

THE URGENCY OF REGULATING ELECTRIC BICYCLES IN THE ROAD TRAFFIC AND TRANSPORTATION LAW IN THE ERA OF TECHNOLOGICAL ADVANCEMENT

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Abstract

This study explores the legal framework and challenges in regulating electric bicycles (e-bikes) in Indonesia, particularly in the context of technological advancements in transportation. Employing a normative juridical approach combined with conceptual and comparative analysis, this research identifies the legal gap between the national traffic law and implementing regulations concerning hybrid vehicles. The findings highlight the absence of specific provisions governing e-bikes in Law Number 22 of 2009 on Road Traffic and Transportation, causing legal uncertainty and potential safety issues. The study concludes that a comprehensive revision of the law is necessary to adapt to evolving transportation technologies and to ensure legal protection and safety for all road users.

Keywords: E-bike regulation; legal framework; road safety; hybrid vehicle; transportation law.

1. Introduction

The development of global transportation technology has experienced significant acceleration, particularly with the emergence of environmentally friendly vehicles such as electric bicycles. This transformation not only enhances the efficiency of mobility but also contributes to efforts to mitigate climate change by reducing greenhouse gas emissions (Tsemekidi Tzeiranaki et al., 2023). However, the increase in the number of vehicles, including electric bicycles, has also created new challenges in terms of regulation and traffic safety. Philosophically, the law functions as an instrument that responds to social and technological dynamics, adapting itself to the ever-evolving needs of society (Ogugua, 2015). In this context, Law Number 22 of 2009 concerning Road Traffic and Transportation in Indonesia serves as the main legal foundation governing the national

transportation system. Nevertheless, the emergence of electric bicycles as a new mode of transportation raises questions about the appropriateness of their classification within the existing legal framework. From a sociological perspective, the adoption of electric bicycles by the public reflects a shift in preferences toward more sustainable transportation modes, although regulations governing their use remain inadequate.

The development of regulations concerning electric motor vehicles has become a focal point in the study of transportation law, particularly in line with the adoption of environmentally friendly electric-based vehicles. Previous studies have primarily focused on the regulation of larger electric vehicles such as cars and motorcycles, which are specifically regulated within the context of energy and environmental policies. (Khan et al., 2015) However, the regulation of electric bicycles as hybrid vehicles that combine electric power and human pedaling has not received sufficient attention in legal literature. Previous studies have tended to overlook the legal classification of electric bicycles, which occupy an intermediate category between motor vehicles and non-motorized vehicles. This indicates a regulatory gap relevant to accommodating the unique characteristics of electric bicycles, in terms of speed, propulsion system, and user safety standards (Lee et al., 2022). The absence of clear regulations creates legal uncertainty, both for users and law enforcement officials. This article seeks to fill this gap by offering a new perspective on the classification and regulation of electric bicycles within the framework of national law. Thus, this study presents a novelty that emphasizes the urgency of revising the Indonesian Road Traffic and Transportation Law to adapt to the advancements of modern transportation technology.

The rising use of electric bicycles in Indonesian society has become a phenomenon indicating a shift in transportation preferences toward environmentally friendly vehicles. However, the popularity of electric bicycles has not been accompanied by sufficient regulatory clarity, creating legal gaps that have the potential to cause serious problems. Incidents involving electric bicycle accidents, whether due to a lack of supervision or use by underage children, serve as concrete evidence of legal risks requiring immediate attention. The lack of clear legal classification for electric bicycles, whether as motor vehicles or non-motorized vehicles, has resulted in a weak legal basis for enforcing regulations, ensuring consumer protection, and maintaining traffic safety (Gkoumas et al., 2021). This situation is further exacerbated by the lack of education on safe usage and the wide variation in technical specifications of electric bicycles available in the market.

