 l/100 km in 2017, the fuel consumption of the ICE motorcycles increased to 1.95 l/100 km in 2021 – a five-year increase of 2.7%. In 2021, it is shown that the adoption of electric two-wheelers reduced the national motorcycle fleet fuel consumption 0.77%, although their market share has not even reached 1% of the annual sales.

In the broader realm of electric two-wheelers, the lighter electric bicycles (e-bikes) offer further additional benefits. Compared to conventional bicycles, e-bikes enable more extended cycling trips with less physical effort, enhancing their utility for door-to-door mobility and broadening the area for public transportation when used as a first-last mile mode.

E-bikes also improve cycling accessibility for diverse user groups, including women, older persons, people with disabilities, beginners, and potential cyclists, as electric motor assistance reduces the physical exertion required. Additionally, e-bikes expand the range of trip purposes achievable by bicycle, making trips involving heavy cargo delivery, steep slopes, or passenger transport more feasible.

Compared to e-motorcycles, e-bikes present a transportation option with lower emissions and greater energy efficiency than motorcycles, including e-motorcycles. Furthermore, e-bikes contribute to enhanced road safety, as their generally lower speeds and lighter weight result in less severe collision impacts than e-motorcycles and even ICE vehicles. A collective increase in the use of low-speed, lightweight vehicles such as e-bikes and bicycles can lead to improved overall road safety.

Nevertheless, the uptake of electric two-wheelers also has shortcomings that should be taken into account. There are concerns about handling battery waste, as poor-quality recycling facilities can leak pollutants. This can lead to significant environmental and health hazards, such as has happened in India, although the evolution of battery technology also continues to lower these impacts, with lithium-ion batteries gradually replacing the lead-acid variants that were once a significant source of lead pollution. Rapid deforestation and environmental degradation due to mining activities, particularly in areas like Kalimantan and Sulawesi, also present a major concern.

Another potential shortcoming relates to the fact that electric motorcycles are much quieter than gasoline motorcycles. While this contributes to a less noisy urban environment, it might introduce a new hazard: pedestrians and other road users may struggle to recognize the sound of an approaching electric motorcycle. This is an issue, especially considering the large number of motorcyclists who tend to speed, violate traffic signs—including traffic lights—and the lack of proper pedestrian crossings.

Regulatory opportunities

The rise of electric two-wheelers presents a unique opportunity for policymakers to minimize externalities currently posed by conventional motorcycles as well as implement regulations to improve road safety before these vehicles become widespread.

One fundamental policy is to clearly distinguish between e-bikes and e-motorcycles since they have different characteristics. Following that, further specifications could involve setting maximum speeds for electric two-wheelers to reduce speed-related accidents, which are a significant factor in road fatalities. Nevertheless, adherence to regulations by motorcycle users has always been an issue in typical Indonesian traffic and might be exacerbated by unclear identification of electric two-wheeler types on the road. To mitigate similar issues, the government should require license plates and driving permits for electric two-wheelers that have speed limits over certain thresholds.

Striking a balance between regulation and maintaining the advantages that encourage people to use electric two-wheelers will be crucial. The objective is not to deter the transition to electric two-wheelers but to ensure that the transition results in safer and more sustainable urban mobility. Furthermore, it should be emphasized that more rigorous law enforcement should apply to all vehicle types, not limited to just electric two-wheelers. Broader actions like introducing an electronic law enforcement system (ETLE) and ensuring the credibility of the government's vehicle identification and registration database must be implemented.

The transition to electric two-wheelers presents an opportunity to reimagine our transportation systems. By leveraging the benefits of electrification and implementing thoughtful and effective regulations, we can create a transportation landscape that is not only more sustainable and efficient but also safer for everyone involved.

KEY TAKEAWAYS



Electric two-wheelers offer benefits such as lower carbon emissions, lower operational costs and improved fuel efficiency. However, considering Indonesia's carbon-intensive electricity grid, the significance of the environmental impact of electric two-wheelers depends on the source of electricity. While electric motorcycles eliminate tailpipe emissions, emissions from brake, tire, and road wear continue to be a challenge. The emission and pollution from coal power plants supplying electricity also needs consideration.



The adoption of electric motorcycles aims to minimize externalities associated with traditional motorcycles. However, managing this transition carefully is essential to prevent potential problems. For instance, while electric motorcycles may offer environmental benefits, a large-scale shift could still contribute to traffic congestion and road safety risks if not managed effectively.



E-bikes offer more inclusive benefits by enabling longer cycling journeys with less effort, making cycling more accessible to diverse user groups such as women, older persons, people with disabilities, and beginners. E-bikes can be used for various trip purposes, including heavy cargo transport and steep slopes. They contribute to improved cycling accessibility and road safety due to lower speeds and lighter weight compared to conventional and electric motorcycles.

2 The Electric Two-Wheelers Market

2.1 POLICY OVERVIEW TO SUPPORT ELECTRIC TWO-WHEELERS IN INDONESIA

In Indonesia, the government has used many different rules and plans to support EVs. These plans involve different government departments, showing a comprehensive approach to promoting and managing the use of electric two-wheelers. However, it is worth noting that regulations and supporting policies pertaining to using electric two-wheelers, particularly those that fall outside the classification of e-motorcycles (such as e-bikes, e-mopeds, and e-scooters), remain relatively limited.

Regarding EV adoption, the Government of Indonesia has formed a coordination team to accelerate the use of battery-based electric vehicles (BEVs) through Presidential Regulation No. 55/2019, which acts as an umbrella regulation for BEV adoption acceleration efforts. Several ministries and institutions are part of this team. The Coordinating Ministry for Maritime and Investment Affairs (CMMIA) coordinates the efforts for BEV acceleration at the national level. Furthermore, the Ministry of Transport (MoT) is responsible for establishing EV testing facilities and the Ministry of Environment and Forestry (MoEF), in collaboration with MoI and the Ministry of Education, Culture, Research, and Technology, is responsible for developing policies related to battery end-of-life.

Coordination team to accelerate the use of battery-based electric vehicles (BEVs)



Based Presidential Regulation No. 55/2019, which acts as an umbrella regulation for BEV adoption acceleration efforts.



The Coordinating Ministry for Maritime and Investment Affairs (CMMIA) coordinates the efforts for BEV acceleration at the national level.



The Ministry of Transport (MoT) is responsible for establishing EV testing facilities.



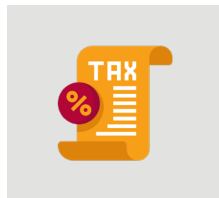
The Ministry of Environment and Forestry (MoEF), in collaboration with MoI and the Ministry of Education, Culture, Research, and Technology, is responsible for developing policies related to battery end-of-life.



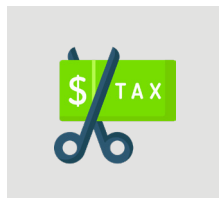
The Ministry of Finance (MoF) plays a role in budget planning and offers fiscal incentives to encourage the adoption of BEVs.

Meanwhile, the Ministry of Finance (MoF) plays a role in budget planning and offers fiscal incentives to encourage the adoption of BEVs. For example, they introduced a reduction in Value Added Tax (VAT) from 11% to 1% for purchases of electric cars, e-motorcycles, and e-buses with a minimum domestic content (TKDN) of 40%. This incentive is implemented in collaboration with the Ministry of Industry (Mol). Alongside these efforts, the Ministry of Home Affairs (MoHA) has also established a policy to completely waive vehicle tax (PKB) and title transfer tax (BBNKB) for electric vehicles, including e-motorcycles. Additionally, there are tax holiday and tax allowance policies for the domestic electric vehicle industry, which also apply to conventional vehicle industries.

