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# Prioritizing Policy for the Electric Vehicle Adoption and Production Ecosystem in Indonesia

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**ABSTRACT**

Most countries are expanding their programs for electric vehicles as part of an action to reduce greenhouse gas emissions and fossil fuel consumption. In Indonesia, EV development is significantly behind target. Indonesia has specific conditions regarding innovative products in the automotive industry. The majority of automotive users are economy users. Foreign-origin equipment manufacturers dominate the automotive industry, whereas local manufacturers are comparatively less competitive. This study examines the critical policies for EV adoption and the ecosystem in Indonesia. This analysis employs the analytic network process method based on the benefits, opportunities, costs, and risks model. The results show that, in both the short and long term, the top three priorities offer users greater attractiveness in terms of price and charging-station availability, including purchasing incentives, annual tax incentives, and incentives for charging infrastructure providers. In the short term, the following priorities focus on a producer-oriented policy, specifically co-production with local start-ups and EV share-targeted production. In the long term, the priority is to enhance the appeal of EVs by granting them driving privileges, which will continue through co-production with local start-ups to increase local content-based EV production.

**Keywords:** electric vehicles, adoption, ecosystem, policy models, ANP-BOCR, Indonesia
**JELClassifications:** L62, O25, O33, O38

## 1. INTRODUCTION

Globally, electric vehicles (EVs) of various types, both battery electric vehicles (BEVs), plug-in hybrid vehicles (PHEVs), and hybrid vehicles (HEVs), have become part of the world's automotive industry products, in line with the mandate of the Paris Agreement and Nationally Determined Contributions (NDCs) related to efforts to reduce greenhouse gas emissions. Most countries promote electric vehicles, which gradually reduce the use of internal combustion engine (ICE) vehicles in sustainable transportation (IEA, 2022). The widespread adoption of EVs is expected to decrease air emissions, as indicated by research on EV life-cycle assessment, and concurrently reduce fossil fuel consumption (Das et al., 2023). Suppose the use phase of EVs is parallel with the use of renewable energy in power plants that serve EV charging stations. As a result, the increasing use of EVs will significantly reduce greenhouse gas emissions (Shafique and Luo, 2022).

According to the multi-level perspective theory on socio-technical transitions towards sustainability, the introduction of electric vehicles represents a radical niche innovation in mobility (Geels, 2019). The shift to electric cars is a nonlinear process driven by reciprocal influences among three levels: Niche innovations, socio-technical regimes, and socio-technical landscapes. (Lin and Sovacool, 2020). The strategy to support the global EV program encompasses long-term goals for EV market share and the prohibition of ICEVs, battery technology development, charging infrastructure deployment, and incentive programs (IEA, 2022). Some countries, such as China and the United States, have adopted radical policies mandating that manufacturers produce a certain number of EVs under a dual-credit policy (Peng and Li, 2022). Globally, the growth in EV volume for 4-wheeled electric cars of all types reached 17 million units in 2024, jumped from 13.9 million units in 2023, representing a 20% market share. About 92% of all electric vehicle sales in 2023 came from China (58.3%), Europe (23%), and the USA (10,1%), the three most prominent markets for EVs (IEA, 2025).

Indonesia launched the battery-based electric vehicle acceleration initiative in 2019 through presidential regulation (GOI, 2019), setting targets of 400,000 units by 2025, 600,000 units by 2030, and 1,000,000 units by 2035 (Kemenperin, 2022). Some policies in the world for fostering EVs have been adopted by the Indonesian government, consisting of fiscal, like incentives for users, manufacturers, and charging infrastructure providers, and nonfiscal policies, such as privileges for EV users to drive in a controlled area, such as the old-even area in Jakarta (Sasongko et al., 2024a). However, as sustainable products, EVs are in the early adopter stage of the diffusion of innovation theory (Rogers, 2003) as they enter the automotive market. In 2022, total sales of electric vehicles (EVs) reached 69,742 units, comprising 17,062 BEVs and 52,680 units, or 1,47% of the market share. In 2023, the market share increased by 6,93% compared to 1,47% in 2022. In 2024, sales increased by 48.01% from 2023, with 103,228 EVs sold, comprising 136 PHEVs, 59,904 HEVs, and 43,188 BEVs, representing an 11.92% market share (Gaikindo, 2024). The EV sales and growth are still far from the target, so Indonesia's government needs to strengthen the ongoing policies, adopt new ones, and set priorities.

Few researchers have conducted EV policy studies that prioritize fundamental policies that integrate those for users, manufacturers, and EVCS providers. Some researchers have proposed that the policy focus on only one subsystem, such as the influence of pricing policy frameworks on the usage of public charging facilities, by analyzing both the behavioral and spatial attributes (Makaremi, 2024). Abdul Qadir et al. (2024) proposed a comprehensive regulatory framework encompassing government strategies, policies, and incentives, adopting a multifaceted approach that considers economic, environmental, technical, and business aspects; however, it lacks prioritization. Zhao et al. (2024) examined the effectiveness of the policy mix in 275 cities in China, charging discounts, charging facility subsidies, and right-of-way priorities. Still, there was a lack of a manufacturer's perspective and priority. Xu et al. (2024) analyze the EV supply chain under dual-credit and subsidy policies, which consist of station-building subsidies and battery R&D subsidies that focus solely on the manufacturing subsystem.

Indonesia has specific barriers that need to be taken into consideration in EV policy and strategy. First, automotive users are cost-conscious; over 95% of car users have a budget of under Rp 400 million for a car, with a preference for multi-purpose vehicles (MPVs). Second, EV manufacturers are dominated by foreign-origin equipment manufacturers (OEMs); almost 100% of passenger EVs and more than 85% of electric bus manufacturers (Sasongko et al., 2024b). Past research has not undertaken policy studies that consider the existence and dominance of foreign original equipment manufacturers (OEMs) in the automotive industries of developing countries, particularly in countries like Indonesia, which are primarily driven by economic user factors and thus require special treatment in decision-making. Therefore, the primary objective of this paper is to determine the priority of EV policies in Indonesia from the perspective of the EV ecosystem, taking into account the dominance of foreign equipment manufacturers and the most economically significant user segments.

The complex system of the EV ecosystem requires a method that accounts for the interrelationships among criteria and policy alternatives to synthesize their priorities. Considering the benefits, opportunities, costs, and risks of adopting and producing EVs in Indonesia, this research applies the analytic network process method, which is robust in overcoming these challenges.

## 2. LITERATURE REVIEW

The development of an EV policy model should consider both adoption and production factors, including drivers (benefits and opportunities) and barriers (costs and risks), within EV ecosystems, which comprise user-oriented, producer-oriented, and infrastructure-oriented policies (Sasongko et al., 2024a). Based on the literature review, Figure. 1 presents an EV ecosystem map for Indonesia, highlighting each subsystem's drivers and barriers, as well as related policy alternatives to increase EV adoption and production.