Electric bicycles face significant legal challenges due to the ambiguity of their classification within the framework of Indonesian legislation. Law Number 22 of 2009 on Road Traffic and Transportation only includes two main categories of vehicles, namely motorized and non-motorized, without specifically accommodating the presence of electric bicycles, which possess dual characteristics as hybrid vehicles (Nur, 2022). This misalignment has resulted in a legal gap, particularly in aspects such as ownership requirements, the necessity of holding a driver's license, speed limits, and safety standards that should be applied to vehicles with electric mechanical components (Agustina, 2024). In addition, Minister of Transportation Regulation Number 45 of 2020, which regulates electric bicycles as certain types of vehicles, is merely an implementing regulation and does not provide legal force equivalent to that of a law. This gap creates serious implications, such as a weak legal basis for enforcing traffic safety rules for electric bicycle users and uncertainty in legal enforcement on the ground. As a result, comprehensive and explicit regulation at the statutory level has become increasingly essential to ensure adequate legal protection for all stakeholders.

This study employs a normative juridical method with a statutory, conceptual, and comparative approach to understand the regulatory gap concerning electric bicycles within the national legal system. The data used include scientific literature, legislation, legal documents, and light empirical findings that support the analysis. The study adopts a descriptive-analytical method to explore in depth the differences in regulations

between motor vehicles, non-motorized vehicles, and hybrid vehicles such as electric bicycles (Irwansyah, 2020). The legal argumentation is built upon the progressive legal theory, which emphasizes the necessity for law to evolve in accordance with the times and the needs of society. Additionally, comparative analysis is conducted by examining electric bicycle regulatory policies in other countries as a point of reference to formulate adaptive and responsive regulatory solutions (Hadiati, 2024). This approach allows for a comprehensive exploration of philosophical, juridical, and sociological aspects, resulting in conclusions that are not only descriptive but also solution-oriented and progressive. By combining these methods, the findings of this study are expected to make a substantial contribution to the improvement of electric bicycle regulations in Indonesia, in line with the spirit of just and sustainable legal development.

This research aims to identify and formulate a more comprehensive legal regulatory solution regarding the existence of electric bicycles in Indonesia within the framework of the Road Traffic and Transportation Law. The existence of electric bicycles as hybrid vehicles combining human and electric mechanical power has not yet been clearly classified, necessitating a legal basis that can accommodate the realities of modern transportation technology. This study also seeks to establish a juridically acceptable legal classification for electric bicycles, considering their operational speed, power source, and technical specifications that distinguish them from both motorized and non-motorized vehicles. Furthermore, the research aims to propose a revision to the Road Traffic and Transportation Law that is not only adaptive to the advancements in transportation technology but also addresses aspects of safety, environmental sustainability, and consumer protection. By achieving these objectives, this study is expected to make a concrete contribution to the formulation of inclusive and sustainable national transportation policies.

2. Dinamika Perkembangan Teknologi Transportasi di Era Modern

The development of global transportation technology over the past two decades has undergone significant transformation, marked by the increasing adoption of Electric Vehicles (EVs) as part of the energy transition agenda and carbon emission reduction efforts. The growth of the EV market has been driven by both national and international policies that support the shift from fossil fuel-powered vehicles toward low-emission transportation systems. (IEA & AIE, 2023) Transportation technology has evolved into one of the key pillars in achieving the targets of the Sustainable Development Goals (SDGs), particularly in relation to climate change mitigation objectives. Developed countries have integrated electric vehicle transition policies into their national regulations, driving innovation in battery technology, electric motor efficiency, and the development of charging infrastructure to support environmentally friendly mobility (Şengül & Mostofi, 2021).