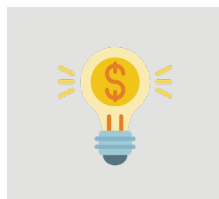
Fiscal incentives provided to encourage the adoption of KBLBB



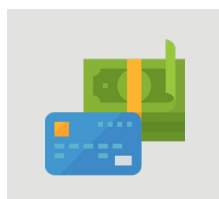
The Ministry of Finance (MoF) in collaboration with the Ministry of Industry (Mol) introduced a reduction in Value Added Tax (VAT) from 11% to 1% for purchases of electric cars, e-motorcycles, and e-buses with a minimum domestic content (TKDN) of 40%. Additionally, there are tax holiday and tax allowance policies for the domestic electric vehicle industry, which also apply to conventional vehicle industries.



The Ministry of Home Affairs (MoHA) has also established a policy to completely waive vehicle tax (PKB) and title transfer tax (BBNKB) for electric vehicles, including e-motorcycles.



Other fiscal incentives, such as bulk electricity tariffs for charging facility providers to boost infrastructure provision and lower electricity tariffs for home charging usage at night, are also available from PLN.



The Authority of Financial Services (OJK) issues incentives for the banking sector, including relaxation of reducing the credit risk weight (ATMR) from 75% to 50% for electric vehicle production and consumption, discount on green bond registration statement fees to fund EV industries, relaxation of credit quality calculation, and removal of maximum limits of granting credits (BMPK) for funding BEV industries and charging infrastructure provisions with guarantees from State-Owned Enterprise (SOE) or Regional Owned-Enterprise (ROE) guarantors. The Bank of Indonesia also allows a 0% down payment scheme for BEV loans, including for e-motorcycles.

Other fiscal incentives, such as bulk electricity tariffs for charging facility providers to boost infrastructure provision and lower electricity tariffs for home charging usage at night, are also available from PLN. To boost financing scheme provision, as per the time of writing this report, the Authority of Financial Services (OJK) issues incentives for the banking sector, including relaxation of reducing the credit risk weight (ATMR) from 75% to 50% for electric vehicle production and consumption, discount on green bond registration statement fees to fund EV industries, relaxation of credit quality calculation, and removal of maximum limits of granting credits (BMPK) for funding BEV industries and charging infrastructure provisions with guarantees from State-Owned Enterprise (SOE) or Regional Owned-Enterprise (ROE) guarantors. The Bank of Indonesia also allows a 0% down payment scheme for BEV loans, including for e-motorcycles.



A government regulation is crucial to facilitate the adoption of electric motorcycles, ensuring a smoother integration into the transportation landscape.

Non-fiscal incentives, such as low emission zones (LEZ), are being introduced in some regions, such as Jakarta and Bali, by the local governments. Implementing LEZs in other cities, including tourism areas, led by the Coordinating Ministry for Economic Affairs, Ministry of Tourism, and MoT in collaboration with local governments, is also part of the EV acceleration strategies.

The Ministry of Energy and Mineral Resources (MEMR) and Ministry of State-Owned Enterprise (MSOE) are appointed to accelerate charging infrastructure provision, hence the development of a charging infrastructure roadmap by PLN (State Utility Company). Charging facilities have also been provided at several ministerial offices, from plug-ins to battery swaps. MSOE may also potentially instruct Pertamina, a state-owned oil company, to expand its charging infrastructure, as well as instructing state-owned banks to provide loans to expedite the BEV acceleration program and other forms of financial aid. Moreover, e-motorcycle retrofitting initiatives have also been supported by MEMR and other ministries.

In addition to incentives, there are also a few policies regulating the use of electric two-wheelers issued by the MoT, such as vehicle type test regulation and “certain vehicles with electric motor drive” regulation, including e-bikes, e-kickscooters, e-mopeds, and electric skateboards, regulating several technical specifications, speed limit, area of usage, and the minimum age to use said two-wheelers. Several measures to support research and development (R&D) in the EV industry have also been made, from allocating funds for R&D to, more recently, including R&D aspects in the calculation of TKDN.

Box 2 Local Efforts on Supporting Electric Two-Wheelers Adoption

Leveraging the momentum of Presidential Regulation No. 55 of 2019, several local governments have issued policies to incentivize the use of BEVs, from introducing Low Emission Zones to exempt the vehicles from road access restrictions or paying parking fees.

Parallel to the electrification efforts, the Provincial Government of DKI Jakarta granted BEVs, including e-motorcycles, a reprieve from vehicle title transfer fees and vehicle tax until December 2024, and plans to provide parking fee exemptions for BEVs. An area in the Old Town of Jakarta has also been branded as a “low-emission zone” by restricting the access of motorized vehicles except public transport and BEVs.

In Bali, the provincial government has issued a comprehensive BEV adoption roadmap and a corresponding Governor Regulation. A local task force has been set up to accelerate the EV ecosystem. Several incentives have also been issued, including allowing charging facility establishment at government-owned assets, shopping centers, and on-street parking; as well as road access restrictions, parking fees, vehicle title transfer fees, and vehicle tax exemptions. Other incentives are also offered, such as funding support for charging facility provision, skilled worker certification for BEV-related industries, product certification, and security support for industry operations. In addition, the government is also starting to implement low-emission zones in several major tourism areas and activity centers.

In conclusion, Jakarta and Bali are not just adapting but leading with bold BEV initiatives. Jakarta champions a greener future with tax breaks and exclusive eco-zones, while Bali’s visionary BEV roadmap and robust support mechanisms signal a new beginning for sustainable transportation.

However, in the electric two-wheelers landscape, the government focuses mostly on e-motorcycles. The Ministry of Industry (MoI) leads the domestic electric vehicle industry development and its supply chain by issuing an industry roadmap containing production targets and minimum domestic content rate (TKDN) requirements to be eligible for fiscal incentives. However, this roadmap (and consequently, the fiscal incentives for the industry) is restricted to electric two-wheelers possessing a battery capacity of at least 1.3 kWh. This primarily pertains to e-motorcycles, rather than being also applicable for e-bikes.

Table 2 BEV Production Targets from the Ministry of Industry

Source: Ministry of Industry Regulation No. 6/2022 on Specification, Development Roadmap, and Domestic Content Rate Calculation of Battery Electric Vehicles

Variable			2020	2025	2030	2035
BEVs with Four Wheels and More	Production	Total (Unit)	0	400,000	600,000	1,000,000
BEVs with Two and Three Wheels	Production	Total (Unit)	5,000	6,000,000	9,000,000	12,000,000

2.2 INITIATIVES FROM THE PRIVATE SECTOR TO SUPPORT ELECTRIC TWO-WHEELERS ADOPTION

In the evolving landscape of urban transportation, the rising significance of electric two-wheelers presents an opportunity for a paradigm shift toward more sustainable, efficient, and cleaner commuting solutions. Central to this transformation is the involvement of domestic electric two-wheeler manufacturers from the supply side as well as ride-hailing and logistic companies from the demand side.



The two major ride-hailing companies in Indonesia, Gojek and Grab, connect drivers with multiple riders, offer food delivery, facilitate payments through e-wallet features, and provide various other services.

With their influence and vast networks, Gojek and Grab, being two of Indonesia's largest ride-hailing operators, have played a pivotal role in driving electric two-wheelers adoption across Jakarta and its broader metropolitan region. The companies primarily offer services such as passenger transportation, food delivery, and goods delivery. The drivers are not employees but partners of these operators, providing their own motorcycles, while the companies currently offer the option to rent electric motorcycles. This partnership model allows for the efficient provision of services and opens doors for the gradual shift towards EVs in the ride-hailing industry.

Box 3 Motorcycle Ride-Hailing Dilemma in Indonesia

From a government perspective, two primary ministries - the Ministry of Transportation (MoT) and the Ministry of Communication and Information (MoCI) - directly regulate ride-hailing operations. The MoT oversees all transportation modes, including ride-hailing services, ensuring they meet the standards of safety, security, convenience, accessibility, and regularity. While traditionally, two-wheelers were not considered public transportation, the government has offered legal protection for online two-wheeler ride-hailing services through various MoT regulations, such as MoT Regulation No. 12 of 2019. This regulation allows motorcycles to be used for shared transportation, even though it is not legally classified as public transportation under Indonesian Law No. 22 of 2009.