### 2.1. Benefits, Opportunities, Costs and Risks

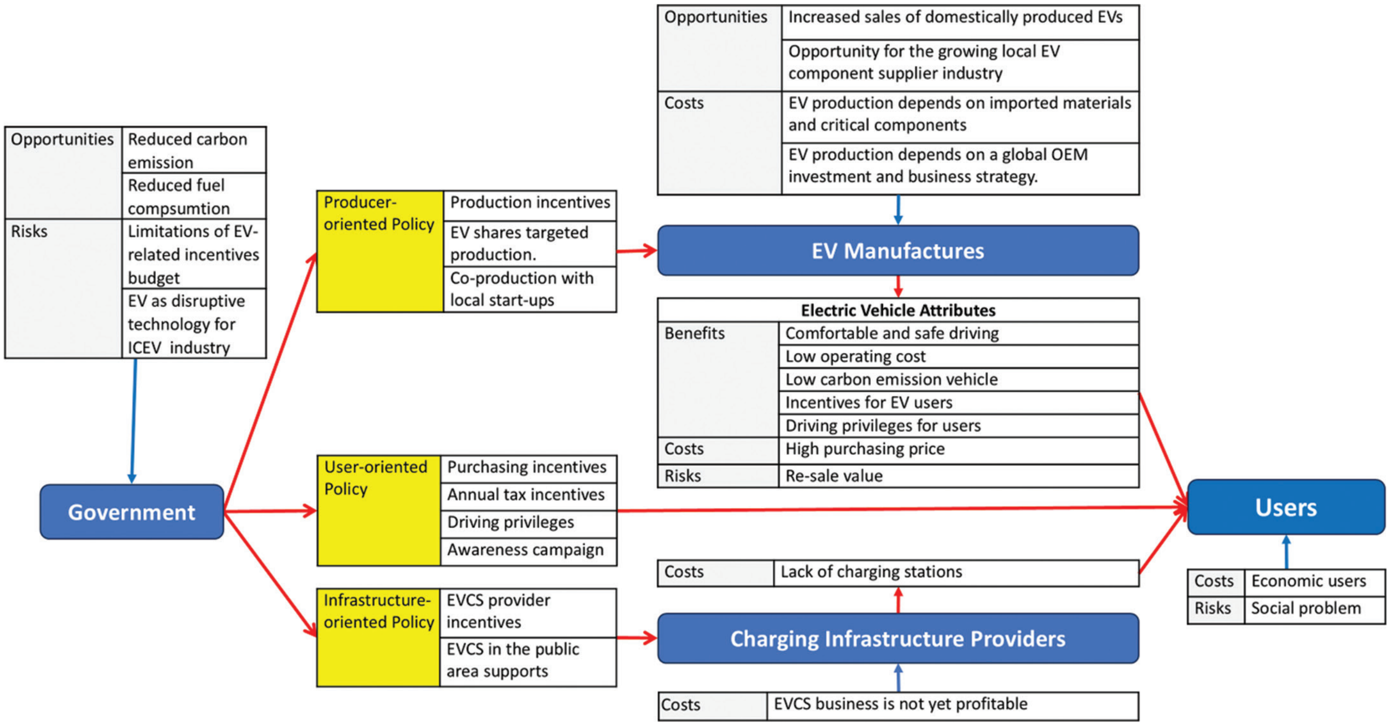
#### *2.1.1. Benefits*

Technically, driving an EV is comfortable and secure (Novizayanti et al., 2021; Chaudhary and Kate, 2023). Except for relative product advantage and range anxiety, price perception, government support, and environmental concern significantly influence consumer attitudes toward electric cars (Mukesh and Narwal, 2023). Economically, EV users benefit from EVs' lower operating costs, including lower charging and maintenance costs (Bhosale et al., 2022). The total cost of ownership of EVs is decreasing due to their lower operational and maintenance costs compared to ICEVs (Tarei et al., 2021). EVs have a lower TCO than ICEVs, excluding battery replacement costs (Dulău, 2024). The development of battery technology and extended battery warranties of more than 8 years is also beneficial for users (Sanguesa et al., 2021).

Environmentally, EVs are low-carbon emission vehicles. The EV program led to a 3.1% decrease in PM2.5 emissions, comparable to a 0.28-1.12% reduction in mortality risk, and resulted in savings of 175.1 billion yuan in government spending on pollution control (Lin, 2025). As more people use EVs for transportation in China's first-tier cities, air quality has improved dramatically, reducing public anxiety about smog (Shi and Lin, 2024).

Incentives and discounts are financial benefits for users. In many countries, the purchasing incentive to reduce EV prices

**Figure 1:** EV ecosystem mapping in Indonesia




is a fiscal instrument designed to make EVs more attractive and encourage users to purchase them (Dong and Zheng, 2022), such as reducing the sales tax on luxury goods (Llopis-Albert et al., 2021). Government policies and financial incentives have a greater influence in developing countries than psychological factors (Hakam and Jumayla, 2024). Benefits for EV users also come from nonfiscal policies, such as driving privileges in dedicated bus rapid transit lanes or exemptions from odd-even license plate number restrictions, which align with the date-number policy (Lu et al., 2022).

### *2.1.2. Opportunities*

The environmental benefits of EVs include long-term use for reducing greenhouse gas emissions (Kearny, 2023), and they are the ultimate goal, given that most countries have programs to switch from fossil-fuel-based vehicles to electrified vehicles (IEA, 2022). The economic opportunity of using EVs is reducing fuel consumption, which, for many countries, translates to a reduced need for imported oil. In Indonesia, imported oil accounts for more than 50% of total energy consumption, and the transportation sector accounted for 36.76% of final energy consumption in 2023 (KemenESDM, 2024). Using EVs as a taxi fleet in Tehran reduces fuel consumption costs by 2.9%, and private cars can decrease fuel consumption by 1.1% (Azarnoosh et al., 2024).

EVs produced domestically drive an increase in demand. The statistical data show that OEMs manufacturing EVs on Indonesian sites generate significantly higher sales than imported completely built units (CBU) of EVs. The EVs manufactured in Indonesia, with more than 40% local content, increase consumer confidence and are more attractive due to the purchase incentive (Sasongko et al., 2024a). In 2021, when there were no domestically produced BEVs, sales of imported BEVs totaled only 685 units. However, in 2022, when two Chinese and Korean OEMs manufactured BEVs in Indonesia, BEV sales reached 10,327 units (Gaikindo, 2023). Local production also drives growth among local suppliers. The new supply chain network industry, which encompasses the battery, electric motor, IT, and raw material sectors, will be fueled by the development of EVs (Lopez-Arboleda et al., 2021). The implications of bringing EVs into the mainstream yield economic and ecological benefits for policymakers and manufacturers (Jain et al., 2025).