In addition to larger vehicles such as electric cars, global trends also show a significant increase in micro or personal mobility vehicles, including electric bicycles, electric scooters, and battery-based hybrid vehicles. Such vehicles offer efficient solutions for short-distance transportation, reduce dependence on large-engine private vehicles, and promote healthy lifestyles (Abduljabbar et al., 2021). The application of environmentally friendly technology is also in line with the philosophy of sustainable development, which integrates economic, environmental, and social aspects, with an emphasis on reducing carbon footprints and improving urban air quality. In the global context, electric bicycles are not merely a technological innovation but also represent a paradigm shift in transportation that is more inclusive and responsive to climate change. This concept of green mobility has become a focal point for policymakers and industry stakeholders to ensure a balance between energy efficiency, user safety, and the sustainability of urban ecosystems.

International policies supporting electric vehicles, including the commitment

to reducing greenhouse gas emissions under the 2015 Paris Agreement, provide a strong impetus for the development of sustainable transportation technology. These initiatives emphasize the necessity for adaptive and innovative regulatory frameworks to accommodate the dynamics of modern transportation technology development. Therefore, the advancement of electric vehicles, including electric bicycles, requires regulatory support that is responsive to technological changes and the evolving needs of global society.

In Indonesia, the development of electric vehicles has experienced significant growth alongside the government's policy push to reduce dependence on fossil fuels and lower urban air pollution levels. Through Presidential Instruction Number 7 of 2022 on the Use of Battery-Based Electric Motor Vehicles as Government Service Vehicles, the country demonstrates its political commitment to accelerating the transition toward sustainable transportation. This policy is reinforced by Presidential Regulation Number 55 of 2019, which governs the acceleration of the battery-based electric motor vehicle program as part of the national effort to address climate change challenges and enhance national energy resilience. The market response to these policies is evident in the increasing penetration of electric vehicle products, including electric bicycles, offered by various domestic and international manufacturers at increasingly affordable prices.

The increasing use of electric bicycles in urban communities is driven by considerations of efficiency, ease of daily mobility, and low operational costs. Electric bicycles have become a popular alternative for students, daily workers, and younger age groups, especially in densely populated areas with limited accessibility for conventional motor vehicles. This trend is also influenced by the growing public awareness of environmental issues and green lifestyles, encouraged by public campaigns and support from electric vehicle user communities. However, regulatory policies for electric bicycles in Indonesia remain fragmented and have not yet been comprehensively integrated into the national transportation legal system.

Minister of Transportation Regulation Number 45 of 2020, which regulates the use of certain electric motor-based vehicles, serves as the only technical guideline for vehicles such as electric bicycles. However, this regulation is administrative in nature and does not carry the same legal weight as a statutory law, leading to legal uncertainty in aspects of safety, vehicle classification, and rider responsibility in cases of violations or accidents. The imbalance between market development and the regulatory framework has the potential to create normative confusion in practice, particularly in the context of law enforcement and protection for road users.

Electric bicycles have become a symbol of technological innovation in transportation widely embraced by society, especially in densely populated urban areas. The use of electric bicycles as an alternative daily transportation mode has gained popularity due to their ease of operation, cost efficiency, and contribution to reducing carbon emissions. (Rose, 2012) In a social context, the presence of electric bicycles facilitates transportation accessibility for groups in society who previously faced mobility limitations, including students, the elderly, and informal workers. This phenomenon indicates a shift in public transportation preferences from fossil-fuel-powered motor vehicles to more environmentally friendly and energy-efficient alternatives. Urban communities in Indonesia, particularly in Jakarta, Bandung, and Surabaya, are showing a continuous increase in electric bicycle adoption, influenced by public campaigns and growing environmental awareness. A significant rise in electric bicycle use has been documented in various urban transportation surveys, highlighting a behavioral shift among commuters from conventional motor vehicles to battery-based electric vehicles (Pendakur, 1984).

The existence of electric bicycle user communities also plays a crucial role in promoting the adoption of this technology, both through education on safe riding

practices and the promotion of its environmental benefits. Social media serves as the primary channel for disseminating information and user experiences, thereby accelerating the spread of the electric bicycle trend among younger generations. However, amid the positive public reception of electric bicycles, challenges remain in terms of supporting infrastructure, such as dedicated lanes, charging stations, and uniform technical standards.(Hosseini Sabbaghian et al., 2023) The lack of adequate infrastructure readiness creates potential risks of accidents and conflicts on the roads, particularly when electric bicycles are used in public lanes that are not designed for medium-speed vehicles.

