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The transition to electric car changes of Indonesia automotive supplier component companies

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Abstract

The popularity of electric cars has risen significantly over the past years and created changes towards the Indonesia automotive industry. The increasing popularity of electric car has made the automotive industry shift its focus to electric cars that disrupt its industrial landscapes. Hence, efforts are required to analyze the potential changes needed by the current Indonesia automotive industry to accommodate the transition to electric cars. The study surveyed car manufacturers and component suppliers, analyzed their perceptions, and assessed the importance of the electric car market. Data were collected via online and on-site surveys and were subjected to descriptive statistical analysis, ANOVA, confirmatory factor analysis, and cluster analysis. Results indicated that successful market penetration of electric cars hinges on strategic decisions and effective coordination among stakeholders. Research and development, along with equipment modifications, are expected to increase, necessitating a streamlined supply chain to manage fluctuating demand. Close collaboration between component suppliers and car manufacturers is also essential to sustain value-added operations.

Keywords: Component supplier; automotive industry; electric car; survey; cluster analysis; change; supply chain

1. Introduction

Globally, the popularity of electric cars, also called as electric vehicles (EV), has risen significantly over the past years. This is in view of EVs that have such low emissions compared to internal combustion engine (ICE) vehicles (Gunawan et al., 2022). The increasing demand for EV cars has made a disruptive change towards the automotive industry that previously focused on ICE cars.

There were 17.2 million units of passenger cars in Indonesia in the end of 2022. While, there were 21 thousand units of electric cars in 2022 now that number has risen significantly to 53 thousand units in 2023 (Kompas, 2023). The Indonesian government has made a target to reach 15 million EV, both cars and motorcycles by 2025.

The increasing popularity of EV car has made the automotive industry has shifted its focus to electric cars that disrupt its industrial landscape. To support the transition of the automotive industry to electric cars, the Indonesian government has released the Presidential Regulation Number 55 of 2019 to give a guidance for the industry to accelerate its transition from ICE to KLBB (Kendaraan Bermotor Listrik Berbasis Baterai or Battery Based Electric Motorized Vehicles).

Electric cars have 80% fewer components than ICE cars, necessitating new production skills (Kulkolkarn, 2019). 47% of Indonesia's automotive component suppliers are affected by this swift transition (GIAMM, 2021). The shift to electric cars disrupts the component supply chain, impacting both the number and type of components required. New components and maintenance procedures are essential, leading to significant changes. This transition poses a major challenge for Indonesian car component suppliers that face many potential obsolescence. A thorough analysis is then deemed crucial to understand the perspective and factors affecting these suppliers. It is anticipated that 30% of Indonesia's automotive component suppliers will become obsolete due to reduced component usage in electric cars (Habiburrahman & Nurcahyo, 2022; Mohamad & Songthaveephol, 2020). This disruption poses challenges at the industrial level, thus bringing an impact on various stakeholders (Dijk et al., 2016). Opportunities exist to facilitate the transition from ICE to EV, needing an industry-wide adaptation. An effective strategy is required for automotive component suppliers to cope with the transition to electric vehicles.

Previous studies have discussed the drivers for consumer adoption of electric cars, and examined some factors such as design, battery technology, government policies, price, environmental awareness, range, availability of charging stations, and herd mentality. It has been found that range emerges as the primary factor determining consumers' decisions (Wei et al., 2020; Asadi et al. 2022). During the transition to electric cars, different worker groups in the automotive industry are facing their own unique challenges with operators as the most vulnerable group. (Osatis et al.,

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2022). Silva et al. (2023) found that in the case of developed countries such as United States of America, most of the automotive workforce felt that the current transition of electric cars did not consider their skills and knowledge. Most workers feel that automotive companies will leave them and ignore their past contributions.

Additionally, Mostafa et al. (2020) found that suppliers often lack the resources to perform research and development towards electric cars. Therefore, governments should be aware of assessing their automotive industries before making a transition. A study in Italy found that the market entrance for electric cars is decided by the car manufacturers and their ability to adapt to the electric car transition. There is a need for collaboration between stakeholders within the automotive industries ranging from car manufacturers, battery manufacturers and automotive component suppliers (Rossini et al., 2016). In the United Kingdom (UK), foreign automotive suppliers are replaced by local automotive suppliers considering them as a key player in the future of the UK car industry. While, in Germany, the policy aims to make sure that every relevant party within the automotive industry is not left behind in the transition process to electric cars (Mazur et al., 2015). To facilitate a smooth and effective transition, there is an urgency to build a strong collaborative relationship with both automakers and consumers, ensuring that both parties have a clear understanding of the adoption and deployment process (Earl et al., 2019; Pichler et al., 2021; Altenburg, 2014).

