World Electric Vehicle Journal

Article

Technological, Environmental, Economic, and Regulation Barriers to Electric Vehicle Adoption: Evidence from Indonesia

Ardhy Lazuardy [1,2], Rahmat Nurcahyo [1,*], Ellia Kristiningrum [1,3], Azanizawati Ma'aram [4], Farizal [1], Syafira Nurin Aqmarina [1] and Muhammad Fadhil Rajabi [1]

[1] Industrial Engineering Department, Faculty of Engineering, Universitas Indonesia, Depok 16424, Indonesia; ardhylazuardy@gmail.com (A.L.); kristiningrum.e81@gmail.com (E.K.); farizal@ui.ac.id (F.); syfiranurin@gmail.com (S.N.A.); fadhilmuhammad32@gmail.com (M.F.R.)
[2] Industrial Engineering Department, Faculty of Industrial Technology, Gunadarma University, Depok 16424, Indonesia
[3] Research Center of Testing Technology and Standards, National Research and Innovation Agency, Central Jakarta 10340, Indonesia
[4] Department of Materials, Manufacturing and Industrial Engineering, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia; niza@utm.my
* Correspondence: rahmat@eng.ui.ac.id

Abstract: This study explores the obstacles to electric vehicle (EV) adoption in Indonesia, focusing on technological, environmental, economic, and regulatory factors. Despite government initiatives, such as the Presidential Regulation 55 of 2019, intended to encourage the adoption of EVs and mitigate air pollution, the EV market share in Indonesia remains low, at 1.47%. The main challenges include inadequate charging infrastructure, limited public revenue, and financial constraints. This research highlights the need for improved government policies, incentives for producers, and increased public awareness to encourage EV adoption. Factors influencing consumer decisions include operational costs, environmental concerns, and the availability of charging stations. Key findings suggest that electric motorcycle users have a lower understanding of technology than electric car users, with particular attention to initial costs, maintenance costs, and the accessibility of charging infrastructure. This study recommends that manufacturers and policymakers consider the different preferences of electric car and motorcycle users in their EV adoption promotion strategies. The study seeks to elucidate the determinants affecting EV adoption in Indonesia and propose potential solutions to accelerate the transition to electric mobility.

Keywords: electric vehicles; barriers to adoption; charging infrastructure; government policies; public awareness

Citation: Lazuardy, A.; Nurcahyo, R.; Kristiningrum, E.; Ma'aram, A.; Farizal; Aqmarina, S.N.; Rajabi, M.F. Technological, Environmental, Economic, and Regulation Barriers to Electric Vehicle Adoption: Evidence from Indonesia. *World Electr. Veh. J.* **2024**, *15*, 422. https://doi.org/10.3390/wevj15090422

Academic Editor: Joeri Van Mierlo

Received: 13 August 2024
Revised: 10 September 2024
Accepted: 12 September 2024
Published: 15 September 2024

1. Introduction

Climate change is currently the biggest worldwide obstacle to sustainable development. One of the most challenging mitigation targets is achieving carbon neutrality, where natural systems may safely absorb the resultant emissions [1]. The substantial emissions from the transportation sector are a primary contributor to declining air quality [2]. Various governmental initiatives encouraging the use of electric vehicles (EVs) promote growth [3], influencing sales worldwide, which are expected to reach 16.5 million by 2021, constituting around 10% of the total automotive market [3,4].

The Indonesian government enacted the Presidential Decree 55 of 2019 to advance the adoption of EVs and stimulate innovation in electric transportation [5]. The government plans to provide EV subsidies to achieve 2.5 million EV users by 2025 and a 29% reduction in air pollution by 2030 [6]. The Indonesian automotive sector is still dominated by foreign original equipment manufacturers (OEMs) since indigenous businesses, such as EV startup producers, are vulnerable [7]. By combining infrastructure development, incentives for

indigenous manufacturers, and fiscal and non-fiscal measures, the Indonesian government has accelerated the adoption of EVs.

Nevertheless, there are still issues with investment value and the preparedness of the charging infrastructure, which emphasizes the need for more legislative changes and encouragement to expand charging stations [8–12]. On the other hand, according to market appeal and expected use, EVs still have a tiny market share [13]. EVs have a lot of advantages, but their market penetration is quite limited, especially in developing nations [14]. The EV market is projected to generate an impressive USD 623.3 billion by 2024, with China representing the predominant portion of sales at USD 319 billion. By 2028, the market is projected to have grown by 9.82% yearly (CAGR 2024–2028) and have reached a volume of USD 906.7 billion. By the same year, 17.07 million cars are expected to be sold, and in 2024, the volume-weighted average price is projected to be USD 52.9k. This demonstrates the sizeable presence and expansion of the EV industry, propelled by rising acceptance globally, especially in nations like Norway, which has the top market share [15]. The EV market share in Indonesia is 1.47 percent of the target of the 10 percent objective set for 2022. Indonesia's low EV adoption rate begs the question of how well government measures are designed to promote EV use among manufacturers, users, and infrastructure providers [7].

Previous studies have connected a lack of public acceptability and challenges with finances, technology, and infrastructure to the sluggish adoption rate of EVs [16]. The proportion of EVs is positively impacted by all government policies, particularly those that interact with charging infrastructure, such as financial incentives, traffic laws that encourage EVs, and charging infrastructure. The policies supporting electric mobility reflect consumer preferences and impact high buying power and the greater uptake of EVs [17]. Research conducted in Pakistan and India indicates that environmental considerations positively influence individuals' attitudes to adopting EVs [18,19]. In Malaysia, the main drivers of EV adoption include pricing value, price sensitivity, faith in EVs, environmental concerns, and subjective norms [20].

Meanwhile, the long-term advantages of EV use are mainly unknown to Indian consumers. Hence, more educational initiatives are needed in India, particularly for young people [21]. Moreover, buyers choose the accessibility of maintenance support post-purchase of an EV over the vehicle's price, which is relatively insignificant [22].

Due to the flow of information, customers have access to a broader choice when deciding what to buy [23]. Consumers continue to hesitate in transitioning from traditional vehicles to EVs despite the numerous advantages presented by EVs [24]. This study examines consumer perspectives regarding factors of concern when using EVs by comparing two groups of potential users: electric cars and electric motorcycles. This research will increase knowledge about EV adoption programs by offering a detailed assessment and comparison of factors facing consumers, thereby representing a step forward in understanding the causes of the lack of progress in EV adoption.

2. Literature Review

2.1. Indonesia EV Industry

The automotive industry is a key sector that significantly enhances the Indonesian economy. In January 2019, Indonesia released an automotive sector strategy outlining production targets for battery electric cars (BEVs). It has established a goal that by 2035, 1.2 million (or 30%) of all four-wheeler outputs will be low-carbon-emissions automobiles [25]. The introduction of EVs marked a significant change in Indonesia's transportation sector policy on a global scale. Indonesia must invest in talent resources, infrastructure, renewable energy, and technology to participate in the future of the region's EV industry. Indonesia aims to establish itself as a significant participant in the EV industry. By 2025, it is anticipated that 2.1 million electric motorcycles and 400,000 electric automobiles will be operational [26]. In Indonesia, there are three types of electric vehicles: BEVs, Plug-in Hybrid Electric Vehicles (PHEVs), and Hybrid Electric Vehicles (HEVs). In 2021, 685 EVs

were sold. In the meantime, yearly sales of hybrid vehicles rose 65.84 percent in 2022, and 7235 hybrid cars were sold [6,27]

There is a need to increase EV readiness levels in these industries since the Indonesian EV market faces problems linked to market and commercialization criteria [28]. The government's lack of incentives and economic factors significantly hinder Indonesia's efforts to electrify conventional automobiles [29]. Analyzing the feasibility and possible impacts of accelerating EV development in Indonesia reveals that substantial financial and non-financial incentives are necessary to encourage Indonesian consumers to prefer EVs over internal combustion engine (ICE) vehicles [30].