The MoCI, on the other hand, supervises the online aspects of ride-hailing operations. The ministry has put in place a series of rules that require ride-hailing applications to register and protect user data, highlighting the government's commitment to safety and security in this digital age. Even though the government doesn't explicitly support two-wheelers ride-hailing, their effort to regulate this area shows no intention to forbid it, signifying an acceptance of this modern mode of transportation.

The two companies have already initiated fleet electrification plans, eyeing complete transitions to electric by 2030. These plans involve pilot programs deploying electric two-wheelers across Jakarta and beyond, often in collaboration with vehicle manufacturers and technology providers. These collaborations include partnerships with manufacturers such as Astra Honda Motor, Gesits, and Viar, among others, in the pursuit of testing and rolling out electric two-wheelers. Supported by CMMIA, Grab has also created an Electric Vehicle Ecosystem Roadmap, paving the way for the wider use of BEVs. Furthermore, Gojek and Grab have taken an initiative step by allowing consumers to choose whether to use electric motorcycles or not, providing flexibility in the ongoing electrification process.

Grab and Gojek stated that further fiscal incentives are required to accelerate the electric two-wheelers adoption rate.



Aside from the major ride-hailing operators, other companies are also contributing to the cause of electric two-wheelers adoption and the wider EV ecosystem. Several logistics companies, for instance, Lazada, AnterAja, and Paxel, among others, have started to adopt e-motorcycles in their fleets. The local e-motorcycle industry is growing, with more than 50 registered players by mid-2023, ranging from SOE subsidiaries to small-medium enterprises.

Charging infrastructure providers, especially battery swapping stations, are progressing with some of the players being large energy companies or e-motorcycle manufacturers. There is also Indonesia Battery Corporation (IBC), a joint venture of four state-owned enterprises, formed by the national government to develop the EV battery industry ecosystem, encompassing upstream to downstream processes, including charging station infrastructure and battery recycling.

State-owned banks such as Bank Rakyat Indonesia (BRI) and Bank Mandiri offer financial support mechanisms like small business credit services for ride-hailing drivers, making it easier for drivers to transition to EVs. The banks also support the broader EV ecosystem through financing, transaction and cash management, and treasury solutions.

These collaborative efforts have yielded a significant impact. Through electrification efforts, ride-hailing companies have not only set the pace for a transition to cleaner transportation but have also demonstrated the economic viability of such a move. Such initiatives, coupled with the proactive roles of other private entities and the government, underpin the robust momentum towards electric two-wheelers adoption in Jakarta.

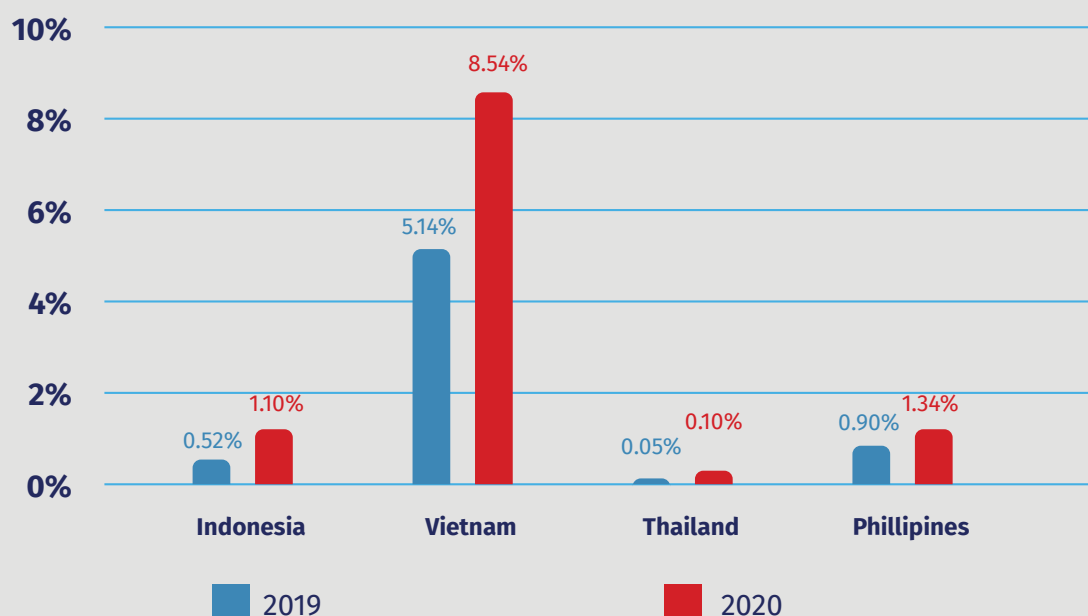
These concerted efforts underscore a broad, multidimensional strategy that could serve as a model for other cities worldwide, ushering in a new era of sustainable urban mobility.

2.3 CURRENT ELECTRIC TWO-WHEELERS UPTAKE, BARRIERS, AND OPPORTUNITIES

Indonesia, like many countries across the globe, is gradually shifting towards EV implementation. As of March 2023, there were around 43,000 e-motorcycles in operation in Indonesia, showing almost 120% YoY growth. Nevertheless, in terms of market share, the sales of e-motorcycles only comprise around 1% of the annual motorcycle sales in 2022. Given that there are almost 130 million ICE motorcycles in Indonesia, the number of e-motorcycles is still insignificant yet shows immense growth potential.

Figure 7 Change in Electric Two-Wheelers Market Share as Compared to Two-Wheelers Sales

Source: UNEP and ITDP Indonesia (2022). Supporting E-mobility focusing on Electric Two- and Three-wheelers and Policies on Urban Traffic Integration in Indonesia.



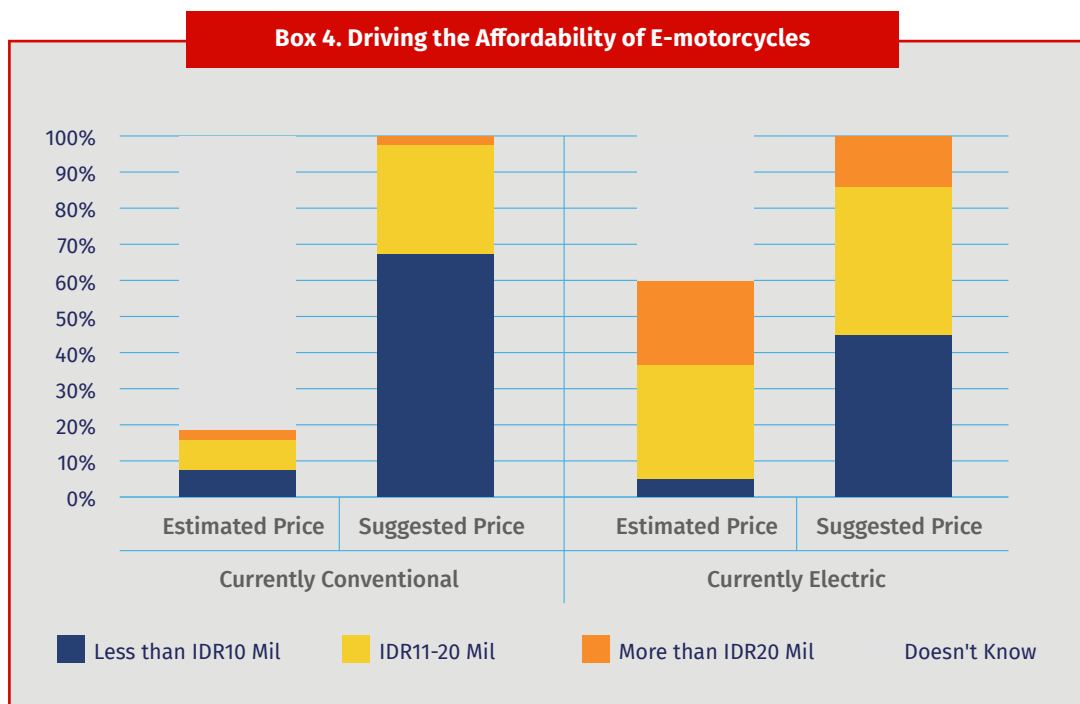
Fewer data is available regarding the use of e-bikes, e-mopeds, and other electric two-wheelers since, currently, vehicle registration is only mandatory for e-motorcycles. However, one can argue that e-bike and e-moped usage is becoming more visible, including in cities outside Jakarta, such as Surabaya.