Bhatti et al. (2021) proposed that the integration of electric vehicles into conventional production lines necessitates various changes contingent upon the specific types of EV. Dash (2023) argued for a shift in the automotive industry towards a buyer-and-vendor relationship approach with a multi-level tier supplier structure, anticipating any increased outsourcing due to a shortage of necessary expertise. The significance of extensive collaboration between original equipment manufacturers (OEMs) and suppliers to maintain the flow of value-added tasks, highlights that alliances and joint ventures play a crucial role in providing access to technology and production capacity from battery suppliers (Dong et al., 2023; Syah et al., 2022; Chaturvedi et al., 2022).

Numerous studies (Kifor et al., 2023; Jin et al., 2015; Link et al., 2015; Ciarapica et al., 2012) found the diverse constraints faced by electric cars, including challenges related to low energy density and battery weight, which markedly limit their driving range. Proposed solutions include rapid recharging options and the availability of exchangeable batteries at charging stations to address the issue. Additionally, the insufficient charging stations, particularly in crucial areas such as residential areas, workplaces, and indoor public spaces, poses a significant obstacle to widespread electric car adoption, particularly in regions lacking comprehensive policies for establishing sufficient charging networks.

Karplus et al. (2010) proposed that the price of plug-in hybrid electric vehicles or called PHEV may range from 30% to 80% higher than that of internal combustion engine vehicles, while Konig et al. (2021) estimated battery electric vehicles (BEV) to have significantly higher value added compared to internal combustion engine vehicles, mainly attributed to the considerable expense of batteries.

Several studies have examined the impacts of monetary incentives on electric vehicle sales. Demartini et al. (2023) found a limited correlation between incentive policies and the uptake of hybrid electric vehicles or HEV. They indicated that dealers frequently integrate state incentives into their pricing strategy, leading to elevated costs for consumers. This practice essentially transforms monetary incentives into dealer subsidies, rather than effectively stimulating EV adoption. According to Un-Noor et al. (2017), the long-term effectiveness of short-term incentive programs is questionable unless manufacturers are able to lower the sticker prices once these incentives end. On the other hand, Sadiq Jajja (2021) argued that providing upfront incentives can accelerate the penetration of electric vehicles into the market. Furthermore, it is found that consumers highly value the tax-free incentives (Setiawan et al., 2022; Patyal et al., 2021).

Prior studies have explored electric car transitions in various aspects of the automotive industries, but insights on Indonesian car component suppliers, in fact, remain scarce. This study fills this gap by providing a comprehensive picture including the perspectives of segments of Indonesian car component suppliers in how they can prepare and adapt to the electric car transition with a focus on labor, technology, economic and organizational aspects.

From the preceding discussion, the following research hypotheses are developed as follows.

- Hypothesis 1 (H1). A transition to an electric car suggests that changes are needed in the automotive supply chains.
- Hypothesis 2 (H2). The higher cost of an electric car is correlated with the level of importance of components.
- Hypothesis 3 (H3). Companies allocate limited resources in the electric car market in view of the technological challenges associated with electric technology.
- Hypothesis 4 (H4). The type of incentive influences the electric car transition.

2. Methodology

This study's first step involved designing a comprehensive questionnaire to evaluate the transformations needed within the existing automotive component supplier to facilitate the seamless transition of electric cars. Semi-structured interviews were conducted with the representatives from the government and automotive industries to pinpoint the relevant elements of the Indonesian automotive component supplier landscape. There were five main elements related to the industry aspect: demographics, market, production capacity, supply chain and incentive. A five-point Likert scale was used in Sections 3, 4, and 5 to value both importance and performance assessment. The scale values are presented as follows: 5 = "very important," 4 = "important," 3 = "neutral," 2 = "unimportant," 1 = "very unimportant", which then would be comparatively analyzed.

The final version of the questionnaire consisted of five sections. Section 1 covers the general aspect regarding demographic data and information on automotive workers. Next, Section 2 deals with the aspects of the electric car market and the Indonesian automotive industry. Then, Section

3 covers the company aspect regarding the production and design towards electric cars transition. Subsequently, Section 4 discusses about the aspect of how the company adapts to its supply chain and lastly, Section 5 discusses the aspects of electric car incentives and policies.