### *2.1.3. Costs*

The purchase price of EVs is higher than that of ICEVs of the same model, and seating capacity is the top barrier to EV adoption (Bitencourt et al., 2021; Huang and Qian, 2021). The user segment that comprises the majority of economic users will be severely constrained by the higher cost of EVs compared to ICEVs in the same class and seating capacity (Sasongko et al., 2024b). The majority of EV users are economic users who still calculate EV prices and consider various factors when buying an EV (Wu et al., 2018). In Indonesia, buyer segmentation primarily focuses on economic users, with car buyers priced below Rp 400 million and seven-seater MPVs being the most popular choice (Gaikindo, 2023).

Besides the initial higher cost of EVs compared to ICEs, the primary obstacles to EV adoption are concerns about charging infrastructure availability, battery servicing capacity, range anxiety, and the placement of charging infrastructure to address blackouts and overloading (Sarda et al., 2024). The lack of charging stations, especially for intercity travel, is a considerable infrastructure barrier to EV adoption (Patel et al., 2024). Although charging stations are more prevalent in urban areas, it is insufficient to support EV growth (Lazuardy et al., 2024). The EVCS business is not yet profitable. The number of EVs is the most fundamental factor affecting the economic aspects of EVCS operation, and vice versa; therefore, these two factors are mutually correlated, with their relationship strengthening or weakening (Liang et al., 2022). Hence, in the early stages, the Government of Indonesia assigned the state-owned enterprise PLN to build and operate EVCSs nationwide, including collaboration with private operators (GOI, 2019; KemenESDM, 2023).

EV production depends on a worldwide OEM business strategy. On the manufacturer side, global OEMs are a key factor that accelerates or slows down the production and adoption of EVs based on their internal interests. Understandably, overseas OEMs need to control all business planning and strategy for producing ICEVs and EVs, including what type to make and when to sell EVs with that type as the effect of EVs as a disruptive technology and product (Sasongko et al., 2024b). Limited resources and parts necessitate imports from global supply chains, particularly for batteries and critical electronic components such as semiconductors. One major obstacle is the absence of local industry readiness in the surrounding area (Maghfiroh et al., 2021).

#### *2.1.4. Risks*

The resale value of used EVs is a significant risk factor. Users remain concerned about the value of used EVs, including their batteries, due to uncertainty about resale value during the early use phase (Kongklaew et al., 2021; Patyal et al., 2021).

EVs are a disruptive product. From a macroeconomic perspective, the ICEV industry contributes significantly to the country's GDP. Still, EV development has the potential to disrupt the automotive sector's role in GDP (Sasongko et al., 2024a). Most EV manufacturers are long-standing ICEV manufacturers and have invested massively in and built ICEV production networks and supply chains. If BEV production is not conducted with careful calculations, it will disrupt the ICEV business (Sasongko et al., 2024b).

Limited financial incentive budgets are among the many drawbacks of offering EV purchasing incentives in developing nations (Brozynski and Leibowicz, 2022; Yuniza et al., 2021). There is still a debate regarding the feasibility of targeting incentives or subsidies to recipients (Patyal et al., 2021). Social problems arise due to low public awareness of EVs and limited socialization of their technical, economic, social, and environmental aspects, as well as the concept of incentives. Government policy and legislation, economic risks, and operational and technological risks are the top three significant risk categories. Meanwhile, social risks are the least considerable category of EV adoption risks (Tripathi et al., 2024).

## 2.2. Alternative Policy Models in EV Adoption and Production

#### *2.2.1. User-oriented policy*

The user-oriented policy is a strategy designed to increase demand for electric vehicles (EVs). Financial purchasing incentives are an effective strategy to increase EV adoption. The incentives are expected to generate a significant sales share of zero-emission vehicles, including EVs, in the Netherlands and Norway (Deuten et al., 2020). Policies to make BEV prices more competitive with ICEVs have played an essential role in the successful adoption of EVs in Norway (Sharpe and Lenton, 2021). Government financial assistance to users for purchasing BEVs, in the form of incentives, helps narrow the price gap between EVs and ICEVs, making it a beneficial instrument for accelerating EV adoption in Australia (Broadbent et al., 2022). Most countries consider purchase price subsidies the most widely applied policy to increase the adoption of electric vehicles (Ali and Naushad, 2022). The implementation of purchasing incentive initiatives, along with the introduction of various electric vehicle models and seat capacities, is crucial for increasing consumer interest in buying electric cars (Sasongko et al., 2024). Another incentive policy for EV users who own EVs as part of low-carbon emission vehicles is to reduce the yearly tax incentive (Llopis-Albert et al., 2021). Nonfiscal policies in many countries offer driving privileges, such as priority lanes for EVs, exemptions from the odd-even driving policy, and concessions on parking locations (Lu et al., 2022). Governments and electric vehicle producers should advocate for environmental consciousness, enhance the perceived value of electric vehicles, and increase understanding of them to facilitate their adoption in developing markets (Chanda et al., 2024). Widespread EV adoption is hampered by low consumer awareness, inadequate infrastructure, and economic inequality. Strong consumer education initiatives are needed in Indonesia to address EV dependability, charging infrastructure, and long-term cost savings. (Hakam and Jumayla, 2024). Promoting a positive attitude towards energy-saving behavior will change consumer behavior towards electric vehicle adoption (Erna et al., 2024).

#### *2.2.2. Producer-oriented policy*

The producer-oriented policy is a supply-side policy that includes providing convenience and incentives to encourage investment in and production of EVs. EV production incentives for EV manufacturers are policy instruments designed to boost EV production (Hu et al., 2020). Some countries offer a favorable environment for investment in electric vehicle manufacturing. Even in China, the EV industry needs foreign investment and collaboration to accelerate sustainable economic growth. The longer the subsidy or incentive policy lasts, the larger the government budget becomes. Some pioneering countries in EV development, such as China, Europe, and the United States, have implemented policies mandating that ICEV manufacturers produce EVs with a minimum target share under a dual-credit policy. The dual-credit policy is an environmental-based market-incentive regulation. This policy significantly promotes the adoption of new energy vehicles and strengthens the automotive industry (Dong and Zheng, 2022). Compared to the subsidy policy, the dual credit policy is more assertive in encouraging the sales of new energy vehicles, and it competitively spurs manufacturing to improve ICEV energy consumption (Peng and Li, 2022; Yang et al., 2022; Yu et al., 2022). Co-production with foreign OEMs and local start-ups to produce EVs and their supporting components is a win-win scheme. The government should support regional EV-related businesses by establishing R&D facilities and platforms for technological innovation, and by providing technical assistance. In Indonesia, the local EV start-up industry faces challenges competing with foreign OEMs that have dominated the ICEV market. As a result, these OEMs have received recognition and trust from automotive users in Indonesia. The local EV industry still lacks the readiness to produce EVs as integrator manufacturers or part vendors (Maghfiroh et al., 2021).