2.2. EV Adoption Factors Form the Consumer's Perspectives

From the standpoint of the customer, the factors that encourage and inhibit the adoption of EVs can be divided into four categories: technological, social and cultural, economic, environmental [14], and regulation [31] (Figure 1). The technological factors include charging infrastructure, availability, and accessibility. They are essential enablers of EV adoption, highlighting the significance of comprehensive charging networks [32–34]. A critical technological consideration is the availability of robust charging infrastructure. A well-spread charging station network can reduce range concerns, making EVs more attractive and practical for customers [35,36]. The mileage of EVs is another essential element that affects the adoption of EVs. If potential consumers think an electric car has an adequate range to satisfy their driving demands without requiring regular recharging, they are more inclined to consider it seriously [37,38].

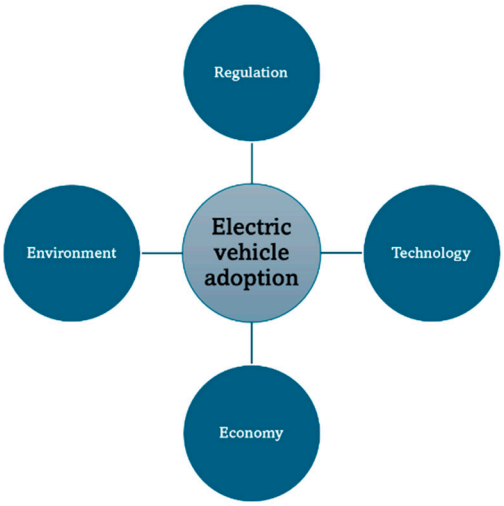

Figure 1. A conceptual framework of factors influencing EV adoption (adapted with permission from Refs. [14,31]).

Furthermore, the likelihood of EV adoption is positively correlated with customer loyalty, societal impact, and social knowledge of EVs [32]. Research has also examined the effects of demographic, contextual, and attitudinal aspects on customers' intentions to use EVs [39]. Several factors, including age, yearly income, attitude, educational background, and vehicle pricing, have a significant impact on how willing people are to embrace EVs [39,40], as well as financial advantages, the functional qualities of electric cars, and consumer awareness, knowledge, and comprehension of these vehicles [34]. The likelihood of younger males embracing EVs positively correlates with their income, environmental ideals, and prior EV experience [32]. Norms, values, and how one presents oneself are social and moral variables that influence whether or not one will embrace EVs [41]. Psychological elements impacting an individual's desire to adopt EVs include social knowledge and cultural influence on EVs [42].

Economically, it is widely recognized that the pricing of consumer goods and environmental considerations substantially influence consumer adoption choices. This outcome contradicts numerous other studies and underscores the necessity for a more resilient infrastructure for EV charging to promote EVs' adoption [42]. Fiscal incentives, like tax credits and government subsidies, are essential in enhancing the attractiveness and affordability of EVs [43]. Policy and financial incentives are essential drivers of adopting EVs [35,36,40]. Regarding the environmental factors, people choose EVs as a more sustainable form of transportation out of concern for the environment and understanding conventional vehicles' environmental effects [33,40]. The adoption of EVs is driven by the intention to save the environment and reduce air pollution [44,45]. Adopting EVs can have a significant positive environmental impact by reducing emissions [46].

Effective instruments comprise municipal activities advocating for the adoption of EVs, direct financial incentives, and regulations influencing the acquisition costs of EVs [47,48]. Policy strategies that can promote the adoption of EVs encompass governmental investments in renewable energy, the establishment of public infrastructure, diversification of the transportation industry, finance for domestically made EV development, and the initiation of a public awareness campaign [49]. Financial incentives play a significant role and favorably correlate with a country's EV market share [6]

3. Methods

This study uses descriptive analytical techniques to assess the four primary factors—economics, regulation, environment, and technology—affecting society's adoption of EVs [14,31] and encompass electric cars and motorcycle users and non-users in Jakarta, Indonesia. According to [6] statistics, there was only 687 electric car owners in 2021, indicating that the number of EV owners is still relatively tiny. In light of this, a random sampling strategy was utilized. The sample size for electric car users was determined by using the sample-to-variable ratio of 15:1 [50,51]. For this reason, a minimum sample size of 60 respondents was needed for this study, which employed four variables. Each respondent was requested to provide seven statements reflecting their level of agreement or disagreement. The cumulative weighted score of a statement was determined by aggregating the weighted responses on a 4-point scale. The cumulative weighted score of a statement was divided by the sample size to derive a weighted average score. The overall weighted score and weighted average score for each picked statement were computed using Formulas (1) and (2) used by [52,53].

$$Total\ weighted\ score = \sum_{i=1}^{n} (wi \times fi) \quad (1)$$

$$Weighted\ avarage\ score = \frac{Total\ weighted\ score}{Total\ number\ of\ respondents} \quad (2)$$

The variable "*wi*" represents the weight of the *i*th criterion, "*fi*" means the score of the *i*th criterion, and "*n*" is the total number of criteria evaluated.

Additionally, there has been a noticeable trend in the past few years toward the more significant usage of electric motorcycles in Indonesia. Electric motorcycle sales are projected to reach 2 million by 2025, up from 31,827 units in 2022 [54]. This indicates that more individuals are converting to electric motorcycles as a more efficient and greener option. Given the expanding number of electric motorbike riders and the demand for excellent representativeness, a reasonably large sample size was chosen in this study. The study sampling table was then used as a reference to choose the sample of electric motorcycle riders and non-users [55]. Online surveys were conducted and disseminated to boost participation using various social media sites, including Facebook, Instagram, WhatsApp, Line, and Telegram.

Additionally, questionnaires were sent to ride-hailing services for electric bicycles and the community of EM users. Community members assisted with the survey's wider dissemination using snowball sampling. Furthermore, a direct (offline) method was used

to obtain more comprehensive data from EV users and non-users. This method augmented the probability that a minimum of 384 replies would be required for data analysis [56]. For this research, 407 responses—from users and non-users of electric motorcycles—were complete and valid.

We communicated the research background, aims, and techniques through the design of questionnaires. Each responder verified some criteria about the variables influencing the adoption of EVs in response to the online questionnaire. The first identification of the factors that were determined to be in the driving and inhibiting categories is shown in Table 1. This study encompassed eighteen factors.

Table 1. A summary of the variables found to affect the uptake of EVs from the literature for analysis.