To gain an initial understanding of the data and the participating respondents, a comprehensive descriptive statistical analysis was performed. Next, to identify the key challenges and opportunities facing automotive component suppliers as the transition to the electric vehicle market within the traditional supply chain framework, the study used cluster analysis. Confirmatory factor CFA was utilized to determine if the measures of a factor aligned with the inherent characteristics of that factor. Cronbach's alpha coefficients were used to estimate the reliability of each factor. After identifying the key factors influencing the transition, we assessed each company's performance across those factors by analyzing individual responses to relevant aspects. This resulted in a set of performance scores for each company, reflecting their capabilities in different areas. Next, to uncover natural groupings among the companies without prior knowledge of their distribution, we performed hierarchical cluster analysis using Ward's method, a robust multivariate technique. The distances between samples were calculated using squared Euclidean distances.

The targeted automotive component suppliers were obtained from the members of the Indonesian Automotive Parts & Components Industries Association (GIAMM), which consisted of 240 companies. The target minimum number of respondents is ten percent of the total GIAMM members (Yount, 1999).

Researchers surveyed 50 automotive component suppliers that provide their products to Indonesia's notable Original Equipment Manufacturers (OEM). The targeted respondents referred to individuals with at least 5 years of work experience within the automotive industries and respondents at manager level or more were prioritized here. The survey was conducted in December 2023 and distributed directly via WhatsApp and Email. Overall, out of 50 companies, 31 responses were collected.

The survey was sent via WhatsApp and Email to the authors' acquaintances and colleagues in the automotive component supplier industries. Then, the survey was also sent to the targeted company emails via their official website. The emails and WhatsApp messages consisted of a link to the online questionnaire that has been developed using Google Forms. The questionnaire link was shared with the author's acquaintances and colleagues. Then, the authors asked for their help in redistributing it through their network within the automotive supplier industries. The respondents were required to have at least five-year work experience in the automotive industry and working for an automotive component supplier company.

3. Results and Discussion

3.1. Respondent characteristics

The surveyed companies were categorized into micro, small, medium, and large-sized companies. Following that, the respondents' positions within those companies were identified to provide insight into their opinions. Additionally, the companies' positions within the automotive supply chain were determined, followed by an assessment of the type of collaboration the companies engaged in. The following tables present general information about the respondents and their characteristics. The survey prioritized respondents at least having the manager level or equivalent, as background and knowledge were deemed important plus background was also related with experience within the automotive industry. Table 1 shows the respondent's position level as well as the percentage of each level. The total number of respondents obtained in this research were 31 responses. The number of respondents was considered sufficient as it was fifty percent of the targeted companies.

Table 1. Position Level

Role	N(31)	Percentage
Staff	8	25.81%
Section Head	10	32.26%
Department Head	3	9.68%
Division Head	1	3.23%
Coordinator	0	0%
Assistant Manager	0	0%
Manager	6	19.35%
Director	2	6.45%
Commissioner	1	3.23%

Table 2. Company Size

Size	N(31)	Percentage
Micro	2	6.45%
Small	0	0%
Medium	7	22.58%
Large	22	70.97%

Table 3. Company Segment

Segment	N(31)	Percentage
Supplier Tier-1	13	41.94%
Supplier Tier-2	5	16.13%
Supplier Tier-3	2	6.45%
OEM	11	35.48%

Table 4. Company Type

Type	N(31)	Percentage
Majority Domestic Owned	12	41.40%
Majority Foreign Owned	13	37.90%
Joint Venture	6	20.70%

To analyze the responses of the 31 questionnaire respondents, descriptive statistics, as presented in Table 3, were performed. Of the respondent roles, there were 10 Section Heads, followed by 8 staffs, 6 managers, 3 department heads, 2 directors, 1 division head, and 1 commissioner. Two roles, coordinator and assistant manager, had zero respondents. Table 4 indicates that most of the surveyed companies were classified as the large-size companies (72.40%), followed by medium-sized (20.70%) and micro-sized (6.90%) companies. No small-sized companies were represented. Additionally, Table 3 shows that 41.40% of the companies were in the supplier tier-1 segment, 37.90% were OEMs, 13.80% were Supplier Tier-2, and 6.90% were Supplier Tier-3. Table 4 further reveals that 41.40% of the companies were Majority domestic-owned, 37.90% were Majority Foreign Owned, and 20.70% were Joint ventures.