#### *2.2.3. Infrastructure-oriented policy*

Infrastructure-oriented policy strikes a balance between supply-side and demand-side policies, leveraging infrastructure-dependent technologies to address the chicken-and-egg problem (Brozynski and Leibowicz, 2022). In the initial stage, some countries provide subsidies for the construction of EVCS (Huang et al., 2022). The ideal ratio of EVCS to EV is 1 unit of EVCS-10 units of EV (IEA, 2022). The existence of charging infrastructure in accessible locations increasingly impacts the intention to purchase EVs (Shi and Lin, 2024). Government policy interventions to increase the EVCS in public areas must consider utilization patterns, user background, and charging behavior (Makaremi, 2024).

## 3. METHODOLOGY

### 3.1. Analytic Network Process Method Considering Benefits, Opportunities, Costs, and Risks (ANP BOCR)

The analytic network process (ANP) is part of multi-criteria decision-making (MCDM) using the multiple attribute decision-making (MADM) approaches and is a DSS (decision support system), where this approach is only intended as a decision tool so that it can learn and understand the problems faced, priorities, values, and objectives through the exploration of the decision components, making it easier for decision-makers later to identify the best choice (Ciptomulyono et al., 2022). The ANP is a general form of the analytic hierarchy process (AHP). The advantage of ANP over AHP lies in its ability to make more accurate predictions and priority calculations, particularly in networks with dependencies within and across criteria. ANP is used to obtain weights in the interdependence among criteria. ANP enables interaction and feedback among elements within and between clusters (Saaty, 2004). The ANP method has several benefits. By pairing tangible and intangible elements, the decision maker can choose an expert to determine the priority. For comparative analysis, ANP can convert qualitative data into numerical values. Decision-makers may readily comprehend and use ANP without a specific understanding, as it is a straightforward, intuitive technique. All decision-makers and stakeholders can participate in the decision-making process thanks to ANP. ANP permits feedback and interaction among criteria (Liang and Li, 2008).

One of the widely used ANPs is the benefits, opportunities, costs, and risks (BOCR) criteria control structure, which enables the identification, classification, and organization of all factors that affect the output or resulting decisions. Benefits refer to positive factors and drivers that contribute to the current condition, while opportunities refer to those that will contribute to the future. On the other hand, costs refer to negative factors and barriers for the current condition, and risks refer to negative factors and risks for the future. The general ANP-BOCR model consists of goals, top-level, and decision networks. The top-level network is a benefits, opportunities, costs, risks (BOCR) network, equipped with a control criteria network and sub-criteria. These criteria influence the decision network, which comprises several alternatives or policies (Liu and Yin, 2019; Saaty and Vargas, 2006). The stages of the ANP-BOCR method are as follows:

Define the network model and the required connections, including the goals, merits (BOCR), control criteria (a subnetwork of each B/O/C/R), and strategic alternatives (policy alternatives). Construct the unweighted supermatrix that comprises the local priorities obtained from the pairwise comparisons across the network. Assume that there are elements $B_1, B_2, \ldots, B_m$ in the control layer of ANP. There is an element set $C_1, C_2, \ldots, C_m$ in the network layer. Among them, there is $e_{i1}, e_{i2}, \cdots, e_{in}$ $(i = 1, 2, \cdots, n)$ in $C_i$. Take the control layer elements $B_s$ $(s = 1, 2, \cdots, m)$ as the criteria and the elements $e_{jl}$ $(l = 1, 2, \cdots, n)$ in $C_j$ as the sub-criteria.

Construct a judgment matrix by comparing and analyzing the elements in the element set $C_i$ according to their size of influence on $e_{jl}$ using the nine-scale method proposed by Saaty (Saaty and Vargas, 2006), which consists of 1 (equal importance); 3 (moderate importance); 5 (strong importance); 7 (extreme importance); 9 (absolute importance); and 2, 4, 6, 8 (intermediate values). If element i has one of the above non-zero numbers assigned to it compared to element j, then j has the reciprocal of that number. The geometric mean compiles the pairwise comparison results from all experts.

Check the consistency ratio ($CR$), which is calculated as the consistency index ($CI$) and consistency ratio ($CR$) of the matrices.

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{1}$$

$$CR = \frac{CI}{RI} \tag{2}$$

Where $\lambda_{max}$ is the maximum eigenvalue of the matrix, $RI$ is the random index. If $CR < 0.1$, the comparison matrix is considered consistent; if $CR \geq 0.1$, the matrix needs to be adjusted until the condition is satisfied.

Determine the network layer according to the consistency test, the sorting vector (weight) $\left(w_{i1}^{jl}, w_{i2}^{jl}, \ldots, w_{in}^{jl}\right)^T$, and the matrix is constructed in Eq. (3).

$$W_{ij} = \begin{bmatrix} w_{i1}^{(j1)} & w_{i1}^{(j2)} & \cdots & w_{i1}^{(jn_j)} \\ w_{i2}^{(j1)} & w_{i2}^{(j2)} & \cdots & w_{i2}^{(jn_j)} \\ \cdots & \cdots & \cdots & \cdots \\ w_{in_j}^{(j1)} & w_{in_j}^{(j2)} & \cdots & w_{in_j}^{(jn_j)} \end{bmatrix} \tag{3}$$

The column vectors of the matrix represent the sorting vector of the importance of the element $e_{i1}, e_{i2}, \ldots, e_{jnI}$ in $C_i$ to the element $e_{j1}, e_{j2}, \ldots, e_{jnJ}$ in $C_j$ If the elements of $C_j$ are not affected by the elements of $C_i$, then $W_{ij} = 0$. By combining the sorting vectors of the interaction between network layer elements, a supermatrix under the control layer element $B_s$ is obtained in Eq. (4).

$$W = \begin{array}{c} \\ \\ \\ \end{array}\begin{matrix} 1 \\ \cdots \\ n_1 \\ 1 \\ \cdots \\ n_2 \\ \cdots \\ 1 \\ \cdots \\ n_N \end{matrix} \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1N} \\ W_{21} & W_{22} & \cdots & W_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ W_{N1} & W_{N2} & \cdots & W_{NN} \end{bmatrix} \quad (4)$$

Construct the weighted supermatrix. The supermatrix is normalized, resulting in the weighted supermatrix $\bar{W} = \left(\bar{W}\right)_{n\times n}$. In the formula, $\bar{W}_{ij} = a_{ij} \times W_{ij}$ and $a_{ij}$ is the weighting factor, i = 1, 2, ⋯, n; j = 1, 2, ⋯, n.

Calculate the limit relative sorting vector of each supermatrix (Eq. [5]).

$$\lim_{k\to\infty}\left(\frac{1}{N}\right)\sum_{k=1}^{N}\bar{W}^{k} \quad (5)$$

If the limit converges and is unique, the value of the corresponding row of the original matrix is the stable weight of each evaluation index.

The strategic priority of the policy is determined based on the weight of the strategy criteria and the BOCR criteria calculated in the previous step. The alternative with the highest priority is selected as the best alternative, and the other alternatives are sorted in order of priority. Short-term priorities will be determined using a multiplicative formula (Eq. [6]), while long-term priorities will be assessed using additive probabilistic formula approaches (Eq. [7]).

$$P_i = B_i Oi/C_i R_i \quad (6)$$

$$P_i = bB_i + oO_i + c(1-C_i) + r(1-R_i) \quad (7)$$

Where Bi, Oi, Ci, and Ri are the result of the synthesis of alternative i. While b, o, c, and r are normalized weights of the merits of B, O, C, and R, respectively.