The lack of clear regulations governing the technical aspects, safety, and classification of electric bicycles also affects users' perceptions regarding the legality of using electric bicycles on public roads. Many users are unaware of speed limits, helmet requirements, and other administrative provisions that should apply. This phenomenon creates an urgent need for clearer and more stringent regulations to ensure that the adoption of electric bicycles can continue safely and orderly.

The rapid growth of electric bicycles as an alternative mode of transportation in Indonesia marks a paradigm shift in public mobility preferences, increasingly favoring sustainability and energy efficiency. However, the successful adaptation of this technology has not yet been fully supported by adequate regulatory and infrastructure preparedness. The ambiguity surrounding the classification of electric bicycles, whether as motor vehicles or non-motorized vehicles, creates a legal vacuum that directly impacts user safety and legal certainty on the roads (Müggenburg et al., 2015). Moreover, limitations in supporting infrastructure such as dedicated lanes, charging facilities, and public education on safe riding rules add to the complexity of the challenges faced (Rasyid & Kusumawaty, 2022). The continuous advancement of technology demands a legal framework that is adaptive and capable of accommodating the dynamic needs of society and the modern transportation industry. Countries with advanced transportation systems have demonstrated that responsive policies, based on empirical studies and the latest technologies, can serve as a crucial foundation for supporting widespread adoption of electric vehicles.

In this context, Indonesia requires a legal framework that is not only reactive to technological developments but also proactive in formulating policies that combine legal protection, user safety, and environmental sustainability. Clear regulations will minimize ambiguity in law enforcement, provide certainty for stakeholders, and build an inclusive and safe transportation ecosystem. Furthermore, adaptive regulations will also encourage technological innovation in the domestic transportation industry, strengthening Indonesia's position in the global landscape of environmentally friendly vehicle adoption.

The regulatory ambiguity surrounding electric bicycles becomes even more apparent when compared to Minister of Transportation Regulation Number 45 of 2020, which serves as an implementing regulation. This regulation defines electric bicycles as specific vehicles powered by electric motors, complete with technical provisions on specifications, maximum speed, and safety requirements. However, the existence of this implementing regulation has not been accompanied by a revision of the parent law, namely Law Number 22 of 2009, which only recognizes two categories of vehicles: motorized and non-motorized. The hierarchical difference between the law and the implementing regulation results in a legal gap concerning the legality of electric bicycles, particularly in terms of driver's license ownership, vehicle registration numbers, and applicable speed limits. Without consistent and integrative regulations, overlapping norms occur, complicating law enforcement and potentially creating uncertainty for riders and law enforcers. This reality highlights the urgent need for regulatory harmonization between the parent law and technical regulations to establish a clear legal foundation for electric bicycles and ensure user safety.

3. The urgency of revising the road traffic and transportation law to accommodate electric bicycles

The rapid development of transportation technology, particularly electric-based vehicles such as electric bicycles, necessitates an adaptive regulatory update in Indonesia's Road Traffic and Transportation Law (UU LLAJ). Currently, Law Number 22 of 2009 only classifies vehicles into two categories: motorized and non-motorized, without considering the presence of electric bicycles as hybrid vehicles that combine electric motors and human pedaling. This gap creates a legal vacuum that has the potential to cause ambiguity in enforcing safety rules, controlling speed, as well as managing ownership and use of electric bicycles. Along with the increasing adoption of electric bicycles in various major cities in Indonesia, there is a growing demand to update the legal framework to accommodate the unique characteristics of electric bicycles and ensure the safety of road users (Oeschger et al., 2020). The existence of Minister of Transportation Regulation Number 45 of 2020, which is merely administrative and technical in nature, is insufficient to meet the legal needs at the national level, particularly because its legal force is lower than that of a statutory law. This has resulted in overlapping implementation of regulations, creating uncertainty for law enforcers, users, and electric bicycle manufacturers.