Category	Factor	Reference
Economy	Operational cost	[37]
	Maintenance cost	[24,57,58]
	Brand reputation	[59,60]
	Country of manufacturing origin	[61]
	Price comparison	[62,63]
	After-sales value	[64,65]
Environment	Emission produced	[66,67]
	Vehicle noise level	[35,68]
	Impact of vehicle use on the environment	[36]
Regulation	Government subsidy	[69,70]
	Availability of public electric charging stations	[58]
	The existence of a vehicle repair shop	[71,72]
Technology	Design or model	[58]
	Mileage	[73,74]
	Speed	[35]
	Battery life	[62]
	Charging time	[69]
	Vehicle safety	[24,75,76]

In Indonesia, explicit regulations mandate that ethics approval is essential, particularly for research involving medical subjects that entails direct connection with human participants, potentially impacting their rights or welfare. This study was not classified under this category and did not necessitate formal ethics approval. All participants received written notification of the questionnaire's objective, which was administered exclusively for research purposes. Participants could accept or decline involvement or withdraw without prior notification. The decision to withdraw did not adversely affect them. Furthermore, participants were guaranteed that their personal information would remain confidential and not be disclosed publicly, according to ethical research standards, by preserving participant anonymity and mitigating harm.

4. Results

4.1. Respondent Characteristics

Descriptive statistics were employed to analyze and illustrate the demographic characteristics of electric car responders. Most respondents—54 percent—are private sector workers, followed by government employees (21%) and employees of state-owned enterprises (15%). Teaching personnel (2%) and self-employed people (7%) comprise a smaller portion. Regarding automobile ownership, 82% of participants drive regular automobiles,

while just 12% drive EVs. Furthermore, 28% of the respondents possess multiple cars, compared to 54% owning only one. In terms of yearly earnings, most participants (32%) make between IDR 50 million and IDR 100 million, while 19% earn less than IDR 50 million and 16% earn more than IDR 200 million.

The characteristics of electric motorcycle respondents show that from the 407 respondents who answered, factors such as age, gender, and individual occupation significantly influence electric motorcycle ownership. The younger generation, especially those aged between 26 and 45 years (57.2%), use electric motorcycles more than any other age group. This is due to greater awareness of the environment and a desire to reduce transportation costs. According to gender, men (65.1%) own more electric motorcycles than women. However, more and more women are looking at electric motorcycles as a way of transportation. In addition, people with vital job roles (young and office workers, or 57%) are more interested in electric motorcycles because they are an easy and efficient way to get around the city. This profile aligns with the research findings [77], which show that wealthy and highly educated early customers have a moderate preference for EV purchases, and the criteria of emotion, functionality, identity, and car price influence purchase intentions.

4.2. Ranking of Sub Factors Considering the Adoption of EVs

In Table 2, the resulting emission factors rank first with a score of 3.97, followed by environmental conservation (3.93) and vehicle maintenance costs (3.84) as the top three factors considered in using electric cars. Factors such as mileage (3.77) and government subsidies (2.70) are next in the rankings. The least considered factors are the availability of public charging stations (2.08) and price comparison (2.21). Meanwhile, Table 3 shows that the availability of public charging stations and battery life are the two most important factors for electric motorcycles, with the same score of 4.41. Other factors such as safety (4.37), the availability of workshops and dealers (4.36), and mileage (4.34) are also the primary considerations. The price comparison is ranked in the middle (4270), while factors such as emissions generated (4.06) and government subsidies (3.96) are ranked lower. The country of origin of production is last, with a score of 3.80.

Table 2. The order of the criteria used while deciding whether to use electric cars.

Sub Factors	Score	Rank
Emissions produced	3.97	1
Environment conservation	3.93	2
Vehicle maintenance cost	3.84	3
Range	3.77	4
Government subsidy	2.70	5
Availability of public charging station	2.08	6
Price comparison	2.21	7

In comparison, people who use electric motorcycles pay more attention to supporting infrastructure and technical elements that affect the comfort and efficiency of daily use. This finding is consistent with other studies. Environmental sustainability and infrastructure accessibility for charging stations are placed first [13,21]. Manufacturers and policymakers must consider these specific needs when developing EVs and their supporting infrastructure to encourage wider adoption and meet established requirements.

Figure 2 illustrates that those who drive electric cars focus more on environmental and economic concerns while making decisions, but those who ride electric motorcycles prioritize rules and technology. These disparities in priority demonstrate the unique requirements and preferences of every category of EV customers. When creating strategies to satisfy the demands of these two groups, manufacturers and policymakers should consider these distinctions. Some of these approaches include enhancing electric cars'

environmental costs and advantages and promoting technological advancements and laws that facilitate using EVs.

Table 3. The order of the criteria used while deciding whether to use an electric motorcycle.

Sub Factors	Score	Rank
Availability of public charging station	4.41	1
Battery life	4.41	2
Safety	4.37	3
Maintenance workshop and dealer availability	4.36	4
Mileage	4.34	5
Charging time	4.31	6
Price comparison	4.27	7
Vehicle maintenance cost	4.24	8
Environment conservation	4.23	9
Battery charging cost	4.22	10
Speed	4.09	11
Emission produced	4.06	12
Brand reputation	4.02	13
After-sales value	4.00	14
Vehicle noise level	4.00	15
Design/model	3.97	16
Government subsidy	3.96	17
Country of manufacturing origin	3.80	18

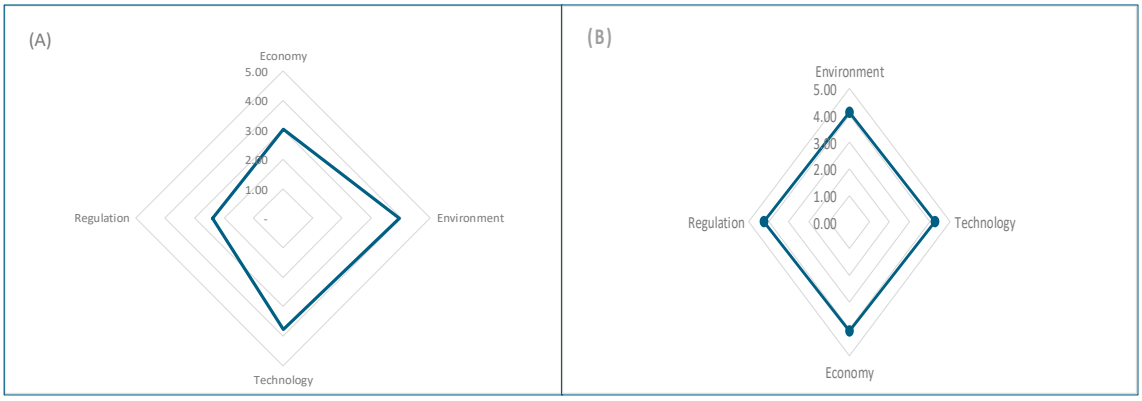

Figure 2. Priority analysis of EV user factors: (**A**) electric cars; (**B**) electric motorcycles.

4.3. Analysis of the Significance of Barriers to EV Adoption Using the Mann–Whitney Test

The Mann–Whitney test was utilized to assess the significance of differences in the perception of factors affecting the adoption of EVs across two distinct population groups. This investigation was conducted to compare the considerations of motorcycle riders with electric car users. The Mann–Whitney test results will indicate whether statistically significant differences exist in the evaluation of economic, regulatory, environmental, and technological variables influencing the adoption of EVs. Assume the *p*-value is below the predetermined significance level of 0.05. Consequently, it can be inferred that the perspectives on EV adoption vary markedly across the two categories, serving as a reference for developing solutions to address these obstacles.

