Electric Vehicles Ecosystem in Indonesia: The Readiness of Infrastructure, Policies, and Stakeholders

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Electric Vehicles Ecosystem in Indonesia: The Readiness of Infrastructure, Policies, and Stakeholders

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Abstract: The Indonesian government is promoting the adoption of electric cars (EV) by implementing national policies that include incentives for EV production and infrastructure development, as well as decreasing taxes for users. Nevertheless, the implementation differs among local-level regions. Using case studies in Jakarta, West Java, East Java, and Yogyakarta, this research investigates the impact of national and local policies on EV development and the responsibilities of relevant stakeholders. The results indicate deficiencies in EV development policies, specifically highlighting inadequate coordination between national and local governments. While some provinces are prepared for EV adoption, others still perceive it as a luxury.

Keywords: electric vehicles, infrastructure, policies, stakeholders

1. Introduction

To achieve the Indonesia Net Zero Emission agenda in 2060, the government has been promoting the conversion of fossil fuel-powered vehicles into electric vehicles (EV). The programme claims that it will decrease carbon gas emissions from the transportation section which has contributed around 28% of the total CO2 emission since 2018 [1)]. The number of electrical vehicles in 2022 is small compared to Internal Combustion Engine (ICE) vehicles. There are 7.600 units of 4-wheeler and 26.000 units of 2-wheeler electrical vehicles registered in the police database[2)] compared to the 141.992.573 units of ICE vehicles combined[3)]. These numbers are far from the national target of 3 million operating EV by 2030.

In order to stimulate EV user growth, the national government has been trying to provide facilities and incentives to EV users by issuing several policies. The first policy is the Presidential Regulation (Perpres) Number 55 of 2019 on the acceleration of Battery Electrical Vehicles (BEV) programme on August 12, 2019. Several policies from various ministries soon followed, such as the Ministry of Transportation, the Ministry of Energy & Mineral Resources, the Ministry of Industry, and other government-related regulations. The policies generally support infrastructure facilities, tax incentives, and local component contents in EV industries.

As an archipelago with 34 provinces, Indonesia applies decentralization principle in its political system, which means every province has the autonomy to manage its own region, including its policy development. The implementation of the national policy may differ in each province; this includes the EV policy. Studies on EV policies in several countries such as the USA, China, and Norway [4–6)] show some evidence that there is no one-size-fits-all model. Therefore, adapting policies to local values is required to deliver adequate benefits within a certain social scope. For instance, Norway has an abundant of clean energy supply to support EVs and provides incentives in the form of Value Added tax (VAT). While China and the United States offer similar appealing incentives, both governments also prioritize research and development to expand EV production, resulting in affordable EVs for their citizens.

Another important factor is the subject i.e., the local actors, including but not limited to local government, universities, communities, and local businesses. According to a study [7)], knowing a subject's duty and functions is useful in identifying their roles in developing an EV ecosystem. Nonetheless, the majority of EV research in Indonesia is currently focused on the technical development and engineering of the production of the vehicles [8–11)], with only a few studies looking at the ecosystem and key actors. Previous studies on the case of Indonesia have only discussed the issue on a national level [12–14)] and we have not identified any at the local level. To the best of our knowledge, there is still a

literature gap on how national and local regulations can effectively nurture Indonesia's EV ecosystem.

This paper aims to explore the local actor's roles in EV development at the regional level following national policies. Exploration can be executed by focusing on two research questions; 1) How can national and local policies contribute to EV development? (2) What is the role of related actors in supporting these policies? This study attempts to fill a gap in previous studies on EV readiness in Indonesia by gathering data at the provincial (sub-national) level. Qualitative multiple-case method is used to collect and analyze data from four provinces in Java, i.e., DKI Jakarta, West Java, East Java and Special Region of Yogyakarta (DIY.) These four provinces are chosen because they have the highest (DKI Jakarta, West Java, and East Java) and the lowest (DIY) number of EV owners compared to other provinces [15].

This paper is divided into four sections. The first section is the introduction; the next section is the methodology; section 3 is the result and discussion; and closed with a conclusion. The result shows that, in general, the implementation of national policy at the local level (sub-national) is still in the early stage. On another note, different leading actors are involved in EV development in those four provinces. Their contribution, though, is still in the coordination stage.

