

The Comparison of Electric Vehicles System in Indonesia and France: a Systematic Literature Review

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Abstract

Indonesia is one of the countries that supports the use of electric vehicles for road transportation. However, efforts to accelerate the diffusion of electric vehicles started only in the last few years, so the current development is still not optimal. On the other hand, France is one of the pioneering countries in the use of electric vehicles. The adoption of electric vehicles in France is the second-highest among EU countries. Therefore, this article compares the electric vehicle systems in Indonesia and France to illustrate what distinguishes them, so we can then get a policy system that can be adopted from the electric vehicle system in France to Indonesia. A systematic literature review was conducted by analyzing 27 articles obtained from Scopus. Based on the analysis results, it is found that there are several differences between the electric vehicle system in Indonesia and France, including those related to the dominant types of vehicles on the road, electricity sources, availability of charging stations, and total cost of ownership. These differences then become an insight for new policies in the electric vehicle system in Indonesia.

Keywords: Electric vehicles, Diffusion, Indonesia, France

Kelompok BoK yang bersesuaian dengan artikel: *Supply Chain Management*

Saran format untuk mensitasi artikel ini:

Widiawati, K., dan Sopha, B.M. (2023). The Comparison of Electric Vehicles System in Indonesia and France: a Systematic Literature Review. *Prosiding Seminar Nasional Teknik Industri (SENASTI) 2023*, 619-627.

1. Introduction

Currently, the use of electric vehicles is being widely implemented in some countries. Generally, the application of electric vehicles as road transportation is based on the need to reduce the amount of greenhouse gas emissions generated by the transportation sector. In 2018, the transportation sector was responsible for 24% of the world's greenhouse gas (GHG) emissions (Künle & Minke, 2022). GHG emissions contribute to the climate change phenomenon due to global warming (Ensslen et al., 2019; Haidar & Aguilar Rojas, 2022). Hence, decarbonizing the transportation sector is a must to reduce GHG emissions, including the use of electric vehicles as road transportation (Ruoso & Ribeiro, 2022; Veza et al., 2022) along with the use of sustainable power plants such as hydro, wind, nuclear, and solar (Veza et al., 2022).

Indonesia is committed to participating in global warming mitigation efforts by reducing GHG emissions to 29% by 2030, including the transportation sector (Haryadi et al., 2023; Murtiningrum et al., 2022; A. D. Setiawan et al., 2022). The electrification of road transportation

has been a concern for the Indonesian government since 2017, indicated by the issuance of Presidential Regulation No. 22 of 2017 concerning the General Plan for National Energy, by implementing electric-based vehicles to reduce fuel consumption (I. C. Setiawan, 2019). In addition, to build an electric vehicle ecosystem in Indonesia, the government issued Presidential Regulation No. 55 of 2019 concerning the Acceleration of the Battery Electric Vehicle Program for Road Transportation (Haryadi et al., 2023). Electric vehicles have been widely introduced to the Indonesian vehicle market, but their diffusion rate remains very slow (Febransyah, 2021). On the other hand, one country that pioneered the use of electric vehicles as road transportation is France. France is the country with the 2nd largest number of EV adoption among countries in the European Union (EU), which is around 18% in 2020 (Kastanaki & Giannis, 2023). Electric vehicle adoption in France is targeted to grow exponentially and reach a large market share within the transportation sector by 2050 (Lauvergne et al., 2022). This article aims to explore the electric vehicle systems in Indonesia and France with a systematic literature review and compare them to get potential policy insights that can be applied to the electric vehicle system in Indonesia.

Electric vehicles and renewable energy have a negative relationship with CO₂ emissions, indicating that CO₂ emissions can be reduced by implementing electric vehicles and renewable energy (Ruoso & Ribeiro, 2022; Sun et al., 2023). Electric vehicles have been on the market for more than 10 years, but their diffusion remains slow, mainly due to the high purchase price of electric vehicles (Flaris et al., 2021; Lévy et al., 2017). In the case of France, the transition to electric vehicles is not as fast as the transition to nuclear power. This could be due to the catalyzing event of the 1973 oil crisis in the transition to nuclear power. Therefore, accelerating the transition to electric vehicles requires policy interventions that can encourage the transition (Doufene et al., 2019)). These policy interventions need to be explored further.