Furthermore, transportation technology is developing much more rapidly than legislative processes, necessitating proactive efforts in updating regulations to prevent legal vacuums. Countries with advanced transportation systems have demonstrated that adaptive, technology-based regulations can create a legal framework that supports the adoption of electric vehicles while also ensuring traffic safety and order. Without a comprehensive revision of the Road Traffic and Transportation Law, the status of electric bicycles will continue to exist in a regulatory grey area, which not only hinders industry development but also has the potential to trigger legal and social risks in society. Therefore, revising the Road Traffic and Transportation Law is an urgent step to provide adequate legal certainty, ensure protection for all involved parties, and guarantee that technological advancements in transportation align with principles of justice and sustainability.

The gap between Law Number 22 of 2009 on Road Traffic and Transportation and Minister of Transportation Regulation Number 45 of 2020 highlights a fundamental weakness in the regulation of electric bicycles in Indonesia. The Road Traffic and Transportation Law only distinguishes between motorized and non-motorized vehicles, without taking into account the existence of electric bicycles as hybrid vehicles with unique characteristics (Greene & Rau, 2018). Meanwhile, Minister of Transportation Regulation No. 45/2020 has established definitions, technical specifications, and safety provisions for electric bicycles, but this regulation is administrative in nature and holds a lower hierarchical level compared to a statutory law. This discrepancy creates a legal gap that complicates the consistent enforcement of regulations, particularly regarding the legality of using electric bicycles on public roads, maximum speed limits, and licensing requirements. Furthermore, the absence of provisions concerning safety standards and rider responsibilities in the main law adds complexity to the issue. Without harmonization between the law and technical regulations, implementation on the ground becomes ambiguous and has the potential to create legal conflicts that disadvantage all parties.

Revising the Road Traffic and Transportation Law to accommodate electric bicycles will yield significant benefits across various aspects of life. From a safety perspective, clear regulations regarding technical standards for electric bicycles, maximum speed limits, and safety requirements—such as helmet use and dedicated lanes—will help reduce the risk of road accidents. Additionally, legal clarity regarding classification and technical regulations will strengthen legal certainty for riders, law enforcement, and the transportation industry. The existence of comprehensive regulations will also

support environmental sustainability goals, as electric bicycles have the potential to reduce greenhouse gas emissions and air pollution in urban areas. With responsive regulations, the use of electric bicycles can be promoted as part of an inclusive, efficient, and environmentally friendly multimodal transportation system. Clear rules will also boost public confidence in the safety and legality of using electric bicycles, ultimately stimulating the growth of the domestic electric vehicle industry and creating a sustainable transportation ecosystem that supports national development.

Adequate regulation of electric bicycles will not only enhance technical and safety aspects but also have significant juridical and sociological impacts. Legal clarity in the law will facilitate consistent enforcement, reduce conflicts on the ground, and ensure fair legal protection for riders and other road users. From a sociological perspective, comprehensive regulation will increase public awareness and compliance with traffic rules while fostering a culture of more responsible riding. This aligns with the objectives of sustainable transportation development, integrating economic, social, and environmental interests into an inclusive legal framework. Therefore, revising the Road Traffic and Transportation Law to accommodate electric bicycles will lay the foundation for a transportation ecosystem that is not only modern and environmentally friendly but also fair and respectful of the rights of all stakeholders. These juridical and sociological aspects must be seriously considered in the next stages of the discussion to ensure regulations that are responsive to the demands of the times.