2. Methodology

This study uses qualitative methods with multiple-case studies. The multiple-case studies are useful in collecting cases, revealing phenomena in several cases, and comparing them [16,17] to understand the bigger picture. Four cases are highlighted in this study: DKI Jakarta, West Java, East Java, and DIY. These four provinces were chosen because, according to the police database in 2021, they have the highest and lowest number of EVs in Indonesia. DKI Jakarta has 3.404 units, East Java has 913 units, West Java has 559 units, and the lowest is Yogyakarta, with 75 units. Yogyakarta was chosen because it is Indonesia's only special region that has the potential to encourage EV adoption due to the high demand in the creative and tourism industries [18].

Data extraction was conducted in 2021 for six months by collecting documents and supporting policy, as well as conducting FGDs, in-depth interviews, and some additional observations (see Table 1). We divided the information into 4 topics: EV development plan, EV infrastructure plan, EV users' experience, and EV communities' involvement. At the national level, we gathered information from experts in the Ministries, industries, EV-related private companies, and national communities. At the local level, we conducted interviews with local governments and some motor taxi drivers.

Table 1. List of topics and activities for data collections

Topics	**Activities**	**Important Stakeholder(s)**
Development plan for EV	FGD	Ministry of Transportation, Coordinating Ministry for Maritime and Investment Affairs
Charging Stations and Battery Swapping Stations Development	FGD	Coordinating Ministry for Maritime and Investment Affairs, Ministry of Energy and Material Resources, LEN, BRIN, OYIKA
	In-depth Interview	PLN, WIMA, local governments (West Java, East Java, Yogyakarta)
	Desk Study	Universities, local government (DKI Jakarta), industries
EV user experience	In-depth Interview	Online motor taxi drivers (Grab, Gojek)
EV communities' involvement	FGD	KOSMIK, KOLEKSI, Grid

The analytical techniques used are stakeholder analysis [19,20] and cross-case synthesis [21]. The former aims to map the parties involved in the development of EV charging station ecosystem and to understand each actor's power and interests. It classifies stakeholders into four groups based on their strengths and interests: *Crowd:* low strength and low interest; *Subject:* low strength but high interest; *Contest Setter:* high strength but low interest; and *Players:* high power and interest. The latter analysis was implemented by comparing two or more cases. The comparison between four provinces in this study focuses on how each province implements national policies and the follow-ups of local players in EV development.

3. Result

3.1. National Plans and Policies on EV

Indonesia's readiness to enter an era of electric vehicles is supported by various regulations issued on electric vehicles. The rules were set to realize a conducive development of ecosystem for BEV in Indonesia. The decree issued by the Government of Indonesia as a legal umbrella is the Presidential Regulation Number 55 of 2019 concerning the Acceleration of the BEV Programme for Road Transportation. The Acceleration of the BEV is a programme that aims to support the improvement of energy efficiency, security, and conservation in the transportation sector. In addition, the programme aims to achieve clean energy, clean and

environmentally friendly air quality, and Indonesia's commitment to reducing greenhouse gas emissions.

In following up on the Presidential Regulation Number 55 of 2019, several policy themes were issued as seen in Fig 1:

- Incentive for EV production

  The primary goal of this policy is to stimulate the EV industry to create EV vehicles and supporting components. The policies published encompass the Regulation of the Investment Coordinating Board of the Republic of Indonesia Number 7 of 2020. it regulates the provision of corporate income tax incentives for industries engaged in the production of EV.
- Utilize domestic component for EV production

  This policy is still related to EV producers, emphasizes management on the using of domestic components during manufacturing process. The objective is to reduce dependency on imported raw materials in order to strengthen the local industries. Some policies include: (1) Regulation of the Minister of Industry Number 27 of 2020. It governs the utilization of local components in the BEV for motorcycles and cars. It is expected that 80% of domestic components will be used by the BEV by 2030. (2) Regulation of the Minister of Industry Number 28 of 2020. It regulates the requirements and convenience for the domestic EV industry in carrying out the manufacturing process if it is necessary to import components.
- Technical EV production

  This policy primarily governs the technical aspects of EV industries, including EV workshops as outlined in Regulation of Minister of Transportation No. 65 of 2020 and Regulation of the Minister of Industry Number 28 of 2020. The first policy governs the specifications and overall standards that authorize the EV industries/workshops to transform of ICE motorcycles into EV. Meanwhile, the latter policy establishes the essential criteria and procedures that owners of specific EV must adhere in order to ensure their comfort and safety while driving on public roads.
- EV Infrastructure development