5. Discussion

5.1. Environmental Concern

Table 4 illustrates a statistically significant disparity regarding environmental concerns between the two groups (electric car and motorcycle users). The *p*-value (Asymp. Sig.) is less than 0.05 ($p = 0.007$). The level of environmental concern among electric car users is higher, while it is lower among electric motorcycle users, despite both groups having a good understanding of environmental protection.

Table 4. Results of the Mann–Whitney comparison of environmental, regulatory, economic, and technological values between motorcycle and electric car users.

Category	Statement	U-Value	*p*-Value
Environmental concern	The distribution of "EVs are environmentally friendly" is the same across categories of users	11,068.000	0.007
Regulation concern	The distribution of "Regulations governing EVs are quite effective" is the same across categories of users	2056.000	0.000
Economic concern	The distribution of "EVs are economically affordable" is the same across categories of users	3604.500	0.000
Technology concern	The distribution of "EVs use advanced technology" is the same across categories of users	7529.000	0.000

EV users stated that environmental protection and emission products are the main sub factors of concern. Both motorcycle and electric car users understand that EVs do not produce exhaust pollutants. This suggests that these vehicles do not release detrimental pollutants such as carbon dioxide, nitrogen oxides, or particulates while driving. This directly contributes to air quality, especially in urban areas. However, the electricity utilized to charge EVs comes from sources that produce emissions, such as coal-fired power plants [78]. Electric car users are more aware of EVs' environmental benefits due to greater media attention and marketing efforts aimed at cars. This gives more attention to the "environmentally friendly" aspect than electric motorcycle users. Motorcyclists, especially those who use them to travel, prioritize comfort, affordability, and maneuverability over environmental concerns. In addition, differences in how cars and motorcycles are used also play a role; car users generally take longer trips, so the environmental benefits of EVs are more prominent.

Both electric cars and motorcycles offer a quieter alternative to gasoline-fueled vehicles for reducing noise pollution. Motorcyclists state the vehicle's noise level as the main factor considered. Because the operation is peaceful, the operated electric motor can lower noise pollution and improve the quality of urban life. Electric motorcycles are much more tranquil than gasoline-powered ones [79]. However, they are generally louder than electric cars, especially those with more powerful motorcycles. An electric motorcycle's degree of interference might fluctuate based on the motor's size and kind. Refs. [68,76] stated that one of the factors contributing to low noise levels has an impact on readiness to adopt. However, this low noise level also poses a safety concern, especially for motorcyclists and pedestrians who rely on the sound of cars to identify their presence. Conversely, EVs offer significant benefits in terms of environmental conservation, with significantly lower emissions than conventional fossil fuel vehicles, which is consistent with the findings reported [68]. However, the production process of EV batteries is still a concern because it can have a significant environmental impact, which is relevant to the results [80].

5.2. Technology Concern

Table 4 illustrates a statistically significant disparity between the two groups (car and motorcycle users) regarding technology concerns. This is indicated by a p-value (Asymp. Sig.) less than 0.05 ($p = 0.000$). The features of an electric motorcycle are more straightforward than those of an electric car, resulting in a higher level of technological understanding among electric car users compared to electric motorcycle users. This study demonstrates how customer trust in electric motorcycles is influenced by mileage, which is the vehicle's maximum mileage while the battery is full, among owners of electric motorcycles. A study [36,71] indicated that range constitutes a primary obstacle to the adoption of EVs. Ref. [81] showed how customer perceptions of EV range limitations—in which the range was thought to be smaller than those of fossil fuel vehicles—influenced their purchase decisions.

In addition to the mileage criteria, electric motorcycle users consider the design or model, speed, battery life, charging time, and safety. Respondents who mostly use electric motors in their daily activities are highly concerned about designs that must meet practical and ergonomic demands to fulfill daily driving needs and long-distance travel. In addition, maximum speed and adequate acceleration ensure that EVs can meet the needs of daily driving and long-distance travel. These results reinforce the results in [67], which state that the range and speed of electric cars are considerations in adopting EVs.

One of the biggest worries for prospective buyers of electric cars is battery life or the distance that can be covered on a single charge. Ref. [68] discovered that consumers presently give BEVs a poor rating for battery life and ease of charging. Ref. [58] suggests that further research and development be done to enhance the performance of electric cars, especially regarding charging and battery life. Users' interest in EVs may increase as a result. Charging an electric car battery is crucial for user comfort, much like battery life. According to the study, potential buyers of electric cars emphasized how quick charging and practical charging infrastructure may save the time needed to charge and increase the use of EVs for daily purposes. This result is in line with the results in [33], which found that concerns about charging times underscored the need for faster and more convenient recharging methods. Furthermore, the safety factor is also a concern for respondents. This is consistent with [24], which found that security is one of the biggest concerns for people in China. The safety features of EVs must be equal to or better than those of conventional vehicles, including battery protection against the risk of fire [76]. Respondents in this research want assurance that EVs are safe regarding performance and potential dangers related to battery technology in the face of extreme weather.

The lifespan of EV batteries, including electric cars and motorcycles, varies greatly depending on the type of battery and how it is used. Generally, lithium-ion batteries used in electric cars have a lifespan of 8 to 15 years, depending on the charging cycle and operational conditions. Meanwhile, electric motor batteries have a shorter lifespan, typically 3 to 5 years [82]. Charging fully using a standard air conditioner usually takes 6 to 12 h. Meanwhile, using DC fast charging, the charging time can be shortened to 30 min to 1.5 h to reach 80% battery capacity. This depends on the type of charger and battery capacity of the EV [83]. Fast charging technology continues to be developed to shorten charging times and overcome one of the biggest obstacles in adopting electric cars, namely, relatively long charging times compared to conventional fuels [84].

5.3. Economic Concern

Many critical economic challenges hamper the adoption of EVs. Maintenance costs and purchase price comparisons impact the adoption of electric cars. Due to the much more expensive initial purchase price than traditional fossil fuel vehicles, electric cars are not the right choice for people on a budget. These results are consistent with research showing that the high cost of EV purchasing is a bottleneck in almost all consumer surveys [24,57,58,65]. Furthermore, although the long-term operating and maintenance costs for electric cars are lower than for conventional cars, these expenses are still a problem due

to replacement components and technology that is still evolving in terms of availability and cost. Ref. [37] shows that although EVs offer a lot regarding the environment and economy, financial constraints are still a big reason hindering widespread adoption. The study found other vital elements that customers consider when choosing an EV, specifically an electric motorcycle, besides price and maintenance cost comparisons. One of them is the cost of charging the battery, which is still a big concern even though it is cheaper than fossil fuels, especially regarding availability and charging speed. These results align with the study's results [31], which state that if the charging infrastructure of EVs is inadequate, buyers will be hesitant to choose them. In addition, brand reputation is also felt to be very important because electric motorcycle users tend to trust companies with a solid reputation regarding reliability and quality. This aligns with research [43,85] that shows consumers are more willing to buy EVs for reputational reasons than environmental reasons. The vehicle's place of origin can also influence the choice because some people believe that the cars of some countries are more technologically advanced and more durable. Another consideration is the after-sales value, as buyers want to be confident that their investment will last a long time, which aligns with [65].