3.2. Company component supplier

Table 5. Company component type

Component	N(31)	Percentage
Chassis	8	25.81%
Engine	6	19.35%
Wheel and Propeller	5	16.13%
Transmission	3	9.68%
Interior	4	12.90%
Electrical	1	3.23%
Exterior	2	6.45%
Suspension	2	6.45%

The study survey requested the respondents, who represented their respective companies, to specify the type of component they supplied or produced. It was crucial to determine whether that component was critical in the electric car transition. Additionally, respondents were asked to select the main market for their company as it was important given that different regions have varying transitional paces based on their unique characteristics. Subsequently, respondents were asked about their company's response to the transition to electric cars and the initiatives they were undertaking.

Upon analyzing the survey responses, it was revealed that the primary component produced by the majority of respondents was the chassis component, which accounted for 25.81% of respondents. Following closely behind was the engine component with 19.35% of respondents indicating it as their main component. Additionally, five companies, constituting 16.13% of respondents, were involved in the production of wheel and propeller components. Furthermore, four companies (12.90%) were engaged in supplying interior components, while three companies (9.68%) focused on transmission components. Each of engine exterior and suspension component had two companies (6.45%) involved in their production. Lastly, only one respondent (3.23%) reported producing electrical components. It is worth noting that all respondents identified Indonesia as their primary market for automotive products.

Then, in terms of how big their initiative towards electric car transition, 11 respondent (35.5%) stated that less than 5% of their portfolio consisted of electric cars, followed by 9 answers (29%) of “we are not yet present in the electric car segment, but soon we will”. Then, 7 respondents (22.6%) answered that more than 10% of their portfolio had electric cars. 5-10 % of their portfolio had 3 respondents (9.7%). Lastly, 1 (3.2%) respondent answered not knowing.

3.3. Confirmatory factor analysis and reliability test

Table 6. CFA and reliability analysis for production

Component supplier company changes to the production	Loading (Alpha = 0.978)
Component suppliers need to adjust to the increasing demand for new products (electric vehicles)	0.953
Modification, investment in existing machines and production equipment	0.953
Your company must modify production capacity (for example, employee’s working hours or machine working hours)	0.956
Providing training and workshop materials for employees (Internal) in facing the electric vehicle transition	0.951
Internal R&D for new products (Electric vehicles)	0.954
Changing several suppliers	0.953
Creating/purchasing new machines/equipment/ production facilities	0.951
Outsource business flow	0.954
Complete Outsourcing	0.954
Recruitment of new workers with new skills	0.955
Adding new production lines to existing lines	0.952
External R&D for new products	0.955
Taking into account collaborative arrangements like joint ventures	0.953
Building relationships with new customers	0.953
Completely new supplier	0.956

Table 7. CFA and reliability analysis for supply chain

Component supplier company changes to the supply chain	Loading (Alpha = 0.978)
Customer Relationship Manager (CRM)	0.973
Customer Service Management	0.971
Demand Management Style	0.972
Manufacture Flow Management	0.971
Order Fulfillment	0.973
Outsourcing / Partnership	0.975
Performance Measurement	0.971
Product Development and Commercialization	0.971
Return Management	0.975
Supplier Relationship Management	0.971
Warehouse Management	0.972

Before performing data analysis, the validity, reliability, and normality of the questionnaire were assessed using appropriate statistical tests. It was found that all responses were valid ($p < 0.05$) (Andrade, 2019), and every value was reliable. The questionnaire was targeted to identify the potential levels of automotive industry's change in incentives, supply chain dynamics, and production processes through a CFA.

The respondents were asked to tell their level of agreement or disagreement on a 5-point Likert scale for each statement within the questionnaire. CFA and reliability analyses were performed accordingly on the respondent answer of each category, and the results are presented in Tables 6, 7, and 8.

Table 8. CFA and reliability analysis for incentive

Component supplier is assisted by the electric car incentive	Loading (Alpha = 0.978)
Incentives help the adoption of electric cars	0.975
Purchase price incentives	0.971
Road Tax Incentive	0.972
Car Insurance Incentive	0.978
Discount on charging/fuel	0.974
Tax Holiday	0.975

3.4. Cluster analysis

Table 9. Cluster Analysis

Cluster	1	2	3
No of Companies	25	2	4
Incentive (Mean)	4.547	1.667	2.708
Supply Chain (Mean)	4.480	1.500	3.568
Production (Mean)	4.115	1.300	3.150

For the next step, the score obtained from the assessment of each respondent's survey was measured against the three identified factors as mentioned earlier. The final score was derived by averaging the numerical values of the company's responses for each item within the factor. Due to the nature of the 5-point Likert scale, the score value ranged from 1 to 5. Using the result, the sample of respondents was subsequently grouped into distinct clusters, which served as clustering variables. To create the initial cluster subtypes, an agglomerative hierarchical clustering approach was employed, utilizing Ward's algorithm and a squared Euclidean distance measure. Next, a cubic clustering criterion and ANOVA were utilized to ascertain the appropriate number of cluster solutions and to identify well-defined clusters. The F values was found at 7.1845 for Incentive, 6 for Supply chain and 0.2055 for Production and each had Sig value of 0.00 ; 0.018 and 0.892 respectively.