Comprehensive regulation of electric bicycles within Indonesia's legal system will have a significant impact on juridical aspects. Clear rules regarding the definition, classification, and technical standards of electric bicycles will enhance legal certainty for users, businesses, and law enforcement alike.(Weber, 2022) This legal certainty serves as a crucial foundation for establishing a fair, transparent, and accountable transportation system. Without clear rules, legal interpretations in practice may vary, leading to confusion, injustice, and potential conflicts. Moreover, clear regulation will strengthen consumer protection, for instance, by setting safety standards and transparent procedures for handling violations. Electric bicycle users will feel safer and legally protected, while manufacturers will also have clarity in producing and distributing products in compliance with applicable regulations. On the other hand, a robust regulatory framework will also facilitate law enforcement.

With a firm legal foundation, law enforcement officials will be able to carry out their duties more effectively and consistently, whether in handling violations, monitoring traffic, or resolving disputes. Good law enforcement will support the creation of a more orderly and safe transportation ecosystem. Furthermore, responsive regulation can also mitigate the potential misuse of electric bicycles by modifying their technical capabilities beyond the established limits, thereby preventing potential safety risks for both users and the general public.(Li et al., 2022) A strong and adaptive regulatory framework that keeps pace with technological developments will facilitate the transformation of transportation towards a more sustainable and environmentally friendly era. Thus, the existence of adequate regulation will firmly establish electric bicycles within the national legal framework, thereby creating a balance between technological innovation and legal certainty that favors consumer protection and public safety.

The implementation of clear regulations for electric bicycles will have a significant impact in the sociological context. Electric bicycles are not merely a technological innovation but also a symbol of changing behavioral patterns and driving culture in society. In major cities, the use of electric bicycles has become a preferred transportation alternative, particularly among younger generations and communities that prioritize efficiency and sustainability. Clear rules regarding the use of electric bicycles, such as safety requirements, dedicated lanes, and maximum speed limits, will influence the public's adaptation patterns to this new mode of transportation. Firm regulations will foster legal awareness and better traffic discipline among users, while simultaneously

encouraging a shift towards more orderly and responsible driving culture.

In the long term, the implementation of comprehensive regulations will strengthen collective values related to safety, compliance, and social responsibility, which are essential foundations for building a modern and sustainable society. Furthermore, clear regulations will reduce conflicts among road users, increase mutual respect, and support the creation of safer and more inclusive public spaces. In the context of a society increasingly open to innovation, adaptive regulations will enhance public confidence in technology-based transportation systems while opening opportunities for improving quality of life through greener and more efficient mobility.

The relationship between juridical and sociological implications in the regulation of electric bicycles is closely intertwined, reflecting the dynamic interaction between established legal norms and the behavior of the regulated society. Clear legal regulations—such as the classification of electric bicycles, speed limits, safety requirements, and administrative obligations—will provide strong certainty for users and law enforcement officials. On the other hand, this legal certainty also acts as a catalyst for the formation of a more disciplined and responsible traffic culture. A society that understands the rules will tend to comply with the applicable provisions, creating order and reducing conflicts on the roads. The social impact of implementing consistent regulations will strengthen collective awareness of the importance of safety, rights, and obligations of road users. Additionally, regulations that are responsive to technological developments will enhance the legitimacy of the law in the eyes of the public, thereby increasing trust in law enforcement institutions and the government. This harmonious interaction between juridical and sociological aspects forms a critical foundation for creating a transportation ecosystem that is not only modern and efficient but also sustainable and equitable. Consistent regulation will facilitate behavioral changes in society toward safer, more orderly driving patterns that contribute to creating inclusive and environmentally friendly public spaces.