This article consists of 4 sections, i.e. introduction, methodology, results and discussion, and conclusion. The next section will explain the systematic literature review method that has been conducted, followed by the results of the analysis and discussion related to potential policies that can be applied to the electric vehicle system in Indonesia, and the last section is the conclusion.

2. Method

A systematic literature review (SLR) is a methodological study using a database that has a primary objective related to a specific topic, and adopts a replicable, scientific, and transparent process to minimize bias by providing an audit trail of review decisions, procedures, and conclusions (Cook et al., 1997). SLR was conducted using the keywords (("electric vehicle*" OR "electric car") AND ("adoption" OR "diffusion") AND ("indonesia" OR "france" OR "french")) on the Scopus database without any limitation on the year of publication and only focused on documents in the article type. The detailed article selection procedure can be seen in Figure 1. The number of articles obtained from these keywords is 36, and after filtering the titles, keywords, and abstracts of each article, there are 27 articles that will be analyzed further. Before conducting further analysis, a bibliometric analysis and profile analysis were conducted as a starting analysis, which can be found in this section.

2.1. Bibliometric analysis

The bibliometric analysis was conducted to determine the relationship between the selected articles based on their keywords. This analysis is used to show in general what is

discussed in the analyzed articles. The results of the analysis are seen in Figure 2. According to the results of the bibliometric analysis conducted, there are seven groups of subjects discussed in the selected articles, i.e. electric vehicles marked in orange, adoption technology marked in red, total cost ownership marked in dark green, electric vehicle adoption marked in purple, consumer response marked in light blue, carbon emission marked in brown, smart charging marked in dark blue, and innovations marked in light green.

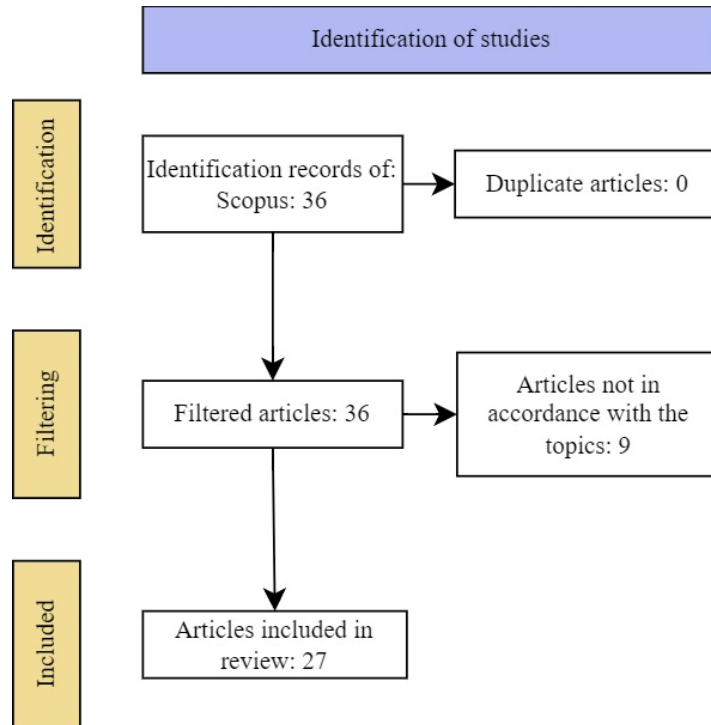


Figure 1. Article selection procedure using PRISMA.