5.4. Regulation Concern

Two essential regulatory elements that affect the acceptance of EVs are the availability of public charging stations and government subsidies. Government subsidies can significantly reduce EVs' high initial price, making them more accessible to customers. The same result is stated by [43], which claims that tax breaks, government subsidies, and infrastructure for electric car charging all contribute significantly to the acceptance of EVs by making them more attractive and affordable. Ref. [8] also stated that fiscal policy in the form of purchase price subsidies substantially influences the decision to choose BEVs and PHEVs [86]. It also suggested that the government and car manufacturers impose tax cuts for EV owners and offer incentives and subsidies to lower the cost of electric cars. With subsidies from the Indonesian government for electric motorcycles, the difference between the initial purchase price of electric motorcycles and that of conventional motorcycles is smaller. Meanwhile, for the purchase of electric cars, the subsidy scheme set is different and generally much smaller than the subsidy for electric motorcycles, so the price difference between electric cars and conventional cars is relatively high.

The policy on providing sufficient public electric charging stations is another vital element. Concerns about mileage and comfort can affect the conversion to EVs, as there is no affordable and convenient charging infrastructure, especially if users want to use EVs outside big cities. The difference in challenges between urban and rural areas is seen in the availability of infrastructure [87]. Up until the first three months of 2024, Indonesia had 1582 public EV charging stations (Stasiun Pengisian Kendaraan Listrik Umum or SPKLU) spread across 1131 regional locations [88]. However, this number is still insufficient to support the target of more widespread EV adoption. Indonesia is estimated to need around 1.6 million charging stations by 2030 to meet the growing needs of EV users [89].

Although the number of charging stations is higher in urban areas, it is insufficient to support EV growth. Meanwhile, in rural areas, charging infrastructure is almost non-existent, exacerbating concerns about EV range anxiety. This is one of the main obstacles to EV adoption in these areas.

Finally, a dealer who can handle EVs is also essential for motorcycle consumers. These results align with [71], which states that the dealer plays a vital role in purchasing a vehicle. Dealers can influence purchasing decisions because they have a direct influence on customers.

6. Conclusions

The aim of this study was to investigate the barriers to adopting EVs in the DKI Jakarta region of Indonesia from the customer's perspective. This study surveyed 68 electric car owners and 407 electric motorcycle owners in urban areas. The present adoption rate of

electric cars is still in its early stages. It is low, even though most respondents believe they offer advantages and a positive future. This is consistent with prior work [11,70]. This analysis demonstrates that some government initiatives, including the Presidential Regulation Number 55 of 2019 and the fiscal and non-fiscal benefits offered to promote the growth of local manufacturing and infrastructure, are insufficient to remove the current barriers and to promote increased funding for the industry and broaden the charging station network. Respondents offered various justifications for embracing electric cars, but many expressed a wait-and-see attitude in light of legislative, technological, financial, and environmental obstacles. The primary elements driving electric car adoption are range, maintenance affordability, battery dependability, accessibility to charging stations, and environmental conservation aims. These findings suggest that consumers are dissatisfied with the availability of present infrastructure and the performance of vehicles.

This research has some limitations. Economic, technological, regulatory, and environmental aspects are examined. If the psychological aspects of the customer are associated with these parameters, the research findings will probably be more satisfactory. Because psychological aspects directly relate to people's perceptions, attitudes, and motives that impact their choice to accept or reject new technology, they play a significant role in adopting EVs. Therefore, further research can explore the adoption of EVs by utilizing psychological factors as variables that are measured in the research framework. In addition, our study includes electric motorcycles and electric cars, the results of which may differ based on whether the car is fully electric or hybrid. Moving forward, future research could differentiate between different types of EVs and conduct a comparative analysis of the results.

Author Contributions: Conceptualization, A.L., R.N. and A.M.; methodology, S.N.A. and F.; software, F.; validation, A.L., R.N. and A.M.; formal analysis, E.K., R.N. and A.M.; investigation, F.; resources, S.N.A. and M.F.R.; data curation, S.N.A. and M.F.R.; writing—original draft preparation, E.K. and A.L.; writing—review and editing, A.L. and E.K.; visualization, E.K. and A.L.; supervision, R.N.; project administration, S.N.A. and M.F.R.; funding acquisition, R.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the University of Indonesia, grant number NKB-724/UN2.RST/HKP.05.00/2024.

Informed Consent Statement: Informed consent was obtained from all individual participants included in the study.

Data Availability Statement: The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors disclose no conflicts of interest. The funders had no involvement in the study's design, data collection, analysis, interpretation, manuscript preparation, or publication decision.

References

1. Li, J.; He, S.; Yang, Q.; Wei, Z.; Li, Y.; He, H. A Comprehensive Review of Second Life Batteries toward Sustainable Mechanisms: Potential, Challenges, and Future Prospects. *IEEE Trans. Transp. Electrif.* **2023**, *9*, 4824–4845. [CrossRef]
2. Zhao, S.J.; Heywood, J.B. Projected Pathways and Environmental Impact of China's Electrified Passenger Vehicles. *Transp. Res. Part D Transp. Environ.* **2017**, *53*, 334–353. [CrossRef]
3. Xiao, J.; Jiang, C.; Wang, B. A Review on Dynamic Recycling of Electric Vehicle Battery: Disassembly and Echelon Utilization. *Batteries* **2023**, *9*, 57. [CrossRef]
4. Al-Alawi, M.K.; Cugley, J.; Hassanin, H. Techno-Economic Feasibility of Retired Electric-Vehicle Batteries Repurpose/Reuse in Second-Life Applications: A Systematic Review. *Energy Clim. Chang.* **2022**, *3*, 100086. [CrossRef]
5. President of the Republic of Indonesia. Peraturan Presiden Nomor 55 Tahun 2019 Tentang Percepatan Program Kendaraan Bermotor Listrik Berbasis Baterai (Battery Electric Vehicle) Untuk Transportasi Jalan. 2019. Available online: https://peraturan.bpk.go.id/Details/116973/perpresno-55-tahun-2019 (accessed on 2 March 2024).
6. Gaikindo. Penjualan Domestik Mobil Listrik Dan Hybrid Januari–November 2022 Naik. 2023. Available online: https://www.gaikindo.or.id/Penjualan-Domestik-Mobil-Listrik-Dan-Hybrid-Januari-November-2022-Naik/ (accessed on 9 March 2024).