Nevertheless, the rise is plagued by road safety issues, especially concerning underage users. In Jakarta, electric micromobility—particularly e-bikes and e-kickscooters—was quite popular until 2019. The popularity of these vehicles, primarily for recreational purposes, surged with a shared e-kickscooter service known as Grabwheels. However, the operation of this service was suspended following a number of fatal accidents and a subsequent ban on e-kickscooters on public roads. Current regulations now restrict e-kickscooters to operate only on designated cycling infrastructure and certain areas, and the service has not yet regained its previous popularity.

More recently, a number of fatal road accidents involving electric bicycles ridden by underage users have prompted several local governments to ban the mode on roads. Also, in response, the MoT is currently planning to further regulate electric micromobility usage to improve road safety.

Figure 8 Estimated and Suggested Electric Two-Wheelers Price by Drivers

Source: UK PACT and ITDP Indonesia (2022). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta.



In a 2021 survey¹⁰, most ICE motorcycle ride-hailing drivers were unaware of how much e-motorcycle costs. Almost 70% of them suggest the price is less than IDR10 million. Interestingly, the drivers that are already using e-motorcycles have a higher suggestion of price point for e-motorcycles, as the share of drivers who suggest the price for under IDR10 million and in the range of IDR11-20 million are relatively even. Although this suggested price might not represent their financial capabilities, it might be considered a competitive price.

Table 3 Drivers' Financial Capabilities for Purchasing Conventional Two-Wheelers

Source: UK PACT and ITDP Indonesia (2022). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta

	In Cash	Using Credit Schemes	
	Vehicle Price (IDR)	Down Payment (IDR)	Monthly Instalment (IDR)
Min	1.500.000	500.000	200.000
Max	33.000.000	5.000.000	2.000.000
Average	14.008.567	2.046.429	825.661
25th Percentile	8.777.778	777.778	604.814
50th Percentile	12.884.615	1.500.000	781.056
75th Percentile	17.261.905	2.500.000	957.298

Analysis was also made on the current 25th, 50th, and 75th percentile of the above-mentioned drivers' financial capabilities related to vehicle acquisition. It was shown that 50% of current drivers would not pay higher than IDR800,000 in monthly installments to acquire their two-wheelers. These figures might be useful to assess how much drivers could actually afford electric two-wheelers based on their price.

¹⁰ UK PACT and ITDP Indonesia (2022). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Output 3.1 Report of Current Perspectives on Ride Hailing Service and Electrification



There are a host of challenges that need to be addressed to improve the current uptake and road safety issues. The primary barriers to uptake seem to be the higher purchasing price of electric two-wheelers and the lower performance compared to ICE motorcycles.

Other notable concerns include limited driving range or “range anxiety”, exacerbated by high ambient temperatures that affect battery performance, congestion, and the lack of available public charging infrastructure, including battery swaps. Add to this, the issue of unstable electricity in many Indonesian regions, which affects both public and private charging infrastructures, may become a significant impediment.

Low public awareness is another formidable obstacle in the path of electric two-wheelers adoption. A lack of understanding regarding the technology, total cost savings in the long term, environmental impact, and available charging infrastructure are deterring potential consumers.

Some common misconceptions, such as concerns over electrocution when an EV passes flooded roads or the perception that all electric two-wheelers are low-powered, also prevent prospective buyers from making a purchase. Additionally, despite the significant operational cost benefits of electric two-wheelers, conveying this advantage to consumers is challenging due to its long-term nature.

On the supply side, manufacturers face their own set of challenges. According to interview sessions with three domestic OEMs in Indonesia in 2022, the slow uptake of demand due to the discussed reasons above is still the main obstacle, and the current government incentives are perceived as insufficient. This calls for the need for stronger incentives and policies, including disincentives for ICE vehicles. Additionally, test drives, positive publications, and positive word of mouth are considered by the engaged OEMs to be effective in improving the e-motorcycles market.

Moreover, the business-to-business (B2B) scheme is a major driver of current electric two-wheelers sales, especially e-motorcycles. Sales or service provisions of vehicles for ride-hailing, logistics, and delivery companies, as well as government fleets, play critical roles in this initial phase of electric two-wheeler uptake. This offers a window for the government to commit to a gradual transition of electric two-wheelers starting from fleet vehicles. Additionally, battery and charging infrastructure need to be standardized to ensure safety and accelerate the provision of battery-swapping facilities.

From Gender Equality, Disability and Social Inclusion (GEDSI) perspective, the electrification of online ride-hailing may boost the participation of women and people with disabilities in jobs, both in the usage of e-bikes or e-motorbikes. Based on ITDP’s study in 2022, there is a potential increase of female (single parent or head of family) participation as drivers up to 224.8% in 2030. These momentum can be used as well to set ‘area-based services’ policy to meet the road safety concerns where women prefer to take food delivery orders rather than people or goods delivery services. In average, about 3.63 km are traveled to provide food delivery services which is good to complete the expected Low-Emission Zone and/or other advanced spatial policies in the future.

In addressing the obstacles on both the demand and supply side, the key main recommendations for the national and local governments of Indonesia are outlined below:



1. Link clear electric two-wheelers adoption targets and roadmaps with national strategic documents and commit budgets.



2. Achieve cost parity by providing fiscal incentives.

- a. Introduce targeted purchase price subsidies, including for e-bikes, which should be coupled with a green vehicle replacement program.
- b. Offer tax incentives for electric two-wheelers and impose tax disincentives for ICE two-wheelers.
- c. Reduce other financial benefits for ICE vehicles, such as increasing the minimum down payment for ICE motorcycles.
- d. Stimulate attractive financing schemes and insurance packages for electric two-wheeler purchases.



3. Ensure safety by implementing technical and operational standards for vehicles, batteries, and charging infrastructure.

- a. Clearly classify electric two-wheelers based on maximum speed and weight.
- b. Clearly regulate vehicle safety and operational standards, including speed, dimension, and street management for each type of two-wheelers.
- c. Implement charging infrastructure safety standards.
- d. Ban lead acid batteries.
- e. Regulate battery waste management.



4. Make riding electric two-wheelers more convenient than ICE two-wheelers.

- a. Improve fuel economy standards
- b. Establish Low Emission Zones/Zero Emission Zones.
- c. Offer exemptions from road access restrictions and reduce parking fares, especially during the initial phase of encouraging electric two-wheelers adoption.



5. Incentivize industry players to provide high-performance models.

- a. Carefully design purchase price subsidies and industry incentives, e.g. by setting subsidy eligibility requirements to higher performance models.
- b. Set public fleet procurement requirements to higher performance models.
- c. Provide incentives or programs for research and development and capacity building.



6. Eliminate range anxiety by improving access to charging infrastructure

- a. Set the national-level guideline and city-level targets for charging infrastructure provision.
- b. Offer fiscal support for charging infrastructure provision.
- c. Update building codes to facilitate charging infrastructure provision in buildings.
- d. Allow government assets to be used as charging infrastructure locations.
- e. Introduce battery swap station standardization in consultation with the industry players.



7. Establish public campaign programs to mainstream electric two-wheelers information

- a. Develop an accessible one-stop informational website for electric vehicle models and incentive programs in collaboration with industry players.
- b. Organize and sponsor offline electric two-wheeler conventions.
- c. Develop public communication strategies on electric two-wheelers safety and operations.

KEY TAKEAWAYS



The Government of Indonesia has implemented a comprehensive approach, involving various ministries, to support and regulate the use of electric two-wheelers. Nevertheless, the supportive policies are still mostly focused on e-motorcycles instead of also including e-bikes which can offer more inclusive benefits.



Fleet vehicles, from ride-hailing and logistic services to government fleets are currently driving the adoption of electric two-wheelers in Indonesia.