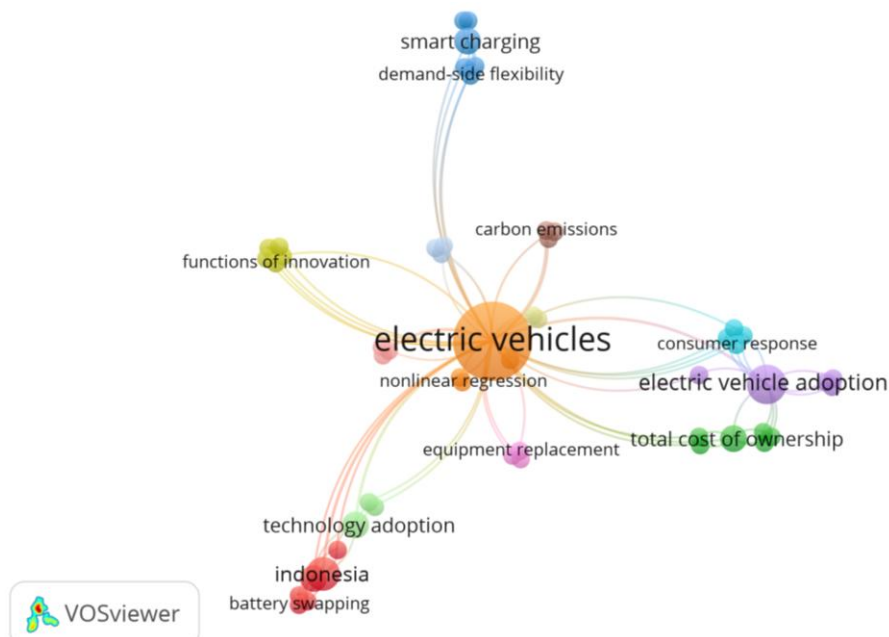


Figure 2. Bibliometric analysis using VOSviewer

2.2. Profile analysis

Profile analysis was conducted to see the country of institutional origin of the first author. The results of this analysis can be seen in Figure 3. Based on this figure, it can be seen that the country of institutional origin of the main author is dominated by Indonesia and France. As the country of institutional origin of the first author is the same as the country that is the subject of this study, it is expected that the results obtained from the analysis can describe the conditions in Indonesia and France.

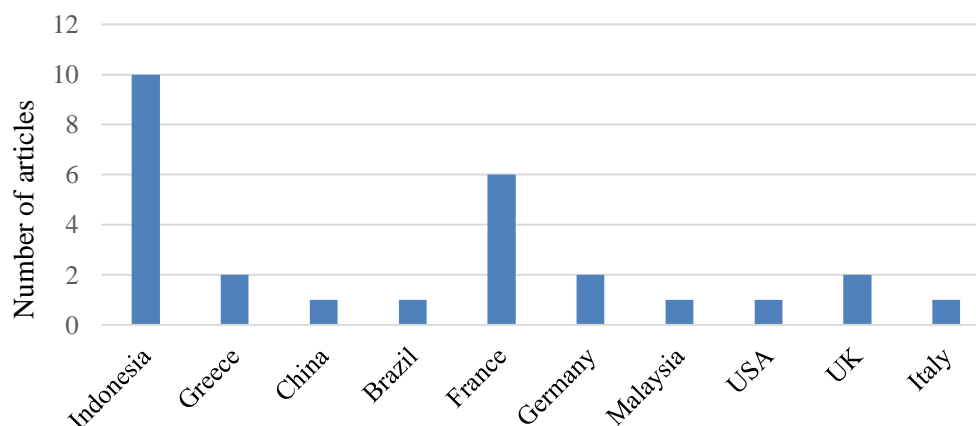


Figure 3. Country of institutional origin of the first author.

3. Results and Discussion

This section consists of three parts, i.e. the electric vehicle system in Indonesia, the electric vehicle system in France, and potential policies for the electric vehicle system in Indonesia.