7. Sasongko, T.W.; Ciptomulyono, U.; Wirjodirdjo, B.; Prastawa, A. Identification of Electric Vehicle Adoption and Production Factors Based on an Ecosystem Perspective in Indonesia. *Cogent Bus. Manag.* **2024**, *11*, 2332497. [CrossRef]
8. Belgiawan, P.F.; Dharmowijoyo, D.B.E.; Novizayanti, D.; Farda, M.; Prasetio, E.A.; Dirgahayani, P. Does Range or Fiscal Policies Matter on EV Adoption in Jakarta Metropolitan Area? *Transp. Res. Interdiscip. Perspect.* **2024**, *23*, 101027. [CrossRef]
9. Lonan, E.S.; Ardi, R. Electric Vehicle Diffusion in the Indonesian Automobile Market: A System Dynamics Modelling. In Proceedings of the 2020 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Singapore, 14–17 December 2020.
10. Setiawan, A.D.; Hidayatno, A.; Putra, B.D.; Rahman, I. Selection of Charging Station Technology to Support the Adoption of Electric Vehicles in Indonesia with the AHP-TOPSIS Method. In Proceedings of the 2020 3rd International Conference on Power and Energy Applications (ICPEA), Busan, Republic of Korea, 9–11 October 2020.
11. Setiawan, A.D.; Zahari, T.N.; Purba, F.J.; Moeis, A.O.; Hidayatno, A. Investigating Policies on Increasing the Adoption of Electric Vehicles in Indonesia. *J. Clean. Prod.* **2022**, *380*, 135097. [CrossRef]
12. Wiratmoko, A.; Apriyanto, H.; Tamtomo, T.D.; Soewargono, B.D.; Dwiananto, Y.I.; Suhendra, A. Policy Analysis of Electric Vehicle Infrastructure Supporting Sustainable Energy Use. *IOP Conf. Ser. Earth Environ. Sci.* **2023**, *1267*, 012036. [CrossRef]
13. Tu, J.-C.; Yang, C. Key Factors Influencing Consumers' Purchase of Electric Vehicles. *Sustainability* **2019**, *11*, 3863. [CrossRef]
14. Hidayat, R.; Cowie, J. A Framework to Explore Policy to Support the Adoption of Electric Vehicles in Developing Nations: A Case Study of Indonesia. *Transp. Res. Procedia* **2023**, *70*, 364–371. [CrossRef]
15. Statista. Electric Vehicles—China. 2024. Available online: https://www.statista.com/outlook/mmo/electric-vehicles/china (accessed on 6 April 2024).
16. Murtiningrum, A.D.; Darmawan, A.; Wong, H. The Adoption of Electric Motorcycles: A Survey of Public Perception in Indonesia. *J. Clean. Prod.* **2022**, *379*, 134737. [CrossRef]
17. Rietmann, N.; Lieven, T. How Policy Measures Succeeded to Promote Electric Mobility—Worldwide Review and Outlook. *J. Clean. Prod.* **2019**, *206*, 66–75. [CrossRef]
18. Lee, J.; Baig, F.; Talpur, M.A.H.; Shaikh, S. Public Intentions to Purchase Electric Vehicles in Pakistan. *Sustainability* **2021**, *13*, 5523. [CrossRef]
19. Mohanty, A.; Hallur, G.G. Impact Analysis of Security and Charging Infrastructure on the Adoption of Electric Vehicles. *J. Phys. Conf. Ser.* **2021**, *1964*, 042066. [CrossRef]
20. Asadi, S.; Nilashi, M.; Iranmanesh, M.; Ghobakhloo, M.; Samad, S.; Alghamdi, A.; Almulihi, A.; Mohd, S. Drivers and Barriers of Electric Vehicle Usage in Malaysia: A DEMATEL Approach. *Resour. Conserv. Recycl.* **2022**, *177*, 105965. [CrossRef]
21. James, A.T.; Kumar, G.; Pundhir, A.; Tiwari, S.; Sharma, R.; James, J. Identification and Evaluation of Barriers in Implementation of Electric Mobility in India. *Res. Transp. Bus. Manag.* **2022**, *43*, 100757. [CrossRef]
22. Goel, P.; Sharma, N.; Mathiyazhagan, K.; Vimal, K.E.K. Government Is Trying but Consumers Are Not Buying: A Barrier Analysis for Electric Vehicle Sales in India. *Sustain. Prod. Consum.* **2021**, *28*, 71–90. [CrossRef]
23. Basil, G.; Etuk, E.J.; Ebitu, E.T. The Marketing Mix Element as Determinants of Consumer's Choice of Made-in-Nigeria Shoes in Cross River State. *Eur. J. Bus. Manag.* **2013**, *5*, 141–147.
24. She, Z.Y.; Sun, Q.; Ma, J.J.; Xie, B.C. What Are the Barriers to Widespread Adoption of Battery Electric Vehicles? A Survey of Public Perception in Tianjin, China. *Transp. Policy* **2017**, *56*, 29–40. [CrossRef]
25. Indonesia Ministry of Industry. Syarat TKDN Insentif PPnBM Dipangkas Jadi 60%. 2021. Available online: https://kemenperin.go.id/artikel/22433/Syarat-TKDN-Insentif-PPnBM-Dipangkas-Jadi-60 (accessed on 6 April 2024).
26. MMR. Indonesia Electric Vehicle Market—Industry Analysis and Forecast (2022–2029). 2023. Available online: https://www.maximizemarketresearch.com/market-report/indonesia-electric-vehicle-market/65817/ (accessed on 25 July 2024).
27. Alqadri, M.R.; Baizal, Z.K.A. Ontology-Based Conversational Recommender System for Electric Vehicles. In Proceedings of the 2023 3rd International Conference on Intelligent Cybernetics Technology & Applications (ICICyTA), Bali, Indonesia, 13–15 December 2023.
28. Pandyaswargo, A.H.; Maghfiroh, M.F.N.; Onoda, H. Readiness Status of Artificial Intelligence Applications on Electric Vehicles: A Mini Global Review and Analysis Using the J-TRA Method. In Proceedings of the 2022 International Conference on Engineering and Information Technology for Sustainable Industry, Tangerang, Indonesia, 21–22 September 2022.
29. Yuniza, M.E.; Pratama, I.W.B.E.; Ramadhaniati, R.C. Indonesia's Incentive Policies on Electric Vehicles: The Questionable Effort from the Government. *Int. J. Energy Econ. Policy* **2021**, *11*, 434–440. [CrossRef]
30. Nuryakin, C.; Riyanto, R.; Riyadi, S.A.; Damayati, A.; Pratama, A.P.; Massie, N.W.G. Socioeconomic Impacts and Consumer Preferences Analysis of Electrified Vehicle in Indonesia. In Proceedings of the 2019 6th International Conference on Electric Vehicular Technology (ICEVT), Bali, Indonesia, 18–21 November 2019.
31. O'Neill, E.; Moore, D.; Kelleher, L.; Brereton, F. Barriers to Electric Vehicle Uptake in Ireland: Perspectives of Car-Dealers and Policy-Makers. *Case Stud. Transp. Policy* **2019**, *7*, 118–127. [CrossRef]
32. Chen, C.-f.; Zarazua de Rubens, G.; Noel, L.; Kester, J.; Sovacool, B.K. Assessing the Socio-Demographic, Technical, Economic and Behavioral Factors of Nordic Electric Vehicle Adoption and the Influence of Vehicle-to-Grid Preferences. *Renew. Sustain. Energy Rev.* **2020**, *121*, 109692. [CrossRef]
33. Purwanto, E.; Irawan, A.P. The Willingness to Purchase Electric Vehicles: A Comprehensive Review. *IOP Conf. Ser. Earth Environ. Sci.* **2024**, *1324*, 012091. [CrossRef]