### 3.2. Expert Panel

The expert panel selected for this research represents each subsystem of the EV ecosystem. The expert panel consists of ten experts, including two experts of subsystem government (from the Coordinating Minister of Maritime and Investment and the Ministry of Industry), four experts of subsystem EV manufacturers (from foreign OEMs and local star-up), two experts of subsystem charging infrastructure providers (from stated-owned electricity company and charging station manufacturer and operator), and two experts of subsystem users/adopters (from electric bus operator and EV user community). The experience ranges between 5 and 28 years. They are competent in forming opinions on EV adoption, production, and related policies within the Indonesian context.

## 4. ANP BOCR MODEL

The ANP BOCR network model, which analyzes EV adoption and production policy in Indonesia, employs a two-layer network model. The top-level network consists of goals and the benefits, opportunities, costs, risks (BOCR) merit model. Meanwhile, the second level is a subnet of each BOCR merit. The alternative policy comprises nine policy models, with priority determined by considering each sub-criterion in the BOCR subnet (Figure 2), as supported by the references.

The goal of the model is to prioritize EV adoption and production in Indonesia, considering the BOCR (benefits, opportunities, costs, and risks) within the EV ecosystem. Based on the literature review, Table 1 summarizes the merits and their control criteria. Table 2 presents the EV adoption and production policy alternatives in Indonesia, including both ongoing policies and proposed policies.

## 5. RESULTS AND DISCUSSION

### 5.1. Priorities of EV Policy Under Each B/O/C/R Subnet

Based on the expert panel's pairwise comparison of the factors and input into the SuperDecision V3.2 software (Creative Decisions Foundation, 2019), the calculation process is carried out using the step-by-step ANP-BOCR method. The weights of BOCR and each sub-criterion in each BOCR cluster, based on the pairwise comparison by the expert panel, are summarized in Table 3. The weights between merit clusters are as follows: M1-Benefits, 0.3432; M2-Opportunities, 0.2426; M3-Costs, 0.1716; and M4-Risks, 0.2426. Under the subnet M2-Benefits, low operating costs and comfortable, safe driving are more beneficial. Under subnet M2-Opportunities, increased demand and local supplier growth are more promising. Under subnet M3-Costs, the lack of charging stations and high purchasing prices result in higher costs. Under subnet M4-Risks, social problems and limited incentive budgets pose higher risks.

The analysis of the ANP-BOCR model individually reveals that EV adoption and production policies prioritized within each BOCR subnet yield different results, as the selected policies focus on only one cluster of B/O/C/R considerations at a time. The results of calculating policy priorities separately under M1-Benefits, M2-Opportunities, M3-Costs, and M4-Risks are summarized in Tables 4 and 5. The Limit column gives the priorities from the limiting supermatrix. The Normal column displays the results normalized for each component within each cluster. The Ideal column shows the results obtained by dividing the values in either the normalized or limiting columns by the largest value in the column, thereby indicating the priority ranking (Creative Decisions Foundation, 2019).

An alternative policy model prioritized based on the perspective of benefits maximizes benefits for subsystems within the EV ecosystem. Providing high policy priorities for users through EV purchase incentives, driving privileges for EVs, and annual tax relief is a high priority. In terms of supply, incentives are necessary to encourage automotive manufacturers to produce more electric

**Figure 2:** ANP-BOCR model of EV adoption and production policy in Indonesia

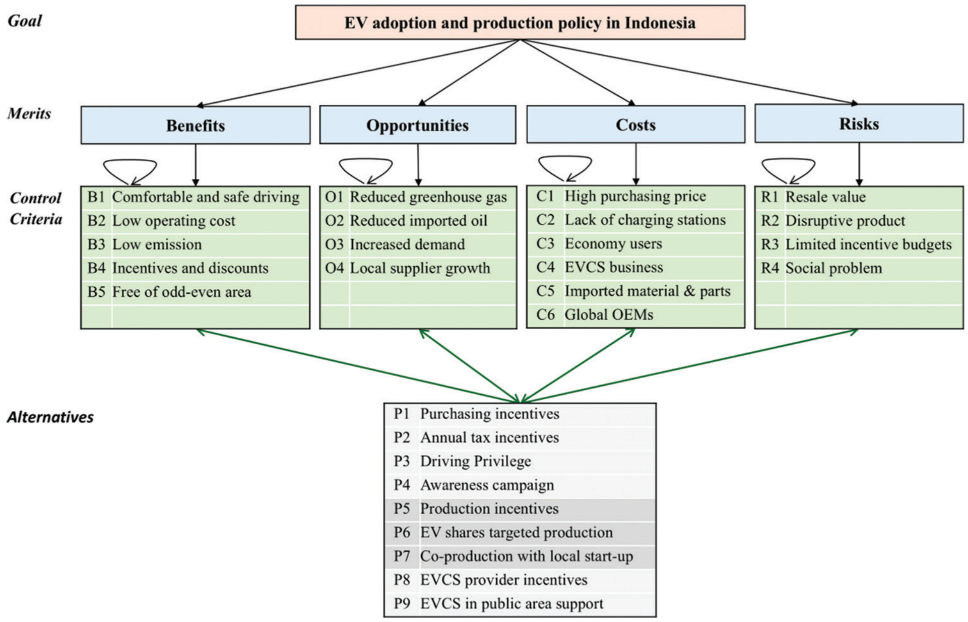



**Table 1: EV adoption and production benefits, opportunities, costs, and risks (BOCR)**

| Merits | Control criteria | References |
|---|---|---|
| Benefits | Comfortable and safe driving | (Novizayanti et al., 2021), (Chaudhary and Kate, 2023), (Mukesh and Narwal, 2023) |
| | The low operating cost of EVs | (Bhosale et al., 2022), (Tarei et al., 2021), (Dulău, 2024), (Sanguesa et al., 2021) |
| | EV is a low-carbon emission vehicle. | (Lin, 2025), (Shi and Lin, 2024) |
| | Incentives for EV users | (Dong and Zheng, 2022), (Llopis-Albert et al., 2021), (Hakam and Jumayla, 2024) |
| | Driving privileges for users | (Lu et al., 2022) |
| Opportunities | Reduced greenhouse gas. | (Kearny, 2023), (IEA, 2022) |
| | Reduced fuel consumption | (KemenESDM, 2024), (Azarnoosh et al., 2024) |
| | Increased sales of domestically produced EVs | (Sasongko et al., 2024a), (Gaikindo, 2023) |
| | The growing local EV component supplier industry | (Lopez-Arboleda et al., 2021), (Jain et al., 2025) |
| Costs | High purchasing price. | (Bitencourt et al., 2021; Huang and Qian, 2021), (Sasongko et al., 2024b) |
| | Economic users. | (Sarda et al., 2024), (Patel et al., 2024), (Lazuardy et al., 2024) |
| | Lack of charging stations. | (Wu et al., 2018), (Gaikindo, 2023) |
| | EVCS business is not yet profitable | (Liang et al., 2022), (GOI, 2019; KemenESDM, 2023). |
| | EV production depends on imported materials. | (Maghfiroh et al., 2021) |
| | Domination of global OEMs. | (Sasongko et al., 2024b) |
| Risks | Resale value. | (Kongklaew et al., 2021; Patyal et al., 2021) |
| | EV is a disruptive technology for the ICEV industry. | (Sasongko et al., 2024a), (Sasongko et al., 2024b) |
| | Limitations of the EV-related incentives budget | (Brozynski and Leibowicz, 2022), (Patyal et al., 2021) |
| | The social problem of incentive fairness | (Tripathi et al., 2024) |

vehicles and to incentivize charging station providers to increase the number of charging stations.