Survey respondents were scored based upon their answers to questions aligned with three key factors. Each factor's score was calculated by averaging the numerical values the company assigned to each answer within that factor, using a 5-point Likert scale (1-5). These individual scores were then used to group respondents into distinct clusters. The clustering process first employed an agglomerative hierarchical method with Ward's algorithm and a squared Euclidean distance to generate initial cluster groups. Finally, a cubic clustering criterion and ANOVA were employed to establish the most suitable number of clusters and verify their clarity.

Cluster 1 consisted of the largest number of respondents, totaling 25, consisting of 80.65% of the respondents. These respondents exhibited higher performance in terms of incentives but scored lower in supply chain and production metrics. It indicated that such respondents showed a higher performance against incentive whereas a lower score was obtained against supply chain and production. Therefore, companies from cluster 1 prioritized a focus on incentives compared to the supply chain and production. Cluster 2 included the smallest number of companies, only accounting for two respondents, creating a low value. The cluster showed high performance against incentive again and lower scores in supply chain and production. This indicated a stronger perspective towards electric car incentive than to change the supply chain and production, quite similar to cluster 1. Cluster 3 accounted for four companies. The respondent's results were characterized by a high performance against supply chain and production and this indicated that a combination of changes was necessary in the supply chain and production processes to integrate electric cars into the traditional automotive supply chain and production model.

Table 10. Clusters vs. Production

Role	Cluster 1	Cluster 2	Cluster 3
Component suppliers need to adjust to the increasing demand for new products (electric vehicles)	4.48	1	4
Modification, investment in existing machines and production equipment	4.48	1	3
Your company must modify production capacity (for example, employee working hours or machine working hours)	3.96	1.5	2.75
Providing training and workshop materials for employees (Internal) in facing the electric vehicle transition	4.64	1	3.25
Internal R&D for new products (Electric vehicles)	4.56	1.5	4
Change several suppliers	4.28	1.5	3.5
Creating/purchasing new machines/equipment/production facilities	4.4	1.5	2.75
Outsource business flow	3.64	1	2.75
Complete Outsourcing	3.32	1	2.5
Recruitment of new workers with new skills	4.08	1.5	2.75
Adding new production lines to existing lines	4.08	1	3
External R&D for new products	3.8	2	3
Taking into account collaborative arrangements like joint ventures	3.96	1	3.5
Building relationships with new customers	4.44	1.5	3.75
Completely new supplier	3.6	1.5	2.75
Average Value	4.115	1.300	3.150

From Table 9 Cluster 3 only accounted for four companies. The respondent's results showed a high performance in supply chain and production, suggesting that a combination of changes in these areas was necessary to integrate electric cars into the traditional supply chain and production processes. Further analyses were conducted to explore the relationship between each cluster and company size. It is noteworthy that Cluster 1 primarily consisted of large-sized companies, followed by medium-sized and micro-sized companies.

Cluster 2 only consisted of one medium-sized company (14.29%) and one large-sized company (4.55%) whereas Cluster 3 included one medium-sized company (14.29%) and three medium-sized companies (13.64%). One possible explanation for the differing performances of clusters regarding the changes needed in the supply chain, incentives, and production for the introduction of electric cars could be company size. The larger-size car companies possessed the most complex and extended supply chains, where significant changes were most likely to be implemented. The relationships between the industry components supplied and the corresponding clusters were vital. According to the report, most industry components are chassis, distributed evenly among all other components, particularly in Cluster 1. However, the outcome showed a lack of homogeneous distribution due to the low number of respondents across all clusters.

Table 10 shows that all production aspects received very high scores mostly achieving 3.5 out of a possible 5, according to the companies in Cluster 1. The exception was "Complete Outsourcing," which scored 3.32. Notably, the aspects such as "Internal R&D for new products (Electric vehicles)," "Component suppliers adapting to the demand for new products," and "Providing training and workshop materials for employees (Internal) to address the electric vehicle transition" were among the highest-scoring items. In Cluster 2, “External R&D for new products” obtained the highest scores, highlighting its importance for companies in cluster 2. The result scores in cluster 3 confirmed the importance of “Component suppliers must adapt to demand for new products” and “Internal R&D for new products” as both received the highest scores in that cluster.