  Regulation of the Minister of Energy and Mineral Resources No. 13 of 2020 concerning the provision of electric charging infrastructure for BEV is one of the regulations that governs the development of EV infrastructure. It governs the provision of infrastructure, which is categorized into two types: (1) non-commercial private electrical installations typically found in government offices and households and (2) battery or electricity exchange facilities in public areas. his facility is owned by authorized commercial entities with the ability to engage in purchasing and selling activities
- EV tax reduction

  In order to encourage the transition from ICE to EV the government has implemented various incentives in the form of tax reductions. One such incentive is Regulation of the Minister of Home Affairs of the Republic of Indonesia Number 1 of 2021 concerning the Basic Calculation of the Imposition of Motor Vehicle Taxes and Transfer Fees for Motor Vehicles in 2020. The rule is annually modified. In 2021, the electric vehicle tax is calculated at 10% of the assessed value of the motor vehicle tax. This proportion is lower than the one in 2020, which imposed a 30% electric car tax based on the value of the motor vehicle tax. In addition, Government Regulation no. 74 of 2021 mandates a 0% tax rate on the selling price of EV.

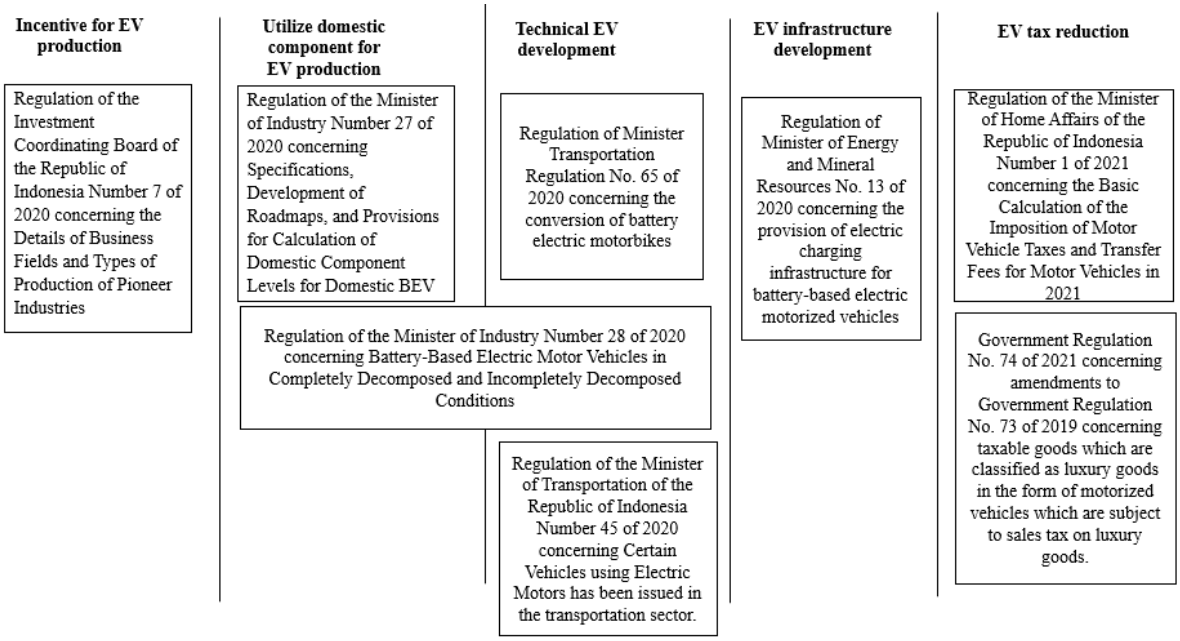

Fig. 1: The Supporting Regulations of EVs In Indonesia

These policies demonstrate the government's focus on two major aspects: supply and demand. n the supply side, the government is offering incentives to the EV manufacturing industry and its components. These incentives include lowering corporate taxes, facilitating the import of components that are not currently produced domestically, and gradually increasing the requirement to use domestic components for EV producing. On the demand side, consumers are provided with incentives such as tax reductions on EV and the development of EV infrastructure, including charging stations, to enhance convenience for EV users. for instance, PT PLN has prepared the projection for a national charging station needs through the 2020-2024 EV Infrastructure Development Roadmap. in the projection calculation, by 2030, it is expected that there will be 254,181 electric cars. With a charging station service ratio of 1:10, it is targeted that by 2030, there will be 24,270 charging station units (Traffic Corps data as of May 2021). This strategy is expected to be able to accelerate and increase the number of EV usage in Indonesia.