Alternative policy models EV prioritized based on the perspective of opportunities are policies that can leverage not only interest in buying EVs as the top priority with purchasing incentives and supported by EVSC provider incentives but also encourage the policies to promote collaboration between the EV manufacturing industry from abroad and the local industry, the provision of certain target market shares for the automotive industry in producing EVs, as well as provision of incentives for EV production.

An alternative policy model, prioritized from a cost-and-constraint perspective, can reduce costs and constraints in EV adoption and production by prioritizing incentives for EV manufacturers and users. Producer-supported policies, including EV production and collaboration between foreign OEMs and local industries as the top priority, EV production incentives, and EV share-based production targets. User-affirmed policies prioritize purchasing incentives as a secondary consideration and driving privileges.

Meanwhile, an alternative policy model prioritized from a risk perspective is a policy that can reduce the risk of dependence on imported materials and products, as well as the dominance of global original equipment manufacturers (OEMs), with a focus on EV industry policies with EV production incentives and EV share-based production targets as the two highest priorities. The following two priorities are related to EVCS-supported policies, specifically EVCS provider incentives and support to increase EVCS in public areas.

**Table 2: EV adoption and production policy alternatives in Indonesia**

| Policy model | Policy alternatives | | References |
|---|---|---|---|
| User-oriented policy | Purchasing incentives | Value added tax (VAT) incentive. The normal VAT rate is 11%. For electric cars and buses with a local content of 40% or more, the government covers 10% of the VAT, leaving buyers to pay only 1%. For local content of 20-40%, the government pays 5% of the VAT rate, so buyers only pay 6% (Kemenkeu, 2023).<br>PLN (state-owned electricity company) offers a 30% discount on electricity consumption from 22.00 to 05.00, and special prices for connection and additional power for home charging (Antaranews, 2022). | (Deuten et al., 2020), (Sharpe and Lenton, 2021), (Broadbent et al., 2022), (Ali and Naushad, 2022), (Sasongko et al., 2024) |
| | Annual tax incentives | The annual tax incentives consist of Sales Tax on Luxury Goods, which is 0% for BEVs and <10% for HEVs and PHEVs (Kemenkeu, 2023).<br>Regional tax reduction, namely the return duty on electric vehicles, up to 90%. No progressive tax applies to EVs (GOJ, 2021). | (Llopis-Albert et al., 2021) |
| | Driving privileges | Driving EVs in Jakarta is exempt from the odd-even policy in certain areas (GOJ, 2020). The dedicated EV parking location, equipped with a charging station, is strategically placed in office and commercial buildings. | (Lu et al., 2022) |
| | Awareness campaign | The campaign to increase knowledge and awareness of EVs involves understanding the importance of EVs in sustainability, specifically economic, social, and environmental aspects that are still underdeveloped. Therefore, government procurement for official and operational vehicles, as well as electric buses for mass public transportation (bus rapid transit), can increase the popularity of EVs, which remains low (GOI, 2022). | (Chanda et al., 2024), (Hakam and Jumayla, 2024) |
| Producer-oriented policy | Production incentives | Production incentives include a tax holiday of 5-20 years, depending on the investment value for its main industrial components, targeting the steel or non-ferrous metal industry, as well as its integrated derivatives, nickel smelters, and battery production (Kemenkeu, 2020).<br>Value added tax (VAT) is exempt on mining goods, including nickel ore, used to make batteries. VAT is exempt from the import and acquisition of capital goods, including machinery and factory equipment, for the motor vehicle industry. The Government has set a special import duty rate of 0% for motor vehicles imported in incomplete condition, known as Incompletely Knocked Down (Kemenkeu, 2022).<br>BEV manufacturers are permitted to import BEVs in the form of completely built-up (CBU) and completely knocked down (CKD), with 0% import duty and the luxury goods sales tax (PPnBM) of 0% until the end of 2025, in an attempt to stimulate investment in the development of BEV manufacturing in Indonesia. Additionally, manufacturers are required to meet minimum domestic BEV production requirements, as imported CBU or production debt, with local content of 40% until the end of 2026, 60% in 2027-2029, and 80% in 2030 and beyond (GOI, 2023; Kemeninves, 2023). | (Hu et al., 2020), (Zhao et al., 2024) |
| | EV shares targeted production. | Proposed policy. The Ministry of Industry has issued quantitative targets for EVs, specifically 400,000 units for 4-wheeled EVs by 2025, 600,000 units by 2030, and 1,000,000 units by 2035 (Kemenperin, 2022). However, there has been no target for automotive manufacturers to produce EVs with a certain percentage of total vehicle production (ICEV and EV), nor has there been a target to ban ICEV production in a specific year. | (Dong and Zheng, 2022), (Peng and Li, 2022; Yang et al., 2022; Yu et al., 2022). |
| | Co-production with local start-ups | Proposed policy. The foreign OEMs that invest in and build EV manufacturing in Indonesia are based solely on the local content threshold. It is not yet mandatory to cooperate with local manufacturers or start-ups to gain the technology transfer. | (Maghfiroh et al., 2021). |
| Infrastructure-oriented policy | EVCS provider incentives | The Government issued a policy to establish an initial market for the charging station industry, assigning PLN to build and operate charging stations in various locations with specific targets. Private charging station operators can also collaborate with PLN to operate charging stations (KemenESDM, 2023).<br>During the 2021-2024 period, PLN and its partners constructed 1,582 EVCS units across 1,131 locations in Indonesia, comprising 990 units owned by PLN and 592 units owned by partners (PLN, 2024). | (Brozynski and Leibowicz, 2022), (Huang et al., 2022), (IEA, 2022) |
| | EVCS in the public area supports | The Government encourages and facilitates the construction of charging stations in various residential areas, hotels, apartments, offices, malls, restaurants, other shopping centers, parking lots, and other open spaces around arterial roads, toll road rest areas, petrol stations, and other locations. In addition, the charging station business model was simplified by allowing each station to have only one machine unit with three types of plug-in connectors, as designated by the Government: Type 2 for AC Charging, CCS2, and CHAdeMO for DC Charging (KemenESDM, 2023). | (Shi and Lin, 2024), (Makaremi, 2024) |

### 5.2. Priorities of EV Policy Under All BOCR Models

The overall outcome of the policy model priority alternatives that are jointly affected by all the sub-criteria under the BOCR Model is shown in Table 6 and Figure 3 using a multiplicative formula for all policy alternatives that provide policy priority choices in the short-term and using an additive (probabilistic) formula for all policy alternatives that offer policy priority choices in the long-term. The results indicate that, in both the short and long term, the first and second priorities are related to the policy of providing fiscal incentives to users through purchasing incentives and annual tax incentives. The third policy relates to incentives for charging station providers. Therefore, the top three priorities offer users greater value in terms of price and charging-station availability.