3.1. The electric vehicle system in Indonesia

Indonesia is one of the countries with the largest vehicle sales in South Asia with only 0.01% of them being non-fossil-based (Alamsjah et al., 2021). The large number of fossil-based vehicles leads to high GHG emissions from this sector. According to Climate Transparency, (2022), the transportation sector contributes 25% of total CO₂ emissions, which is the second highest after the power sector. The high number of private vehicles in Indonesia shows that the current public transportation system cannot meet the needs of community mobilization (Murtiningrum et al., 2022; Veza et al., 2022). The high mobility of the public using private vehicles leads to increased CO₂ emissions (Murtiningrum et al., 2022). To reduce the amount of CO₂ emissions from such a road transportation system, the Indonesian government is pursuing vehicle electrification (Veza et al., 2022). The Indonesian government is targeting the adoption of 2.13 million electric motors and 2,200 electric cars by 2025 (Haryadi et al., 2023).

Indonesia is a supplier of about 27% of the world's nickel, an important component in the production of electric vehicle batteries. This shows that the use of electric vehicles as road transportation is an opportunity for Indonesia as a country that has an abundant supply of raw materials for the manufacture of electric vehicle batteries (Alamsjah et al., 2021).

In Indonesia, the type of electric vehicle that has a higher market potential is the electric motorcycle. This is based on the price difference between electric motors and internal

combustion engine (ICE) motor is not as high as the price difference between electric cars and ICE cars, and the charging time of electric motors is much faster than electric cars ((Veza et al., 2022; Waluyo et al., 2022).

Nowadays, Indonesia is also developing ride-sharing and ride-hailing services. The development of these services does not reduce people's mobility, but instead accelerates it. If the development of these services is not accompanied by the use of low-emission vehicles, it will increase emissions from the transportation sector (Suwignjo et al., 2023; Waluyo et al., 2022).

The transition to electric vehicles is challenging because of several factors, such as the selling price of an electric motorcycle is higher than non-electric one (Alamsjah et al., 2021; A. D. Setiawan et al., 2023; Veza et al., 2022), long battery charging durations (A. D. Setiawan et al., 2022, 2023), lack of supporting infrastructure for electric vehicles (Murtiningrum et al., 2022; A. D. Setiawan et al., 2022; Veza et al., 2022), Lack of public concern for the environment (Alamsjah et al., 2021), Subsidies and incentives can affect the adoption of electric vehicles (Novizayanti et al., 2021), huge and scattered of Indonesian populations (Murtiningrum et al., 2022; Novizayanti et al., 2021), and limited driving range (A. D. Setiawan et al., 2022).

3.2. The electric vehicle system in France

France's transportation sector is responsible for about 36% of national CO₂ emissions, which is why the transition to electric vehicles is being implemented to restore air quality and achieve GHG emissions reduction targets (Dusart A., 2015; Flaris et al., 2021). In December 2019, the European Union announced a target of net zero emissions of greenhouse gases by 2050 (Ravigné et al., 2022). France aims to reduce petroleum products by 40% by 2030 (Haidar & Aguilar Rojas, 2022). In France, free parking for electric vehicles has been implemented since 1993, followed by the creation of public charging stations (Dusart A., 2015).

Electric vehicle adoption is influenced by various factors, one of them is related to charging infrastructure (Künle & Minke, 2022). The EU Directive on alternative fuels infrastructure recommends 1 charging point per 10 electric cars in 2020, whereas in 2018 France already had 1 public charging point for 7 electric vehicles (Künle & Minke, 2022). Currently, the number of charging stations in France has met the needs according to the number of electric vehicles in circulation, but the development of smart charging still has the potential to continue to be developed to increase the flexibility of using electric vehicles (Lauvergne et al., 2022). About 80% of the total electrical energy in France comes from nuclear power (Kleindorfer et al., 2012). This causes the use of electric vehicles in France to greatly reduce the carbon footprint in the transportation sector.