3.2. Stakeholder Mapping Model: Challenges in Coordination and Collaboration

Continuing our previous discussion, in this section we explore the implementation of the national government's efforts to construct an EV ecosystem. The implementation of the project involved a wide range of stakeholders. Practically, as depicted in Fig. 2, the stakeholders are integrated to facilitate the establishment of an EV ecosystem. For instance, PLN, which is a national electricity cooperation playing the important role of energy supplier, is connected to EV users (Gojek and Grab Taxi online drivers) and other related industries (OYIKA, Gesits, Hyundai, etc). Necessary R&D works are performed by research institutes such as BRIN (National Research and Innovation Agency) and major national universities. Such organizations engaged in research collaboration with various stakeholders including BEV and CS Industries, governments, and electricity providers. Local and national governments are expected to provide supportive policies and incentives. Finally, the EV ecosystem is supported by BEV communities (Kosmik, Koleksi, GRID) to disseminate the economic and environmental benefits of using EVs to the public.

The stakeholder mapping analysis identified stakeholders' strengths, interests, and influence. It was carried out to find the interests of significant and influential stakeholders in the development of battery-based electric vehicles in Indonesia, especially in the aforementioned four provinces (DKI Jakarta, West Java, East Java, and DIY).

As seen in Fig 2 stakeholder mapping in the development of EV based on a matrix of strengths and interests. The stakeholder mapping is explained as follows:

- Subject is an organization, agency, institution, company, or community with great interest but low resources. It can be interpreted as an organization that cares about the development of battery-based electric vehicles but does not have the means to influence or make policies or regulations. Stakeholders included in this group are KOSMIK, KOLEKSI, and GRID.
- Player is organizations, agencies, institutions, companies, or communities with great interest and resources. These stakeholders have great power to make policies or regulations to support the development of battery-based electric vehicles. Stakeholders included in this group are the central and regional governments.
- Contest Setter is an organization, agency, institution, company, or community with great resources but low interest in developing electric vehicles in Indonesia. Stakeholders included in this group are the electric vehicle industry and electric vehicle/charging station manufacturers.
- Crowd is an organization, agency, institution, company, or community with little interest and resources. They simply follow the trend and market interests. Stakeholders included in this group are the public, electric vehicle users, and electric vehicle-related taxi operators.

Stakeholder mapping reveals a direct relationship between the 'player' and 'contest setter' actors. The 'Player' directs the use of the extensive resources available to 'contest setters' to facilitate the rapid advancement of EV manufacturing in Indonesia. For example, the government implements a program that provides tax breaks to EV manufacturers, as well as a strategy to increase the use of domestic components in the production of EV. This policy encourages both convenience and active participation by local industry in the development of EVs. Meanwhile, another direct collaboration was discovered between 'crowd' and 'subject'. The 'subject' conducted a promotional campaign highlighting the advantages and benefits of EVs to encourage and direct the 'Crowd' to transition from ICE vehicles to EV. Therefore, the relationship between these actors is primarily concerned with guiding the actors' interests and data sources to bolster the development of EVs.