As shown in Table 11, it was revealed that companies in Cluster 1 dominated all other clusters as they had the highest scores against all the proposed supply chains. This indicated that these companies focused on making changes to their supply chain processes. This was also due to the large number of respondents grouped up in Cluster 1. Like incentives, companies in Cluster 2 have shown the low scores from 1.5 to 2.00. Cluster 3 had more variety compared to Incentive, with “Order Fulfillment” being the highest score, meaning companies in Cluster 3 highly valued order fulfillment in the supply chain process. As shown in Table 12, the companies in Cluster 1 consistently outperformed other clusters, achieving the highest scores across all the proposed incentives. This showed that all these companies paid a lot of attention to these incentives. All scores of Cluster 1 had a value of more than 4.00. Due to a low number of respondents, companies in Cluster 2 received low scores, ranging from 1.5 to 2.00. In contrast, Cluster 3 had very uniform scores with almost all being 2.75 except for the Road Tax Incentive, i.e. 2.5. Notably, Cluster 2 showed the lowest values across all incentives, although it only included two respondents. Cluster 3 had the second-highest number of respondents in the three clusters, with Road Tax Incentives scoring the highest at 4.68.

Table 11. Clusters vs. Supply Chain

Role	Cluster 1	Cluster 2	Cluster 3
Customer Relationship Manager (CRM)	4.56	2	3.5
Customer Service Management	4.56	1.5	3.75
Demand Management Style	4.52	1.5	3.5
Manufacture Flow Management	4.68	1.5	3.75
Order Fulfillment	4.6	1	4.5
Outsourcing / Partnership	4	2	3
Performance Measurement	4.52	1.5	4
Product Development and Commercialization	4.72	1	4
Return Management	4.36	2	2.75
Supplier Relationship Management	4.44	1	3.25
Warehouse Management	4.32	1.5	3.25
Average Value	4.547	1.500	3.568

Table 12. Clusters vs incentive

Role	Cluster 1	Cluster 2	Cluster 3
Incentives help the adoption of electric cars	4.52	1.5	2.75
Purchase price incentives	4.56	2.00	2.75
Road Tax Incentive	4.68	1.5	2.5
Car Insurance Incentive	4.52	2.00	2.75
Discount on charging / fuel	4.4	1.5	2.75
Tax Holidays	4.6	1.5	2.75
Average Value	4.547	1.667	2.708

3.5. Electric car market

Table 13. Electric car type vs. company size

Electric car type	Micro	Small	Medium	Large
Hybrid	0	0	4	4
Plug-in Hybrid	0	0	1	4
Full Electric	2	0	2	11
Other	0	0	0	3
Total	2	0	7	22

The respondents were asked to indicate which type of EV their company is the focus for future development or currently developing and which car styles they are developing as the new electric car. The results are listed in Table 13. Full electric cars became the most popular focus for the company, accounting for 100% of micro-sized companies, 28.5% of medium-sized companies, and 50% of large-sized companies. Then, Hybrid cars accounted for 57.14% of medium-sized companies, and 18.18% of large-sized companies. Note that 18.18% of large-sized companies also invested in Plug-in Hybrid, and 14.29% of medium-sized companies. Furthermore, all companies, irrespective of their size, showed a limited interest in electric cars. This finding is presented in Table 13.

Table 14. Car design vs. company size

Electric car type	Micro	Small	Medium	Large
City Car	1	0	3	15
Sedan	0	0	3	8
Station Wagon	0	0	1	3
MPV	1	0	2	6
SUV	0	0	0	9
Crossover	0	0	0	6
Hatchback	0	0	0	6

Table 14. Market conditions encourage innovation towards electric cars

Company Size	1 (Strongly disagree)	2	3	4	5 (Strongly Agree)
Micro	0	0	1	0	1
Small	0	0	0	0	0
Medium	1	1	0	3	2
Large	0	4	7	6	5

Table 15. Company's priorities in the electric car market

Company Size	1 (Strongly disagree)	2	3	4	5 (Strongly Agree)
Micro	0	0	1	0	1
Small	0	0	0	0	0
Medium	1	2	0	3	1
Large	1	3	6	6	6

Table 16. Electric car market period

Company Size	2025-2030	2030-2035	2035-2040	2040-2045	2050 onwards
Micro	0	2	0	0	0
Small	0	0	0	0	0
Medium	2	2	1	0	2
Large	2	7	4	3	6

Tables 14 and 15 present the results of survey questions regarding whether the market fosters an environment conducive to innovation in electric cars and the level of importance respondents attribute to the electric car market. The results indicated that 50% of micro-sized companies, 28.57% of medium-sized companies, and 50% of large-sized companies did not fully agree that the current market fosters an environment conducive to innovation in electric cars. Despite these results, 50% of micro-sized companies, 71.43% of medium-sized companies, and 50% of large-sized companies attributed a high degree of importance to the electric car market.