The current uptake of electric two-wheelers remains low due to barriers such as higher costs, limited driving range, lack of charging infrastructure, low public awareness, and unstable electricity in some regions.



To boost electric two-wheelers adoption, the government should consider stronger incentives and policies, standardized battery and charging infrastructure, and target companies to transition their operational fleets to EVs.

3 Promoting Road Safety Through the Adoption and Regulation of Electric Two-Wheelers

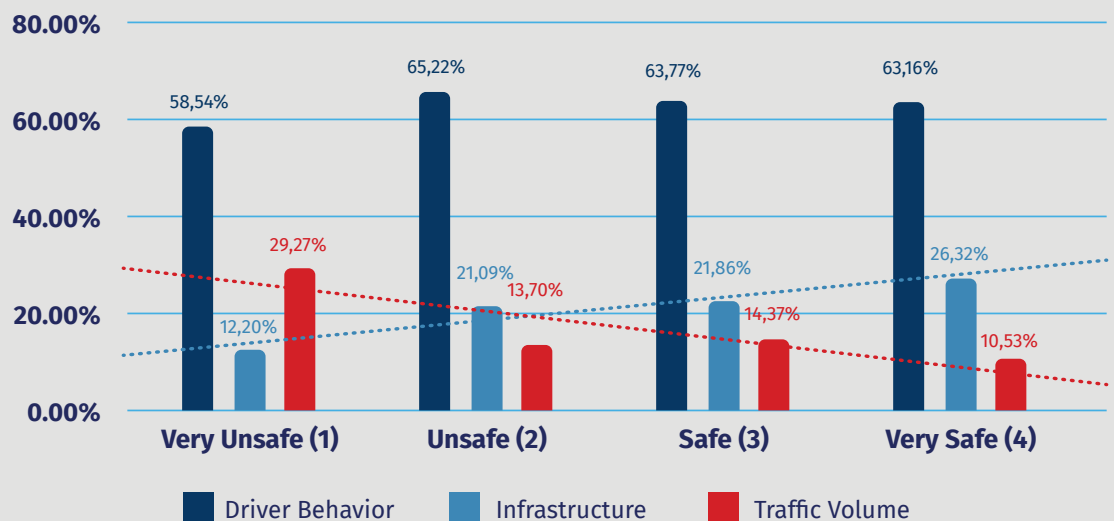
3.1 ROAD USERS' PERSPECTIVE AND CONCERNS REGARDING SAFETY

ITDP and UK PACT conducted a study to understand road users' perspectives and concerns about current motorcycle usage and anticipate potential issues with future widespread electric two-wheelers adoption.

In Greater Jakarta, local roads are generally perceived to be safer than collector and arterial roads, primarily due to their lower traffic volume. Even though many respondents cited driver behavior as influencing their safety perceptions, the availability of suitable infrastructure, such as sidewalks and pedestrian crossing facilities, and traffic volume levels had a stronger correlation with safety perceptions, as shown in Figure 9. Therefore, adequate infrastructure and reduced traffic could lead to improved safety perception. Driver behavior, however, was inconsistently rated, suggesting it remains an influential yet complex factor to address.

Figure 9 Factors Affecting Road Safety Perception Related to Motorcycles

Source: UK PACT and ITDP Indonesia (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta



Further analysis was also conducted towards motorcycle safety level, rated by all types of road users, including car users, cyclists, and pedestrians. In general, all road users rated motorcycle safety performance in Greater Jakarta moderately between safe and unsafe, regardless of road type. One interesting finding was that car users tend to perceive motorcycles to be less safe than what is currently perceived by other road users.

On the matter of electric vehicles, a significant number of respondents are familiar with electric vehicles, but fewer know about charging infrastructures. While the majority are not concerned about using electric two-wheelers, those who are worried primarily cite the vehicle's specifications as a cause for concern. Specifically, the quiet nature of electric two-wheelers makes them harder to detect on the road, potentially posing risks. Their lower speed is also a cited concern, as several respondents perceived that they could impede faster-moving traffic or cause delays for other road users if allowed to be driven on motorized vehicle lanes.

Given their concerns, respondent made a few safety improvement recommendations. To enhance road safety, particularly for older persons and people with disabilities (PwD), it is recommended to address rule-breaking behaviors that are often displayed by motorcycles, like riding on sidewalks. Women have expressed concerns about safety in high-crime areas, suggesting increased surveillance systems are needed. For increased comfort, especially for older persons and children, better and well-maintained pedestrian infrastructure is necessary.



Table 4 Safety Improvement Suggestions by Vulnerable Road Users for Regulating Electric Motorcycles

Source: UK PACT and ITDP Indonesia. (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta

Road Users' Profile	1 st Recommended Policy	2 nd Recommended Policy	3 rd Recommended Policy
All Respondents	Special lane	Special vehicle's plate	Minimum noise produced
Older Persons	Special lane	Speed restriction	Minimum noise produced
People with Disabilities	Minimum noise produced	Minimum brightness of headlight	Differentiation with electric bike

Regarding some concerns about specifications like speed and sound, respondents suggest recommendations as shown in Table 4. There is also a call for better familiarity with charging infrastructures, especially among older persons.

From a regulatory standpoint, a consistent view across demographics is the need for dedicated lanes for electric two-wheelers, followed by speed limits. PwD has unique concerns, emphasizing the need for minimum sound standards, headlight brightness, and clearer distinctions between electric motorcycles and electric bikes. They also recommend standard safety features for electric motorcycles and better education for PwD on electric vehicle usage.

3.2 REGULATION OF ELECTRIC TWO-WHEELERS TO IMPROVE ROAD SAFETY

The adoption and regulation of electric two-wheelers present a unique opportunity to enhance road safety and transform urban transportation policies. This comprehensive approach involves targeted action items that address various aspects of street design, management, user behavior, and vehicle regulation, as shown in Table 5. By systematically addressing these elements, the Government of Indonesia can effectively promote the adoption of electric two-wheelers while ensuring road safety for all users.

Topic	Recommendations	Regulator and/or Implementer				Prioritization
		Ministry of Transportation	Ministry of Public Works and Public Housing	Jakarta Transport Agency	Jakarta Public Works Agency	
Street Design and Operations	1. Modify Lane Assignment	✓		✓	✓	Medium
	2. Lower Vehicle Speed	✓	✓	✓	✓	High
	3. Reduce Conflicts	✓	✓	✓	✓	High
Street Management	4. Limit Through Traffic		✓	✓	✓	Medium
	5. Manage Curb Use		✓	✓	✓	Low
Street Users	6. Encourage Last Mile Connectivity with Transit	✓		✓		Low
	7. Clarify Minimum Age, Permit, And Safety Accessories	✓				Medium
Vehicle	8. Require Speed Limiters	✓				High
	9. Require Noise Limiters and AVAS	✓				Low

Table 5
Action Items and
Prioritization

Source: UK PACT and ITDP Indonesia. (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta

In the context of street design and operations, modifications to lane assignments can contribute significantly to road safety. Addressing the concerns of slower vehicles within faster traffic involves revisiting lane assignments. By designating separate lanes for vehicles with different speeds and revising existing regulations, cities can ensure a safer coexistence between different modes of transportation. Moreover, recognizing speed as a primary determinant of road safety, lowering speed limits becomes imperative. Leveraging the inherently lower speeds of electric two-wheelers provides an opportunity to reduce accidents and injury severity, fostering safer urban streets. These adjustments go hand in hand with addressing high-conflict areas, such as intersections and bus stops. By reimagining the design of these zones, prioritizing vulnerable road users, and updating policies, cities can minimize accidents and enhance overall safety.

Figure 10 Speed Restriction and Lane Assignments Modification

Source: UK PACT and ITDP Indonesia. (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta



Effective street management strategies are essential to create safer urban environments and encourage sustainable transportation modes. Restricting traffic in residential areas not only improves safety but also enhances the quality of life. Tailoring traffic networks, installing barriers, and optimizing curb space all contribute to safer and more accessible streets. Additionally, efficiently utilizing curb space is vital for enhancing road safety. Reserving waiting zones for electric two-wheelers, along with proper management, ensures safer interactions between different types of vehicles and pedestrians.