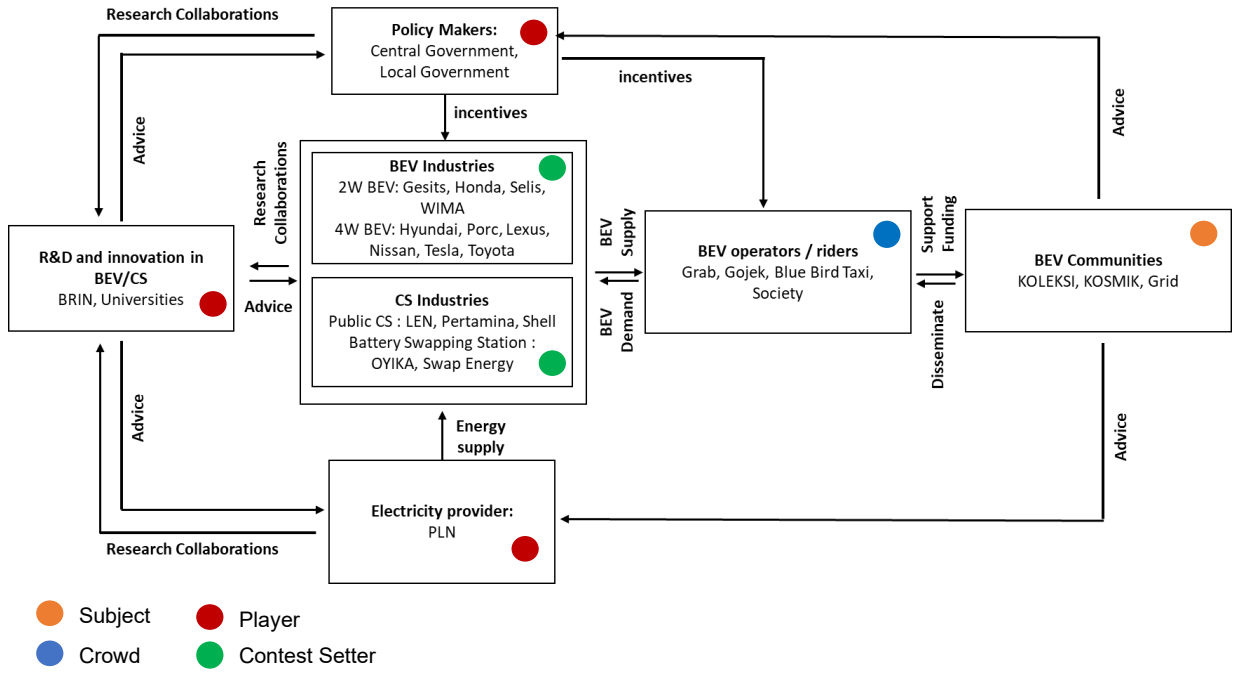

Fig. 2: Stakeholder Mapping of EV Ecosystem in Indonesia

3.3 Readiness at Regional Level (four case studies)

We explore four major provinces in Indonesia to analyse how they have adopted the mandate of the national government to accelerate the development of EVs.

As the capital of Indonesia, Jakarta has the privilege of supporting the development of EVs. One of the privileges (and one that could be a challenge at the same time) is that Jakarta is always supported by its peripheral conurbation areas, namely Jabodetabek (Greater Jakarta). Transportation arrangements in the Greater Jakarta area are then regulated by a special agency under the Ministry of Transportation, namely the Jabodetabek Transportation Management Agency (BPTJ). It is regulated through the Presidential Regulation Number 103 of 2015 and Regulation of the Minister of Transportation of the Republic of Indonesia Number 110 of 2018. Based on the Jabodetabek Transportation Master Plan and fulfilling pillar 9 on the use of new renewable energy-based fuels, charging stations will be installed in various regional assets such as offices, government buildings, city parks, and more. In 2021, a pilot project was executed: a feasibility study of solar panel charging station at Jatijajar and Pondok Cabe Terminals.

Currently, the number of electric vehicles in the agglomeration area recorded by the Korlantas Polri (Traffic Corps) is 3,404 units in the Polda Metro Jaya area (Jakarta, Depok, Bekasi, Tangerang, and South Tangerang). The number is broken down into 250 passenger cars, 7 minibuses, 3146 motorcycles, and 1 truck (data as of May 2021).

To respond to the charging station infrastructure needs in Jabodetabek, more than 100 charging station units have been installed at various points. Most charging locations are in DKI Jakarta, with a total of up to 58 locations out of 85 points in this agglomeration area.

Meanwhile, the development of EV infrastructure in West Java has been regulated in Regional Regulation Number 2 of 2019 concerning the General Plan of Regional Energy for West Java 2018–2050. The West Java Provincial Government has projected the final energy demand in the transportation sector at 12.3 MTOE (million TOE) by 2025 and at 23.0 MTOE by 2050. Based on this projection, electrical energy is expected to contribute 5.4% to the total energy use of the transportation sector. West Java has also issued the Regional Regulation number 9 of 2019 concerning regional taxes. The policy regulates taxes for electric cars at 10% and electric motorcycles at 2%. All coordination and programmes for EVs (and sustainable energy in general) are led by the Energy and Mineral Resources Office of West Java.