34. Shetty, D.K.; Shetty, S.; Raj Rodrigues, L.; Naik, N.; Maddodi, C.B.; Malarout, N.; Sooriyaperakasam, N. Barriers to Widespread Adoption of Plug-in Electric Vehicles in Emerging Asian Markets: An Analysis of Consumer Behavioral Attitudes and Perceptions. *Cogent Eng.* **2020**, *7*, 1796198. [CrossRef]
35. Pamidimukkala, A.; Kermanshachi, S.; Rosenberger, J.M.; Hladik, G. Barriers and Motivators to the Adoption of Electric Vehicles: A Global Review. *Green Energy Intell. Transp.* **2024**, *3*, 100153. [CrossRef]
36. Pamidimukkala, A.; Kermanshachi, S.; Rosenberger, J.M.; Hladik, G. Evaluation of Barriers to Electric Vehicle Adoption: A Study of Technological, Environmental, Financial, and Infrastructure Factors. *Transp. Res. Interdiscip. Perspect.* **2023**, *22*, 100962. [CrossRef]
37. Kim, M.-K.; Oh, J.; Park, J.-H.; Joo, C. Perceived Value and Adoption Intention for Electric Vehicles in Korea: Moderating Effects of Environmental Traits and Government Supports. *Energy* **2018**, *159*, 799–809. [CrossRef]
38. Kim, S.; Lee, J.; Lee, C. Does Driving Range of Electric Vehicles Influence Electric Vehicle Adoption? *Sustainability* **2017**, *9*, 1783. [CrossRef]
39. Kumar, S.; Nisa, S. Sustainable Transport Utilisation: A Study on Factors Influencing Electric Vehicle Adoption Intention. *Prog. Ind. Ecol. Int. J.* **2022**, *15*, 70–91. [CrossRef]
40. Prasanna, S.; Rangarajan, V.; Khan, M.; Ahmed, K.A.A. Examining the Factors Influencing Consumers' Choice for Electric Vehicles in India. *Int. J. Electr. Hybrid Veh.* **2021**, *13*, 302–320. [CrossRef]
41. Whittle, C.; Whitmarsh, L. Choosing the Electric Car. In *Electrifying Mobility: Realising a Sustainable Future for the Car*; Parkhurst, G., Clayton, W., Eds.; Emerald Publishing Limited: Bingley, UK, 2022; Volume 15, pp. 97–115.
42. Devi, S.; Ng, H.; Rajermani, R.; Raman, A. Factor Influencing Consumer's Adoption of Electric Car in Malaysia. *TEM J.* **2023**, *12*, 2603–2612. [CrossRef]
43. Javadnejad, F.; Jahanbakh, M.; Pinto, C.A.; Saeidi, A. Analyzing Incentives and Barriers to Electric Vehicle Adoption in the United States. *Environ. Syst. Decis.* **2023**, *44*, 575–606. [CrossRef]
44. Gerber Machado, P.; Rodrigues Teixeira, A.C.; Moutinho dos Santos, E.; Mouette, D. Electric Vehicles Adoption: A Systematic Review (2016–2020). *WIREs Energy Environ.* **2023**, *12*, e477. [CrossRef]
45. Yuniaristanto, Y.; Sutopo, W.; Hisjam, M.; Wicaksono, H. Factors Influencing Electric Motorcycle Adoption: A Logit Model Analysis. *E3S Web Conf.* **2023**, *465*, 02035. [CrossRef]
46. Wu, Y.; Gu, F.; Ji, Y.; Ma, S.; Guo, J. Electric Vehicle Adoption and Local PM2.5 Reduction: Evidence from China. *J. Clean. Prod.* **2023**, *396*, 136508. [CrossRef]
47. Künle, E.; Minke, C. Macro-Environmental Comparative Analysis of E-Mobility Adoption Pathways in France, Germany and Norway. *Transp. Policy* **2022**, *124*, 160–174. [CrossRef]
48. Wee, S.; Coffman, M.; La Croix, S. Do Electric Vehicle Incentives Matter? Evidence from the 50 Us States. *Res. Policy* **2018**, *47*, 1601–1610. [CrossRef]
49. Müller, M.; Saulich, C.; Schöneich, S.; Schulze, M. From Competition to a Sustainable Raw Materials Diplomacy: Pointers for European Policymakers. 2023. Available online: https://nbn-resolving.org/urn:nbn:de:0168-ssoar-86751-5 (accessed on 13 August 2024).
50. Hair, J.F. *Multivariate Data Analysis*; Pearson: London, UK, 2009.
51. MMemon, A.; Ting, H.; Cheah, J.-H.; Thurasamy, R.; Chuah, F.; Cham, T.H. Sample Size for Survey Research: Review and Recommendations. *J. Appl. Struct. Equ. Model.* **2020**, *4*, 1–20. [CrossRef] [PubMed]
52. Chakrabartty, S.N.; Chakrabartty, S.N. Scoring and Analysis of Likert Scale: Few Approaches. *J. Knowl. Manag. Inf. Technol.* **2014**, *1*, 31–44.
53. Mitra, S.; Khatun, M.N.; Prodhan, M.M.H.; Khan, M.A. Consumer Preference, Willingness to Pay, and Market Price of Capture and Culture Fish: Do Their Attributes Matter? *Aquaculture* **2021**, *544*, 737139. [CrossRef]
54. AISI. Target Produksi 2 Juta Motor Listrik Di 2025. 2023. Available online: https://www.aisi.or.id/target-produksi-2-juta-motor-listrik-di-2025/ (accessed on 20 March 2024).
55. Krejcie, R.V.; Morgan, D.W. Determining Sample Size for Research Activities. *Educ. Psychol. Meas.* **1970**, *30*, 607–610. [CrossRef]
56. Hashim, Y.A. Determining Sufficiency of Sample Size in Management Survey Research Activities. *Int. J. Organ. Manag. Entrep. Dev.* **2010**, *6*, 119–130.
57. Egbue, O.; Long, S. Barriers to Widespread Adoption of Electric Vehicles: An Analysis of Consumer Attitudes and Perceptions. *Energy Policy* **2012**, *48*, 717–729. [CrossRef]
58. Kongklaew, C.; Phoungthong, K.; Prabpayak, C.; Chowdhury, M.S.; Khan, I.; Yuangyai, N.; Yuangyai, C.; Techato, K. Barriers to Electric Vehicle Adoption in Thailand. *Sustainability* **2021**, *13*, 12839. [CrossRef]
59. Bessenbach, N.; Wallrapp, S. Why Do Consumers Resist Buying Electric Vehicles. In *An Empirical Study of Innovation Perception and the Effect of Consumer Characteristics, Innovation Exposure and Buying Incentives*; Copenhagen Business School: Frederiksberg, Denmark, 2013.
60. Buhmann, K.M.; Criado, J.R. Consumers' Preferences for Electric Vehicles: The Role of Status and Reputation. *Transp. Res. Part D Transp. Environ.* **2023**, *114*, 103530. [CrossRef]
61. Abo-Khalil, A.G.; Abdelkareem, M.A.; Sayed, E.T.; Maghrabie, H.M.; Radwan, A.; Rezk, H.; Olabi, A.G. Electric Vehicle Impact on Energy Industry, Policy, Technical Barriers, and Power Systems. *Int. J. Thermofluids* **2022**, *13*, 100134. [CrossRef]
62. Noel, L.; Zarazua de Rubens, G.; Kester, J.; Sovacool, B.K. Understanding the Socio-Technical Nexus of Nordic Electric Vehicle (EV) Barriers: A Qualitative Discussion of Range, Price, Charging and Knowledge. *Energy Policy* **2020**, *138*, 111292. [CrossRef]