**Table 3: The weights of each sub-criterion in each BOCR cluster**

| Subnet | Normalized by cluster | Sub criteria | Normalized by cluster |
|---|---|---|---|
| M1 benefits | 0.3432 | B1 Comfortable and safe driving | 0.2033 |
| | | B2 Low operating cost | 0.2221 |
| | | B3 Low emission | 0.1810 |
| | | B4 Incentives and discounts | 0.1946 |
| | | B5 Free of odd-even area | 0.1989 |
| M2 opportunities | 0.2426 | O1 Reduced greenhouse gas | 0.2093 |
| | | O2 Reduced imported oil | 0.2240 |
| | | O3 Increased demand | 0.2908 |
| | | O4 Local supplier growth | 0.2759 |
| M3 costs | 0.1716 | C1 High purchasing price | 0.1686 |
| | | C2 Lack of charging stations | 0.1768 |
| | | C3 Economy users | 0.1651 |
| | | C4 EVCS business | 0.1654 |
| | | C5 Imported material and parts | 0.1582 |
| | | C6 Global OEMs | 0.1660 |
| M4 risks | 0.2426 | R1 Resale value | 0.2137 |
| | | R2 Disruptive product | 0.2441 |
| | | R3 Limited incentive budgets | 0.2620 |
| | | R4 Social problem | 0.2802 |

Source: Author data processing results

Prioritized short-term policies aim to create demand and overcome obstacles on the demand side, where economic users dominate automotive users in Indonesia, and high purchase prices constrain this group. A user-oriented policy prioritizing purchasing incentives aims to make EV prices more attractive. If the gap between EV and ICEV prices in commensurate classes and seating capacities is narrower, it will make EVs competitive. The policy will complement EVs' low operating costs. The second policy priority, annual tax incentives for EVs, will strengthen fiscal policy. The third policy is infrastructure-oriented. The incentives for EVCS providers help make the EVCS business more competitive. The policy offers users the convenience and attractiveness of adopting and using electric vehicles, free from concerns about running out of battery power. The fourth and fifth priorities focus on a producer-oriented policy, specifically co-production with local start-ups and EV share-targeted production, to encourage the automotive industry to produce electric vehicles with models and prices that meet user needs, based on targeted local content, and to follow the volume targets in the roadmap.

Policies aimed at increasing EV adoption and production in the long term have more complex dimensions. The top three policies —purchasing incentives, annual tax incentives, and EVCS provider incentives —are expected to remain in place in the long term. The fourth priority is to enhance the appeal of EV use by offering driving privileges, such as exemptions from the odd-even policy in Jakarta. The fifth priority focuses on co-production with

**Table 4: The overall synthesized priorities for the alternatives from the subnetwork under M1-benefits and M2-opportunities**

| Overall BOCR model | Subnet M1 benefits | | | | Subnet M2 opportunities | | | |
|---|---|---|---|---|---|---|---|---|
| Alternatives | Limit | Normal | Ideal | Ranking | Limit | Normal | Ideal | Ranking |
| P1 Purchasing incentives | 0.0564 | 0.1693 | 1.0000 | 1 | 0.0618 | 0.1855 | 1.0000 | 1 |
| P2 Annual tax incentives | 0.0411 | 0.1234 | 0.7290 | 4 | 0.0332 | 0.0995 | 0.5364 | 7 |
| P3 Driving privilege | 0.0412 | 0.1236 | 0.7304 | 3 | 0.0214 | 0.0643 | 0.3464 | 9 |
| P4 Awareness campaign | 0.0256 | 0.0769 | 0.4540 | 9 | 0.0278 | 0.0834 | 0.4494 | 8 |
| P5 Production incentives | 0.0416 | 0.1248 | 0.7373 | 2 | 0.0356 | 0.1067 | 0.5749 | 5 |
| P6 EV shares targeted production | 0.0308 | 0.0923 | 0.5452 | 6 | 0.0382 | 0.1147 | 0.6183 | 4 |
| P7 Co-production with local start-up | 0.0267 | 0.0800 | 0.4726 | 8 | 0.0411 | 0.1233 | 0.6647 | 2 |
| P8 EVCS provider incentives | 0.0398 | 0.1194 | 0.7054 | 5 | 0.0394 | 0.1181 | 0.6366 | 3 |
| P9 EVCS in the public area support | 0.0301 | 0.0902 | 0.5331 | 7 | 0.0348 | 0.1044 | 0.5629 | 6 |

Source: Author data processing results

**Table 5: The overall synthesized priorities for the alternatives from the subnetwork under M3-costs and M4-risks**

| Overall BOCR Model | Subnet M1 Costs | | | | Subnet M2 Risks | | | |
|---|---|---|---|---|---|---|---|---|
| Alternatives | Limit | Normal | Ideal | Ranking | Limit | Normal | Ideal | Ranking |
| P1 Purchasing incentives | 0.0382 | 0.1146 | 0.7212 | 4 | 0.0323 | 0.0969 | 0.6828 | 7 |
| P2 Annual tax incentives | 0.0328 | 0.0984 | 0.6191 | 6 | 0.0296 | 0.0887 | 0.6251 | 9 |
| P3 Driving privilege | 0.0274 | 0.0823 | 0.5177 | 9 | 0.0417 | 0.1250 | 0.8804 | 3 |
| P4 Awareness campaign | 0.0276 | 0.0829 | 0.5216 | 8 | 0.0386 | 0.1157 | 0.8148 | 4 |
| P5 Production incentives | 0.0416 | 0.1249 | 0.7859 | 3 | 0.0473 | 0.1420 | 1.0000 | 1 |
| P6 EV shares targeted production | 0.0352 | 0.1056 | 0.6644 | 5 | 0.0430 | 0.1290 | 0.9084 | 2 |
| P7 Co-production with local start-up | 0.0316 | 0.0949 | 0.5968 | 7 | 0.0380 | 0.1141 | 0.8040 | 5 |
| P8 EVCS provider incentives | 0.0530 | 0.1589 | 1.0000 | 1 | 0.0324 | 0.0971 | 0.6842 | 6 |
| P9 EVCS in the public area support | 0.0458 | 0.1375 | 0.8652 | 2 | 0.0305 | 0.0915 | 0.6445 | 8 |