**Figure 11 Through
Traffic Restrictions
in Residential Areas**

Source: UK PACT and ITDP
Indonesia. (2021). Road Map
and Timetable of Two-
Wheeler Electrification in
Greater Jakarta



Empowering street users to adopt safer practices and promoting integration with public transit contributes to a comprehensive road safety strategy. Ride-hailing can be encouraged as first-last mile connections instead of direct, point-to-point mobility service, so it improves the efficiency of both private and public transportation. By integrating ride-hailing and also possibly bike-sharing systems with public transit, cities can create a more cohesive and sustainable transportation system.

Clearly defining regulations surrounding electric two-wheelers use, including minimum age requirements, permits, and safety accessories, establishes standardized practices and fosters a safer urban environment. Moreover, regulating vehicle characteristics and performance is essential to ensure safe and harmonious traffic flow. Mandatory speed limiter installation on electric two-wheelers addresses the issue of excessive speeds and enhances road safety. Furthermore, ensuring electric vehicles emit minimum noise levels by equipping them with Acoustic Vehicle Alert Systems (AVAS) enhances safety for pedestrians and visually impaired road users. By mandating these features and enforcing compliance, cities can create a safer and more inclusive urban environment.

Micromobility and beyond

Micromobility is swiftly becoming an integral part of the global transportation matrix, offering sustainable, efficient, and accessible means of transit for short distances. Predominantly marked by its lightweight and environment-friendly modes, micromobility solutions bridge the gap between traditional public transport and destination points, proving indispensable in congested urban landscapes.

Micromobility is recommended to encompass vehicles that are lightweight, small, and generally designed for speeds below 25 km/h, covering distances up to 10 km. These mobility devices can either be powered by human effort or electricity and can be owned privately or rented. Devices under the micromobility banner should not employ conventional fuels (combustion engines). Therefore, it is important to note that electric motorcycles and ICE motorcycles, while being part of the broader two-wheelers spectrum, do not fall under the micromobility category.

The variety of devices classified under micromobility is vast. Two-wheeled vehicles include pedal or electric bicycles and e-mopeds. Three-wheeled vehicles comprise cargo bikes, which can be pedal-driven or electric, and rickshaws, commonly known as “becak,” that can come in pedal or electric variants. There are also Personal Mobility Aids (PMA), including electric wheelchairs, and a range of Personal Mobility Devices (PMD) such as manual and electric kick scooters, self-balancing devices (e.g., Segway or electric unicycles), and skateboards, whether manual or electric.

Electric kick scooters provide a convenient and eco-friendly solution for short-distance travel. Oftentimes, workers use this vehicle from the train station to their office.



Recommended classification and regulation for motorized vehicles and micromobility devices

Given the wide range of devices that fall under the micromobility category, each with its own set of capabilities and limitations, there is a need for comprehensive classification and regulations, particularly for two-wheelers. Regarding classification, the recommended classification is outlined in Figure 12.

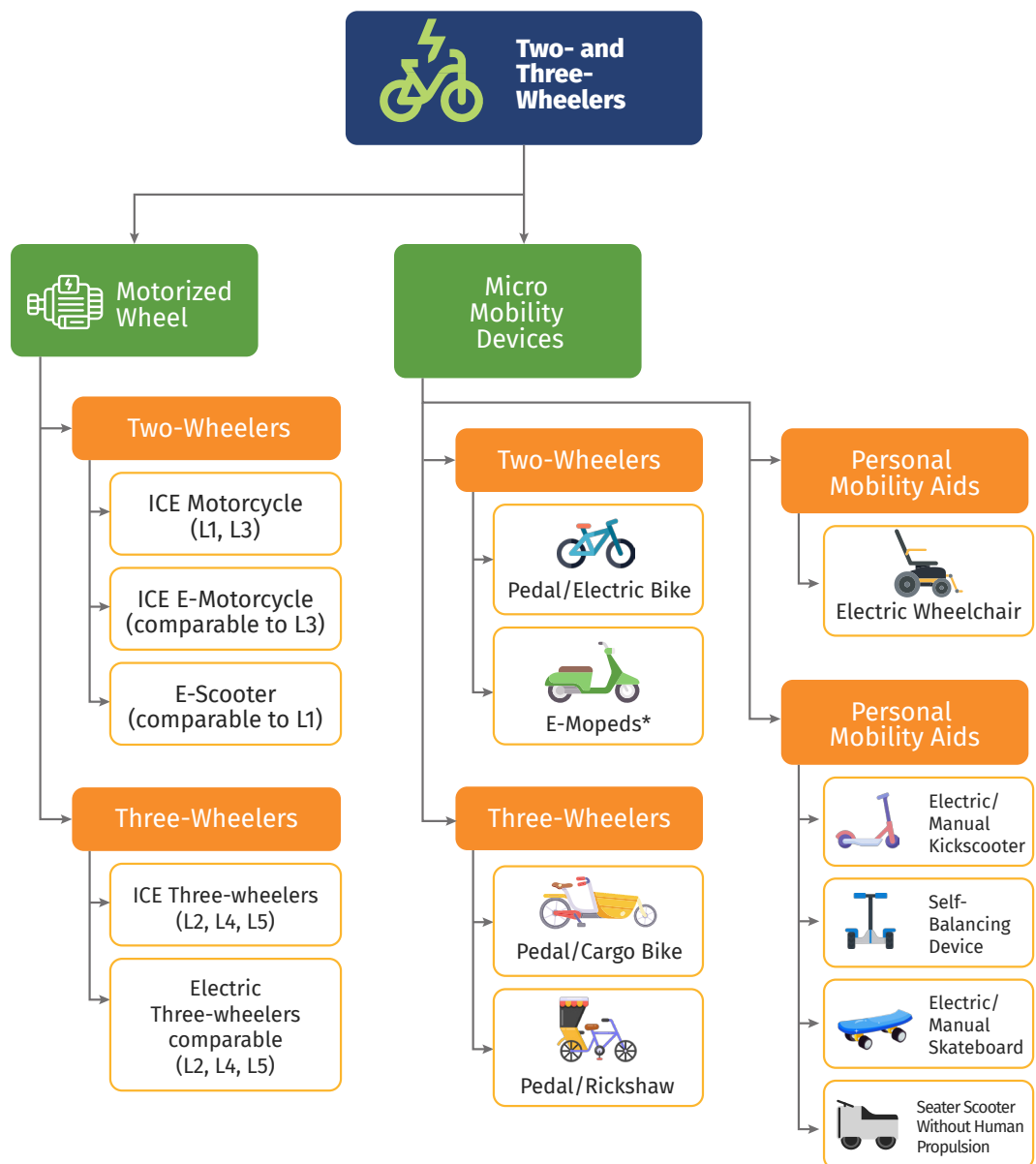








Figure 12 Proposed Classification of Two- and Three-Wheelers in Indonesia

*Note on using the term "e-moped": Internationally, mopeds are known as two-wheeler vehicles with less power than scooters. Therefore, in this English version, the term "e-moped" is used to describe a type of two-wheelers within the micromobility group. This replaces the term used in MoT Regulation 45/2020, which is "skuter listrik"—its direct translation is "e-scooter"—to denote this lower-power type of electric two-wheelers. Consequently, in this English version, "e-scooter" refers to electric two-wheelers that have higher power and speed limits than e-mopeds but are less powerful than e-motorcycles (which are comparable to L1 type ICE motorcycles).

Table 6 Recommended Regulations for Motorized Vehicles and Micromobility Devices in the Two-Wheelers and PMD segments

Based on the above classification, Table 6 highlights the recommendations for road users and vehicle regulations for two-wheelers. The recommendations are focused on two-wheelers and personal mobility devices (PMD).