As of May 2021, 559 EVs are operating in West Java, including 57 passenger cars, 5 minibuses, and 497 electric motorcycles. In addition, the West Java Provincial Government actively conducts outreach programs to communities and industries to support the implementation of EVs through events. The West Java Provincial Government also initiated the procurement of EVs as the official vehicles for the Governor, Deputy Governor, and Patrol Guards. In the public transportation sector, the Bandung Government, in collaboration with the Ministry of Transportation, will launch an electric bus with a "Buy the Service" scheme on the Leuwipanjang-Dago route. Twenty electric busses are planned to operate in Bandung.

Meanwhile, the EV development programme in East

Java is still at a coordination stage within the local governments. No formal programmes related to EV support is listed in the regional development planning and the related OPD strategic plan. The same situation is apparent in the regional energy support recorded in the Regional Regulation Number 6 of 2019 on Regional Energy General Plan (RUED) of East Java 2019–2050, which states the ongoing struggle to provide general electricity in rural areas. Nevertheless, an incentive for EV users is legalized through the Governor's Decree Number 59 of 2019 on the amendment of the Governor's Decree Number 101 of 2011, which regulates the discount on automotive vehicle ownership data changes tariff. The tariff for EVs is 10% less compared to ICE vehicles. PLN as the business provider of national electricity has also constructed a charging station infrastructure in Embong Ungu Street, Surabaya.

Supporting the development of the industry, several stakeholders such as provincial government, PLN, the Regional Police, and financial institutions such as Bank Jatim and Bank Indonesia (BI), are planning a coordination on the marketing of industry components for EVs produced by local small and medium businesses as well as ensuring their standards and legalities. Local industries appear to be encouraged to participate in the production of EV to reduce national imports of EV components.

Despite having the smaller number of EV owners, Yogyakarta or DIY is committed to EV development. DIY's EV development programme is currently in the inter-office cooperation level. Yogyakarta's Regional Law Number 6 of 2020 on the general planning of regional energy 2020-2050 still focuses on the general delivery of electricity in rural areas. Nonetheless, efforts have been made to give incentives to EV owners, such as a 10% reduction in vehicle taxes. These laws are codified in the Governor's Decree Number 26 of 2021, which governs the basic computation of vehicle tax and vehicle ownership change tariffs. Nevertheless, existing charging stations in DIY are mainly provided by private companies (such as Hyundai) to facilitate their EV customers. These charging stations are normally located in hotels or lodgings.`

Support for EV development is conducted side by side with local cultural development. The government office proposes to buy six Transjogja electrical buses through special funds in late 2021. These purchases were made to support Yogyakarta as a world heritage city registered with UNESCO. The proposal was also conducted to fulfil the requirement of net zero emissions (NZE). The buses are used on the philosophy axes routes of Panggung Krapyak, Kraton, Beringharjo, Malioboro, Tugu Putih, and Imogiri.

Table 2 EV' Regional Policy Development and Its Implementation

Region		DKI	West Java	East Java	DIY
Policy	Development of EV Infrastructure	✓✓	✓✓	*	*
	EV tax reduction	✓✓	✓✓	✓✓	✓✓
	odd-even traffic permits for EV	✓✓			
	EV for public transportation	✓✓			✓
	EV for government officials' vehicles	✓✓	✓✓		

Notes: ✓✓: Policy aligns with implementation.
✓: Policy without implementation
**: Implementation lacking policy*

4. Discussion

The four provinces' cases illustrate an intriguing fact: policies at the national and local levels are not always in-sync. This does not necessarily imply that they work in opposition, but some attempts should be made to harmonise this levelling of governance, especially in Indonesia. Table 2 shows that the local-level implementation of the national EV policies still focuses on infrastructure development and EV tax reduction. Meanwhile, the execution of other national policies, including those pertaining to the production of electric vehicles (EVs) and their batteries using domestic components, has not yet been realised.

In detail, we compare the strategies of those four local cases as diverse attempts to comply with national goals.