The main recommendation for regulating electric bicycles in Indonesia is the need for a comprehensive revision of Law Number 22 of 2009 concerning Road Traffic and Transportation (UU LLAJ). This revision is essential to align the regulations with the development of transportation technology, particularly the existence of electric bicycles as hybrid vehicles that combine electric motor power and human pedaling. The revision should include a clear definition of electric bicycles, technical classification, safety requirements, and usage procedures, thereby eliminating legal gaps that could potentially cause uncertainty and conflicts in practice. In addition to revising the main law, implementing regulations such as the Minister of Transportation Regulation (Permenhub) need to be strengthened to detail technical specifications, vehicle registration procedures, ownership requirements, and supervision mechanisms for electric bicycle use. Regional regulations (Perda) also play an essential role in accommodating local conditions, such as establishing dedicated lanes, restricted areas, and determining maximum speed limits for electric bicycles in urban areas. Strengthening regulations from the national to local levels will create harmonized rules, ensuring effective and consistent implementation in practice. Moreover, the revision of the law and the enhancement of implementing regulations must involve relevant stakeholders, such as the Ministry of Transportation, the Police, industry players, user communities, and civil society organizations. This participatory approach will ensure that the resulting policies are not only adaptive to technological advancements but also responsive to societal needs and aspirations. In practice, the implementation of this revision must be supported by effective communication strategies, public education on new regulations, and firm yet fair supervision. Thus, revising the UU LLAJ, along with strengthening technical and regional regulations, will create a comprehensive and adaptive legal framework that not only supports technological innovation in transportation but also ensures adequate legal protection for all road users.

The implementation of realistic regulations for electric bicycles requires a well-planned and integrated strategy, encompassing public education, the development of supporting infrastructure, and multi-stakeholder collaboration. Education is the key to building public awareness about the rules for using electric bicycles, including understanding speed limits, the use of dedicated lanes, and the importance of safety equipment such as helmets and reflective gear. This educational program should be carried out massively through mass media, digital platforms, and integration into educational curricula, to reach various segments of society, including the younger generation, who are the primary users of electric bicycles.

In addition to education, the development of adequate infrastructure is also crucial. The government needs to build safe, dedicated lanes for electric bicycles, separate from motor vehicles, provide accessible electric charging stations, and establish clear road markings for these light vehicles. Improving infrastructure will not only smooth traffic flow but also minimize the risk of accidents due to interactions with motor vehicles. An effective implementation strategy also requires multi-stakeholder collaboration, involving relevant ministries, local governments, user communities, industries, and civil society organizations. This collaborative approach will strengthen the sustainability of electric bicycle regulation programs by considering local needs and community aspirations. A public-private partnership model can be adopted to support infrastructure investment, while regulation and oversight remain under government control.

The use of digital technology, such as online registration systems, speed monitoring sensors, and integration of transportation data, will strengthen the implementation of efficient and adaptive regulations. This comprehensive strategy will ensure that the regulation of electric bicycles is not only normative but also practical and has a positive impact on safety, sustainability, and the modernization of the national transportation system.

4. Conclusions

The rapid development of electric-based transportation technology, particularly electric bicycles, has created new dynamics in Indonesia's legal and social systems. Although electric bicycles offer an environmentally friendly and efficient transportation solution, their regulation within the national legal framework remains inadequate. Law Number 22 of 2009 on Road Traffic and Transportation only differentiates between motorized and non-motorized vehicles, without providing legal recognition of the unique characteristics of electric bicycles as hybrid vehicles. This legal gap creates uncertainty in classification, speed control, safety requirements, and rider responsibility. Moreover, Minister of Transportation Regulation Number 45 of 2020, which is administrative in nature, has not provided a comprehensive solution to address the challenges posed by modern transportation technology. As a result, this situation not only hampers industrial development but also increases legal and safety risks for users.

From a sociological perspective, regulatory ambiguity leads to low legal awareness and compliance among users and has the potential to cause conflicts on the roads. Therefore, a comprehensive revision of the Road Traffic and Transportation Law and the strengthening of technical regulations through implementing provisions are urgent steps to create a safe, orderly, and just transportation system. A participatory approach involving stakeholders, the development of supporting infrastructure, and the use of digital technology will be key pillars in effective implementation. With adaptive and responsive regulations, electric bicycles can contribute to the creation of an inclusive, sustainable, and technologically advanced national transportation ecosystem.

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