Table 16 shows the respondents' opinions about when the electric car will dominate the car market compared to conventional vehicles. Most respondents predicted a transition of 2030-2035 consisting of 100% of micro-sized companies, 28.57% of medium-sized companies and 31.82% of large-sized companies. Table 17 shows the results of respondents indicating the difference in price between an electric car and a conventional car. Hybrid cars will cost 50 - 100 million rupiah more than a conventional car according to 45.61% of respondents whereas 22.58% chose the difference to 100 - 150 million rupiah more. Plug-in Hybrid were expected to cost 150 - 200 million rupiah more than a conventional car by 32.26% of the surveyed companies. Whereas, 25.81% chose they will cost 100 - 150 million rupiah more. Finally, 38.71.9% and 22.58% of respondents chose that fully electric cars will cost more than 200 - 250 million rupiah and 150 - 200 million rupiah over the price of a conventional car, respectively. Full electric cars were found as the most expensive category among the analyzed electric vehicles.

There are four major critical aspects: safety, range, battery, and consumption. Conversely, aspects such as top speed, acceleration, and hi-tech appearance were not considered critical. Then, it can be noted that the standard deviation of the results of Table 20 appeared to be uniform ranging from 1.0234 to 1.2048.

Table 17. Electric car preferred price

Cost difference	50 - 100 million (Rp)	100 - 150 million (Rp)	150 - 200 million (Rp)	200 - 250 million (Rp)	More than 250 million (Rp)
Hybrid	14	7	5	5	2
Plug-in Hybrid	4	8	10	6	3
Full electric	3	5	7	12	4

3.6. Discussion

Based on the findings, companies can be grouped into three clusters. In Cluster 1 respondents showed high performance against Incentive. This cluster mainly included the large-sized companies and has produced the highest scores against all three factors: incentive, production and supply chain. Cluster 1 achieved the highest scores across all proposed factors, providing a comprehensive overview of the entire automotive industry. Next, Cluster 2 included a limited number of companies that is two companies that showed a performance with the highest score in incentive factor 2 but still with a significant score against the supply chain. The cluster included one medium-size company and one large-size company. Cluster 3 included four companies characterized by high performance against supply chain and Production. The cluster included three large-sized companies and one medium-sized company. Cluster 3 has achieved the highest scores across all the major supply chain processes proposed, confirming a comprehensive overview of the entire supply chain.

The result from this study supported hypothesis H1, which suggested a relationship between company size and their willingness to adapt the current automotive supply chain for the transition to electric cars, indicating the necessity for changes. It is found that large, medium, and micro shared the same concern to the transition of electric cars in terms of changes in the automotive supply chain.

This study also supported hypothesis H2 regarding the relationship between the higher cost of an electric car and the significance of certain components. The survey highlighted that safety and range were perceived as the most crucial components, both receiving equal importance, followed by battery packs. Range anxiety is one of the main concerns of the public regarding electric cars, as they cannot predict the actual range of the car (Yuniaristanto et al., 2022), and safety is related both with range and battery, as range anxiety starts, the feeling of unsafety also starts. Battery packs have a high cost and represent up to 50% of the electric car price (Ernst et al., 2012). Moreover, the weight and size of batteries remain significant, limiting the driving range of vehicles. Another concern associated with batteries is safety, as they have the potential to catch fire and occasionally explode in electric cars.

Assuming an ICE car with a price of 150 million rupiahs, companies stated that Hybrid cars of the same category will be more expensive from 50 to 100 million rupiahs. Plug-in Hybrid cars appear to be more expensive than Hybrid cars with the final price being approximately 150 to 200 million rupiah more than an ICE car of the same segment. The purchase of a fully electric car is the most expensive, surveyed companies expect that the price will exceed 200 to 250 million rupiah more than an ICE car.