The main barrier to the diffusion of electric vehicles is due to their uncompetitive cost (Lévy et al., 2017). France provided additional subsidies to boost EV sales after the pandemic (Kastanaki & Giannis, 2023). In France, the subsidies, various tax and parking exemptions, and lower electricity prices make the total cost of electric vehicles almost equal to the total cost of ICEVs (Lévy et al., 2017).

France targets 10% of the energy consumed in the transportation sector to come from renewable energy (Künle & Minke, 2022). It is estimated that batteries that reach the end of life and can be used for a second life can fulfill 26-87% of the stationary storage demand for PV by 2030 (Kastanaki & Giannis, 2023). The recycling option will only become profitable in 2035 when the diffusion of electric vehicles is massive (Ravigné et al., 2022). The same goes for

repurposing, the end-of-life option will only be viable when electric vehicle adoption is sufficient (Weiller & Neely, 2014).

3.3. Potential policies for the electric vehicle system in Indonesia

Based on the results of the analysis that has been conducted, the results obtained several main differences between the electric vehicle system in Indonesia and France, which are related to the dominant types of electric vehicles on the road, electricity sources, availability of charging stations, and total cost ownership. The details of these differences can be seen in Table 1.

Table 1. Differences between electric vehicle systems in Indonesia and France

Variables	Indonesia	France
Dominant type	Electric motorcycle	Electric car
Electricity source	Fossils	Nuclear power
Charging stations	Not sufficient	Already sufficient
Total cost ownership	Higher than ICEV	Almost equal with ICEV

The main difference between the electric vehicle system in Indonesia and France is the type of electric vehicles on the road. In Indonesia, the dominant type of electric vehicle is the electric motorcycle. This can be one of the considerations for increasing the number of battery swapping stations, considering that battery swapping is easier to apply to electric motorcycles compared to electric cars. In addition, the use of swapping stations can solve one of the barriers to the adoption of electric vehicles related to long charging time.

The second difference is related to electricity sources. Electricity sources in France mostly come from nuclear power, which causes the use of electric vehicles in France to significantly reduce GHG emissions. In Indonesia, the source of electricity comes from fossil sources, so the use of electric vehicles still causes GHG emissions, it just moves it to power plants. Therefore, it is necessary to develop electrical energy from renewable power plants.

The third difference is related to the availability of charging stations. In Indonesia, the infrastructure that supports electric vehicles is still insufficient. It is necessary to improve the infrastructure to be able to increase the adoption of electric vehicles in Indonesia.

The last difference is related to the total cost of ownership of electric vehicles. In France, with subsidies and low electricity prices, the total cost of ownership of electric vehicles is almost the same as ICEVs. However, in Indonesia, the total cost of ownership of electric vehicles is still higher than that of ICEVs. This is one of the main reasons for the slow adoption of electric vehicles in Indonesia. Government policy intervention is needed to reduce the difference in total cost ownership of electric vehicles and ICEVs in Indonesia.

3.4. Potential future research

The topic related to electric vehicle systems is nowadays widely considered as a research focus due to the need for a rapid transition to electric vehicles. Electric vehicles are currently a popular issue in various countries around the world due to their role as a solution to reduce the carbon footprint generated by the transportation sector. This article explores the potential policies that can be applied to accelerate the diffusion of electric vehicles in Indonesia. Future research directions that can be developed are conducting a study that can confirm the truth of

this qualitative research results by conducting a simulation method that can represent the actual system. This research will provide confirmation of whether the policy recommendations from this qualitative research provide the expected effect.

4. Conclusion

Indonesia is one country that participates in implementing electric vehicles as road transportation. One pioneer country in the use of electric vehicles as road transportation is France. This article aims to compare the electric vehicle system in Indonesia and France to get potential policy insights that can be applied in Indonesia. The differences include the dominant types of vehicles on the road, electricity sources, availability of charging stations, and total cost of ownership. This difference will provide new insights for the electric vehicle system in Indonesia regarding potential policies that can be applied. This study is a qualitative study based on SLR. So, it needs further study with quantitative methods to confirm the potential policies that have been found in this study.

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