The DKI Jakarta government has good plans and policies to boost EVs. They impose a 0% vehicle tax for electric vehicles in DKI Jakarta until December 31, 2024, and exempt odd-even traffic restrictions for vehicles operated by electric motors. As of October 2021, the government has also launched TransJakarta electric busses for daily public transportation. Based on PT TransJakarta's 2020–2030 company plan, the transformation of the electric bus fleet will continue until 2030, which is 83% of the total operating fleet. Apart from the entire infrastructure, the communities and many EV firms are located in Greater Jakarta, which increases the likelihood of EV awareness in this province. This finding is consistent with the previous research [22], showing that as a national capital with extensive infrastructure and understanding of renewable energy, Jakarta is the province best positioned to adopt EVs as its principal method of transportation.

The performance of the West Java government in adapting the EV trend is quite admirable. In addition to the support from the government in the forms of tax

reduction and regional energy plan which supports renewable energy for vehicles, the government is willing to invest in EV infrastructure and manufacture. The number of EV charging stations in West Java is among the highest in Indonesia, allowing EV users to drive without fear of running out of power.

We can also learn how East Java encourages domestic industries to participate in the EV national development plan. Despite the fact that it is still early in the process, the local government urges local stakeholders to assist component industries for EV manufacture. It is carried out through the empowerment of small- to medium-sized firms, start-ups, and vocational high schools to manufacture component parts and convert conventional vehicles to EVs. To help these businesses, the industrial office hosts webinars. Small and medium-sized businesses as well as vocational high schools frequently participate in these activities, which also serve as public education on the advantages of converting to EV. This may not be the quickest approach to increase the number of EVs on the road, but it may follow China's and the USA's lead in the long run [4,5].

While three provinces are keen to endorse national programmes, DIY is one of the several local administrations that is less enthusiastic. Instead of prioritizing EV development, the government is focused on how to utilize power to improve the lives of the lower working class. Although not overjoyed, the DIY government hopes and does its best to support the national policy. During the conversation, they advised that the EV be focused on traditional vehicles such as electric *becak* (pedicab) or how EV charging stations may be used to help the needy. It is important for Indonesian policymakers to note that EVs are currently considered a luxury. EV also seems to be perceived as disruptive innovation which might affect the poor[23]. As a result, measures that support the benefits of EVs such as minimal emissions and the usage of clean energy are required to fit that specific group of people. These measures could mean providing electric buses for low-middle income individuals rather than encouraging personal electric vehicles. According to numerous studies, electric vehicles are not just for the wealthy because the primary concern is energy efficiency and economic advantage for all [24–26].

Looking at the previous research on EVs and their infrastructure readiness in Indonesia, these findings depict some progress. For instance, a previous study [13] suggests government regulations to ensure the efficiency of the operation of EV charging networks by matching infrastructure supply with users' needs. A recent study [14] also supports this recommendation that more detailed government regulations should be issued to further expand the Perpres Number 55 of 2019. Based on our findings, the roles of local government and local regulations are urgent and essential in supporting this initiation of EVs. Furthermore, as we have seen in other countries that have succeeded, local governments and local actors do play very prominent role in strengthening the EV ecosystem.

5. Conclusion

The Indonesian government has prioritized EVs in the national energy and environment plan, as evident in Perpres Number 55 of 2019. However, given how fluid the current EV ecosystem is, the policies are still imperfect and require significant improvements. According to our research on EV policies and conditions at the provincial level, there is still room for improvement on the policy of EV development. The missing links and lack of coordination between national and local governments are some of the issues. National-level plans and policies will not be impactful without any local supports. Despite the lack of coordination, we identified the level of readiness in four major provinces, demonstrating that each region understands the EV plans differently. DKI Jakarta as the capital, is clearly prepared for EV development, followed by West Java and East Java. However, DIY and presumably many other provinces still regard EV as a luxury, in contrast to their goal of using technology for pro-poor programmes and low-income prosperity.

We recommend that policy makers and relevant stakeholders devise a strategy for the collaboration of provinces and demand that each province develop its own regional EV plan. Under the coordination of the Ministry of Finance, national and local governments, for example, can allocate funds for EV procurement, not only for services but also for pilots, to attract the lower middle class. Policymakers should consider how to make electric vehicles a necessity rather than a luxury. Also, communities who support EV can play a role in promoting and disseminating the benefits of EV. If these actors work together, Indonesia can compete with other countries in creating a better EV ecosystem.

We propose future research on EV challenges in Indonesia, such as studies on renewable energy resources for the future of EV or the societal impacts of EV development.

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