63. Biresselioglu, M.E.; Demirbag Kaplan, M.; Yilmaz, B.K. Electric Mobility in Europe: A Comprehensive Review of Motivators and Barriers in Decision Making Processes. *Transp. Res. Part A Policy Pract.* **2018**, *109*, 1–13. [CrossRef]
64. Dua, R.; Hardman, S.; Bhatt, Y.; Suneja, D. Enablers and Disablers to Plug-in Electric Vehicle Adoption in India: Insights from a Survey of Experts. *Energy Rep.* **2021**, *7*, 3171–3188. [CrossRef]
65. Krishnan, V.V.; Koshy, B.I. Evaluating the Factors Influencing Purchase Intention of Electric Vehicles in Households Owning Conventional Vehicles. *Case Stud. Transp. Policy* **2021**, *9*, 1122–1129. [CrossRef]
66. Kumar, R.R.; Alok, K. Adoption of Electric Vehicle: A Literature Review and Prospects for Sustainability. *J. Clean. Prod.* **2020**, *253*, 119911. [CrossRef]
67. Rezvani, Z.; Jansson, J.; Bodin, J. Advances in Consumer Electric Vehicle Adoption Research: A Review and Research Agenda. *Transp. Res. Part D Transp. Environ.* **2015**, *34*, 122–136. [CrossRef]
68. Liu, R.; Ding, Z.; Jiang, X.; Sun, J.; Jiang, Y.; Qiang, W. How Does Experience Impact the Adoption Willingness of Battery Electric Vehicles? The Role of Psychological Factors. *Environ. Sci. Pollut. Res.* **2020**, *27*, 25230–25247. [CrossRef] [PubMed]
69. Adhikari, M.; Ghimire, L.P.; Kim, Y.; Aryal, P.; Khadka, S.B. Identification and Analysis of Barriers against Electric Vehicle Use. *Sustainability* **2020**, *12*, 4850. [CrossRef]
70. Candra, C.S. Evaluation of Barriers to Electric Vehicle Adoption in Indonesia through Grey Ordinal Priority Approach. *Int. J. Grey Syst.* **2022**, *2*, 38–56. [CrossRef]
71. Krishna, G. Understanding and Identifying Barriers to Electric Vehicle Adoption through Thematic Analysis. *Transp. Res. Interdiscip. Perspect.* **2021**, *10*, 100364. [CrossRef]
72. Tarei, P.K.; Chand, P.; Gupta, H. Barriers to the Adoption of Electric Vehicles: Evidence from India. *J. Clean. Prod.* **2021**, *291*, 125847. [CrossRef]
73. Barisa, A.; Rosa, M.; Kisele, A. Introducing Electric Mobility in Latvian Municipalities: Results of a Survey. *Energy Procedia* **2016**, *95*, 50–57. [CrossRef]
74. Chidambaram, K.; Ashok, B.; Vignesh, R.; Deepak, C.; Ramesh, R.; Narendhra, T.M.; Muhammad Usman, K.; Kavitha, C. Critical Analysis on the Implementation Barriers and Consumer Perception toward Future Electric Mobility. *Proc. Inst. Mech. Eng. Part D J. Automob. Eng.* **2023**, *237*, 622–654. [CrossRef]
75. Abdul Qadir, S.; Ahmad, F.; Mohsin A B Al-Wahedi, A.; Iqbal, A.; Ali, A. Navigating the Complex Realities of Electric Vehicle Adoption: A Comprehensive Study of Government Strategies, Policies, and Incentives. *Energy Strategy Rev.* **2024**, *53*, 101379. [CrossRef]
76. Pandita, D.; Bhatt, V.; Kumar, V.; Gotise, P. A Conceptual Model for Understanding the Barriers to the Adoption of Electric Vehicles in India. *Int. J. Soc. Sci. Econ. Res.* **2022**, *7*, 2544–2556.
77. Febransyah, A. Predicting Purchase Intention Towards Battery Electric Vehicles: A Case of Indonesian Market. *World Electr. Veh. J.* **2021**, *12*, 240. [CrossRef]
78. Sadek, N. Urban Electric Vehicles: A Contemporary Business Case. *Eur. Transp. Res. Rev.* **2012**, *4*, 27–37. [CrossRef]
79. Sheng, N.; Zhou, X.; Zhou, Y. Environmental Impact of Electric Motorcycles: Evidence from Traffic Noise Assessment by a Building-Based Data Mining Technique. *Sci. Total Environ.* **2016**, *554*, 73–82. [CrossRef]
80. Arora, R.; Singh, P.; Sarangi, P.K.; Kumar, S.; Chandel, A.K. A Critical Assessment on Scalable Technologies Using High Solids Loadings in Lignocellulose Biorefinery: Challenges and Solutions. *Crit. Rev. Biotechnol.* **2024**, *44*, 218–235. [CrossRef]
81. Kley, F.; Lerch, C.; Dallinger, D. New Business Models for Electric Cars—A Holistic Approach. *Energy Policy* **2011**, *39*, 3392–3403. [CrossRef]
82. Karthick, K.; Ravivarman, S.; Priyanka, R. Optimizing Electric Vehicle Battery Life: A Machine Learning Approach for Sustainable Transportation. *World Electr. Veh. J.* **2024**, *15*, 60. [CrossRef]
83. Shahjalal, M.; Shams, T.; Tasnim, M.N.; Ahmed, M.R.; Ahsan, M.; Haider, J. A Critical Review on Charging Technologies of Electric Vehicles. *Energies* **2022**, *15*, 8239. [CrossRef]
84. Paul Sathiyan, S.; Jensen, S.; Abirami, J. Electric Vehicle Charging Technology: Recent Developments. In Proceedings of the Innovations in Electronics and Communication Engineering, Singapore, 18–20 October 2022.
85. Rahmani, D.; Loureiro, M.L. Assessing Drivers' Preferences for Hybrid Electric Vehicles (HEV) in Spain. *Res. Transp. Econ.* **2019**, *73*, 89–97. [CrossRef]
86. Ali, I.; Naushad, M. Insights on Electric Vehicle Adoption: Does Attitude Play a Mediating Role. *Innov. Mark.* **2022**, *18*, 104–116. [CrossRef]
87. Schulz, F.; Rode, J. Public Charging Infrastructure and Electric Vehicles in Norway. *Energy Policy* **2022**, *160*, 112660. [CrossRef]
88. industri.kontan.co.id. Layanan Charging Station Kendaraan Listrik Kini Terintegrasi Di PLN Mobile. 2024. Available online: https://industri.kontan.co.id/news/layanan-charging-station-kendaraan-listrik-kini-terintegrasi-di-pln-mobile (accessed on 30 July 2024).
89. ekonomi.republika.co.id. Perbanyak Charging Station EV, PLN Gandeng Utomo Charge+ Dan ACME Corporation. 2024. Available online: https://ekonomi.republika.co.id/berita/sjjbmp370/perbanyak-charging-station-ev-pln-gandeng-utomo-charge-dan-acme-corporation (accessed on 9 September 2024).