Classification	Class	Type	Type			Users				Operational area				Examples
			Max. speed	Max. weight	Pedal	Driving Pedal license	Vehicle registration (plate number)	Mandatory helmet usage	Minimum age of user	Sidewalk < 10 km/h	Cycling lanes < 25 km/h	Motorized vehicle lanes	Designated area (e.g. housing/tourism area with clear boundaries)	
Non-motorized Micro-mobility	Class 2	Bicycle	-	35kg	✓	✗	✗	✗	-	✓	✓	✓	✓	
Electric micro-mobility	Class 2a	E-bikes (Pedal Assist Only)	< 25 km/h	35kg	✓	✗	✗	✓ <17 yo	12-16yo require adult supervision	✗	✓	✓ >17yo	✓	
	Class 2b	E-moped (Throttle dan Pedal Assist)	< 25 km/h	35kg	✓	✗	✗	✓	17	✗	✓	✓	✓	
Electric two-wheelers	Class 2c	E-scooter (Comparable to L1)	25-50 km/h	350kg	✗	✓	✓	✓	17	✗	✗	✓	Depends on area regulation	
	Class 2d	E-motorcycle (Comparable to L3)	> 50 km/h	350kg	✗	✓	✓	✓	17	✗	✗	✓	Depends on area regulation	
ICE/conventional motorized two-wheelers	Class 2e	Motorcycle (L1, L3)	-	-	✗	✓	✓	✓	17	✗	✗	✓	Depends on area regulation	

Classification	Type	Type		Users				Operational area				Examples
		Max. speed	Max. weight	Driving Pedal license	Vehicle registration (plate number)	Mandatory helmet usage	Minimum age of user	Sidewalk < 10 km/h	Cycling lanes < 25 km/h	Motorized vehicle lanes	Designated area (e.g. housing/tourism area with clear boundaries)	
Non-motorized Micro-mobility	Skateboard	-	35kg	✗	✗	✗	-	✓	✓	✓	✓	
	Manual Kickscooter	-	35kg	✗	✗	✗	-	✓	✓	✓	✓	
Electric micro-mobility	Electric skateboard	< 25km/h	35kg	✗	✗	✗	17	✗	✓	✓	✓	
	Electric Kickscooter	< 25km/h	35kg	✗	✗	✓ <17yo	12	✗	✓	✓ >17yo	✓	
	Seated scooter without human propulsion	< 25km/h	35kg	✗	✗	✗	17	✗	✓	✓	✓	
	Self-balancing devices	< 25km/h	35kg	✗	✗	✗	17	✗	✓	✓	✓	

In general, the key recommendations are as follows:



1. All non-motorized micromobility devices should be permitted on cycling lanes and sidewalks (in the absence of a cycling lane), as long as they adhere to speed limits and prioritize pedestrian safety and mobility. Electric-powered vehicles, including electric micromobility, should not be allowed on sidewalks.



2. The speed of electric micromobility devices should be capped at 25 km/h with a weight restriction of 35 kg. Personal mobility aids, such as electric wheelchairs, and three-wheelers such as cargo bikes can weigh more while keeping the speed limit, but this is beyond the scope of the recommendations made in this report. For pedal-assisted bicycles and e-mopeds, the additional electric drive should be deactivated once the speed reaches 25 km/h. Vehicles surpassing the designated speed and weight limits should be categorized as motorized vehicles, obliging them to comply with associated regulations. These regulations encompass vehicle registration and the display of license plates, compulsory helmet usage, and a prerequisite for users to possess a valid driver's license.



3. Users of electric micromobility in the two-wheelers and PMD segments, except for e-bikes and e-kickscooters, should ideally be 17 years or older.