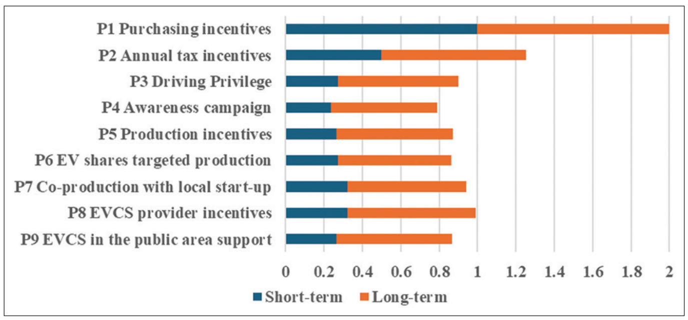
Source: Author data processing results

**Table 6: The overall synthesized priorities for the alternatives from the network whole model, with the multiplicative formula for short-term policies and the additive (probabilistic) formula for long-term policies**

| Overall BOCR model | Short-term (multiplicative formula) | | | | Long-term (additive-prob formula) | | | |
|---|---|---|---|---|---|---|---|---|
| Alternatives | Limit | Normal | Ideal | Ranking | Limit | Normal | Ideal | Ranking |
| P1 Purchasing incentives | 2.0307 | 0.2891 | 1.0000 | 1 | 0.7106 | 0.1663 | 1.0000 | 1 |
| P2 Annual tax incentives | 1.0103 | 0.1438 | 0.4975 | 2 | 0.5366 | 0.1256 | 0.7552 | 2 |
| P3 Driving Privilege | 0.5551 | 0.0790 | 0.2733 | 6 | 0.4464 | 0.1045 | 0.6283 | 4 |
| P4 Awareness campaign | 0.4801 | 0.0684 | 0.2364 | 9 | 0.3919 | 0.0917 | 0.5515 | 9 |
| P5 Production incentives | 0.5394 | 0.0768 | 0.2656 | 7 | 0.4292 | 0.1004 | 0.6040 | 6 |
| P6 EV shares targeted production | 0.5585 | 0.0795 | 0.2750 | 5 | 0.4169 | 0.0975 | 0.5867 | 8 |
| P7 Co-production with local start-up | 0.6547 | 0.0932 | 0.3224 | 4 | 0.4402 | 0.1030 | 0.6195 | 5 |
| P8 EVCS provider incentives | 0.6564 | 0.0935 | 0.3232 | 3 | 0.4732 | 0.1107 | 0.6659 | 3 |
| P9 EVCS in the public area support | 0.5382 | 0.0766 | 0.2650 | 8 | 0.4289 | 0.1004 | 0.6036 | 7 |

Source: Author data processing results

**Figure 3:** Prioritized EV policies for the short-term and long-term




local start-ups and on implementing a local-content-based EV production policy.

## 6. CONCLUSION

The results show that, in both the short and long term, the top three priorities offer users greater attractiveness in terms of price and charging-station availability, including purchasing incentives, annual tax incentives, and EVCS provider incentives. In the short term, the fourth and fifth priorities focus on a producer-oriented policy, specifically co-production with local start-ups and EV share-targeted production, to encourage the automotive industry to produce electric vehicles with targeted local content and to meet the volume targets outlined in the roadmap through a reward-and-penalty system. The system needs to be tailored to the context of a developing country. In the long term, the fourth priority is to enhance the appeal of EV use by offering driving privileges, such as exemptions from the odd-even policy in Jakarta. The fifth priority focuses on co-production with local start-ups, the local-content-based EV production policy.

The result strengthens previous research findings by a clear priority ranking. The government can support EV adoption by providing incentives, enhancing battery and charging infrastructure, investing in accessible facilities, and optimizing the distribution of electric vehicles (Purnama et al., 2025). In Europe, financial incentives for electric vehicle adoption across 30 countries have led to sustained growth in new EV registrations (Correia Sinézio Martins et al., 2024). In China, incentives have emerged as a priority to support producers through production-based incentives, aid customers through purchase and usage incentives, and support charging infrastructure operators with EVCS building subsidies (Ehsan et al., 2024). The electric vehicle incentives in China significantly influenced direct network effects, which were stronger during the subsidy period and then diminished after the subsidy period ended. Removing subsidies has a more significant negative impact on EV adoption (Zhang et al., 2024). Subsidies, incentives, and transparent regulatory frameworks exemplify good strategies. While these techniques have effectively promoted market expansion in several regions, their variable effectiveness underscores the need for tailored policies that account for regional market dynamics and technical progress (Zaino et al., 2024).

The government should implement supply-side regulations to accelerate EV uptake and achieve the 2030 EV target by adopting a dual credit policy approach that incorporates ICEV fuel consumption standards and EV sales target requirements (Hall et al., 2024). The government should develop a strategy to gradually transition from hybrid cars to BEVs, aligning with the roadmap of the Indonesian automotive industry. The Indonesian government has the authority to implement laws mandating that international automakers exchange information with domestic businesses and provide significant financial resources for EV technology research and development (Habiburrahman et al., 2024).

### 6.1. Policy Implications

The results of this study can help policymakers develop strategies to increase EV market share and strengthen the domestic EV industry's capacity by guiding decision-making that systematically considers all subsystems of the EV ecosystem. The results of this research can inform the decision-making process for the socio-technical transition of other new products or technologies, particularly sustainable products, as well as the adoption of new technologies that rely on infrastructure (infrastructure-dependent technology adoption).

Government policy should support users' ability to buy EVs through various incentives while expanding the campaign on the benefits of EV use within a sustainability framework. Early adopters will play a crucial role in helping the Government introduce electric vehicles (EVs) to the public during the transition period. Given that the majority of automotive users in Indonesia are economy users, policymakers in the EV manufacturing sector are advised to develop a business strategy focused on producing

MPVs (multi-purpose vehicles). It narrows the price gap between EVs and ICEVs within comparable classes and seating capacities.

On the one hand, government policies need to maintain the macro balance of the national industry and give OEMs a proportional global role. Still, it should continue to encourage the growth of local industries by implementing policies that require foreign investors to collaborate with domestic industries. In this case, establishing an EV manufacturing industry with a nation-owned enterprise status will make it easier for the Government to provide financial and managerial support. The Government's efforts are a well-balanced combination of aggressive regulatory enforcement, comprehensive policy initiatives, provisions for resource support, and initiatives to drive the potential growth of electric vehicles (Jain et al., 2024).

### 6.2. Limitations and Future Research

This research has limitations due to its qualitative analysis and reliance on expert panel opinions. More comprehensive, data-driven support would increase accuracy and provide measurable targets. In the following study, the EV adoption policy model can include all NEVs (new energy vehicles), such as FCEV (fuel cell electric vehicle) and other new technologies, so that the concept of "multi-pathway platform to the common enemy of carbon emissions" can be taken into account in the policy model.

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