The hypothesis (H3) states that companies allocate limited resources to the EV market due to technical challenges is not supported by this study. Most surveyed companies somewhat agreed that the current market fosters innovations towards electric cars. There are several reasons contributing to this moderate agreement. Firstly, customers lack confidence due to insufficient information about electric cars, and these vehicles are perceived as challenging to use because of their charging requirements and unique maintenance needs. The high purchase price of electric cars is perceived as a deterrent. A product that lacks economic attractiveness to customers will result in the low economies of scale. As a result, the design and manufacturing costs of cars will be spread over a small number of units produced. Ultimately, these costs will be passed on to end customers, rendering the product economically unappealing. Additionally, the current number of charging stations for fully electric cars remains limited. Most surveyed companies reported investing in fully electric cars, with a smaller percentage investing in Hybrid cars. Significantly, only one medium-sized company mentioned investing in Plug-in Hybrid cars. Companies commonly view both Hybrid and Plug-in Hybrid cars as the transitional vehicles on the path to fully electric cars. Therefore, companies perceive this investment as unappealing. Another aspect of this study involved examining the types of body styles that companies are developing to produce EV.

For the irrespective of their size, most of the surveyed companies were found to focus their investments on city cars. City cars offer several advantages compared to other car segments. They are primarily used in urban areas or for short-distance travel; hence the limited driving range of electric cars is typically sufficient. Additionally, city cars are easy to park due to their compact size as stated in (Rossini et al., 2016).

Overall, all three sizes of companies indicated that 2030-2035 will be the transition year between ICE cars and electric cars. Smaller companies are a little more pessimistic about electric car adoption. It is estimated that 2033 is the transition year for electric cars.

The survey findings supported hypothesis H4, suggesting the type of incentives determining the transition to electric cars. Surveyed companies believed that incentives would greatly facilitate this transition. Road tax incentives are seen as the most effective incentive for promoting the adoption of electric cars, followed closely by purchase price incentives and car insurance incentives, which also received notable scores.

4. Conclusion

Overall, this study seeks to offer a thorough insight into Indonesian car component suppliers' perspectives in preparing for and adjusting to the shifts associated with the transition to electric vehicles. The study focused on labor, technology, economic, and organizational aspects. The survey was conducted among Indonesian supplier companies through both online and offline methods. Subsequently, the responses were analyzed using statistical methods.

From all four hypotheses, the study found that there was a support positing a relationship between company size and their receptivity towards changes in the automotive supply chain for electric car integration. Regardless of scale, companies across the spectrum exhibited a unified concern for adapting supply chain dynamics to accommodate electric car production, underlining the industry-wide recognition of the imperative for adaptation. Then, the correlation between the higher cost of electric cars and the importance of critical components were supported. Safety, range, and battery packs emerged as the crucial concerns.

All three clusters have expressed apprehension regarding changes in the supply chain necessary for transitioning to electric cars. Cluster 1, which comprised predominantly large companies with the highest respondent count, generally emphasized the minor adjustments to the supply chain while giving less focus to major changes. In contrast, Clusters 2 and 3 highlighted the need for significant alterations in their supply chains.

Suppliers were reluctant to invest primarily in economic factors such as high purchase prices and limited infrastructure, emphasizing the importance of addressing these concerns to drive market growth. Furthermore, incentives, particularly road tax incentives, were identified as the significant facilitators of electric car adoption, emphasizing the pivotal role of policy support in driving market uptake and industry transformation.

The market penetration of electric cars hinged on the strategic technological decisions made by specific manufacturers of cars and components suppliers, as well as their capacity to effectively organize and manage the coordinated efforts of stakeholders. These stakeholders included both car manufacturers and component suppliers. Successful market entry requires utilizing economies of scale, building on established capabilities in electrical technology and automotive expertise, and forming collaborative partnerships with experts throughout the emerging value chain to facilitate the transfer of critical knowledge.

Research and development with modifications in existing and production equipment previously not prioritized by suppliers will occur soon. Furthermore, companies need to streamline their supply chain management, prioritizing manufacturing flow control and the commercialization of product development to effectively navigate fluctuating demand, particularly during the early stages of development.

Component suppliers must be active in collaboration with car manufacturers to sustain value-added operations. Their competitive edge will stem from their expertise in electrical car critical components, such as battery packs. Innovation stands as the primary means through which they can effectively distinguish themselves from other suppliers.

This study is limited by its number of respondents, as it only managed to collect responses from 31 out of 50 companies. Future studies could aim for a higher response rate by employing more effective survey strategies or targeting more specific groups within the industry. Additionally, for future studies, adopting a case study approach with a focus on a specific supplier company could be beneficial to identify the best options for adaptations.

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