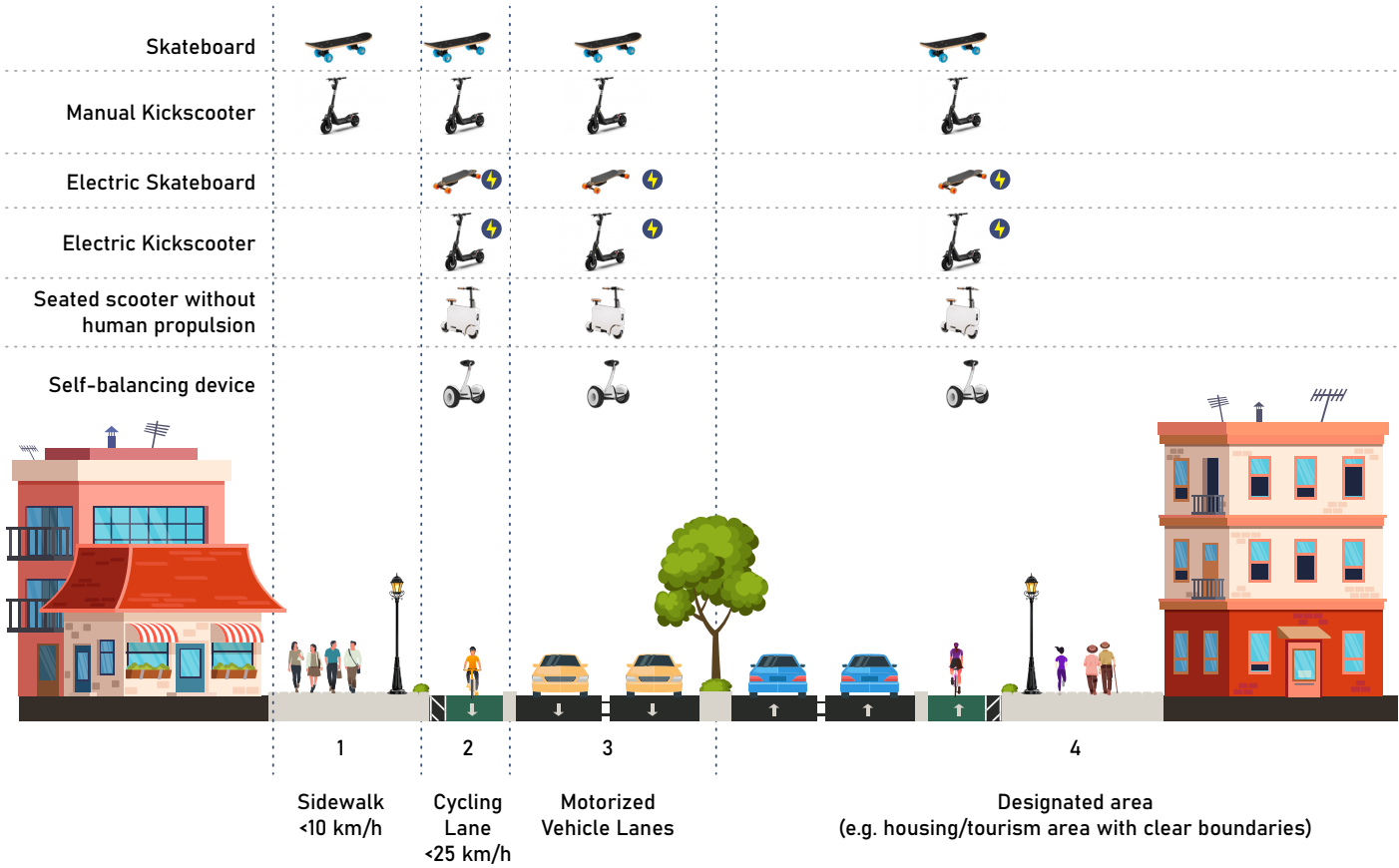


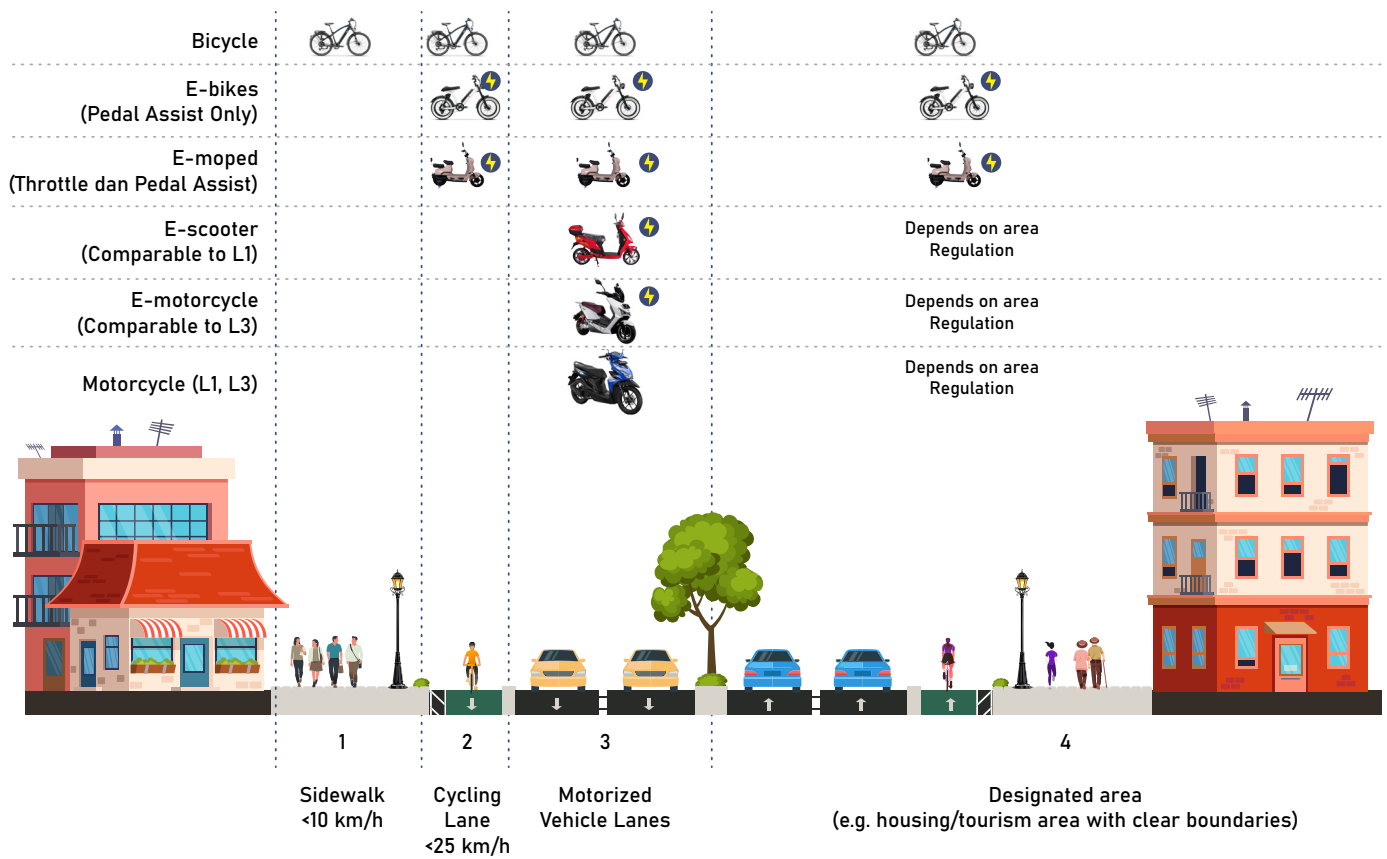
4. Vehicle registration and a plate number should be mandatory for vehicles capable of exceeding a speed of 25 km/h.

Figure 13
Illustration of
Recommendations
of Road Allocation
for Two-Wheelers

Moreover, other specific guidelines are also recommended for two-wheelers and micromobility devices based on their characteristics and usage. For example, electric bicycles and kick scooters are permitted for use by individuals aged 12 and older with adult supervision. In contrast, other electric micromobility and motorized two-wheelers are only allowed for those aged 17 years and older. Nevertheless, the use of electric bicycles and e-kickscooters by those under 17 years old are recommended to be restricted on cycling lanes and designated areas for electric micromobility, such as residential or tourism areas with clear boundaries.

It is recommended for the government to establish a regulation stating clear road allocation for each type of two-wheelers. The recommendations for two-wheelers road allocation are as illustrated below.





KEY TAKEAWAYS



Road safety perceptions of motorcycle usage from other road users are strongly influenced by the availability of suitable infrastructure and traffic volume, with additional concerns arising from the silent operation and slower speeds of electric two-wheelers.



The introduction and regulation of electric two-wheelers offer an opportunity to improve road safety, requiring a combination of street design changes, traffic management strategies, and user behavior adjustments.



Micromobility, as defined by the ITDP, focuses on lightweight, eco-friendly transportation modes designed for short distances, with specific regulations based on device type and features.



Clear classification for two-wheelers is needed to enforce specific regulations for each class, avoid grey areas of traffic regulations and law enforcement, and streamline their integration into the existing transportation ecosystem, enhancing both safety and usability. Manufacturers of two-wheelers should also adhere to the classification and produce compliant products.



4 Moving Forward

The adoption of electric two-wheelers is more than a mere shift in the mode of transportation. It represents a new vision for Indonesia's urban landscape, one that promises a safer, cleaner, and more sustainable environment. However, this vision is not self-executing. It demands concerted efforts, thoughtful regulations, and strategic incentives. The journey to a more sustainable mobility system and safer road environment in Indonesia begins with a thorough rethinking of its road safety regulations and transportation systems.

The road safety challenges faced by Indonesia are not impossible to tackle. Through strategic planning, careful execution, and ongoing evaluation, these challenges can be overcome. Policies that incentivize the adoption of electric two-wheelers, along with the introduction of stringent safety regulations, and prioritize the convenience of using these vehicles are a fundamental part of this strategic approach. To make these changes possible, the government needs to commit substantial resources and strong policies to facilitate the transition.

Improving road safety through the adoption of electric two-wheelers also requires a radical change in mindset and habits. This is a change that must spread through every level of society. It involves respect for traffic rules, enforcement of lane designations, use of safety equipment, and recognition of the rights and safety of all road users. This necessitates a strong law enforcement system, such as by widely establishing ETLE on Indonesian roads, as well as comprehensive educational campaigns that reach all corners of society.

While the government plays a pivotal role in improving road safety, the responsibility does not lie solely with it. Everyone, from industry players to everyday road users, has a role to play in this transition. This includes adhering to vehicle regulations and road safety rules, contributing to research and development, and sharing accurate information about these vehicles.

Going forward, the road to a cleaner, safer Indonesia requires urgent action, thoughtful planning, and the collective effort of all members of society. Every step taken towards the adoption of electric two-wheelers, every rule enforced, and every safe driving habit adopted brings Indonesia closer to this goal. The task may seem daunting, but the potential rewards – safer roads, cleaner cities, and a more sustainable future – make the effort worthwhile. It is a journey that Indonesia must embark on with urgency and determination.

REFERENCES

Institute for Transportation and Development Policy (ITDP) dan The United Nations Environment Programme (UNEP). (2022). *Recommendations Of National Policies And Standards On Electric 2&3 Wheelers In Indonesia: Supporting E-Mobility Focusing on Electric Two- and Three-Wheelers And Policies On Urban Traffic Integration In Indonesia*.

Institute for Transportation and Development Policy (ITDP) dan The United Nations Environment Programme (UNEP). (2022). *Supporting E-mobility focusing on Electric Two- and Three-wheelers and Policies on Urban Traffic Integration in Indonesia: Baseline Assessment of 2&3W in Indonesia*.

Institute for Transportation and Development Policy (ITDP) dan The United Nations Environment Programme (UNEP). (2022). *Supporting E-mobility focusing on Electric Two- and Three-wheelers and Policies on Urban Traffic Integration in Indonesia: Guidelines On The Integration Of Electric Two- and Three-Wheelers In Urban Traffic*.

UK PACT dan ITDP Indonesia. (2021). *Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Report of Broader Motorcycle Landscape in Greater Jakarta*.

UK PACT dan ITDP Indonesia. (2021). *Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Timetable and Roadmap for Ride-Hailing Fleet Electrification*.

UK PACT dan ITDP Indonesia. (2021). *Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Road Users' Perspectives and Concerns*.

UK PACT dan ITDP Indonesia. (2022). *Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta: Electric 2W Integration to Urban Traffic Guideline*.

