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# Environmental impacts of electric cars implementation from its manufacturing, operation, to disposal stages and their combative solutions in Indonesia

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ABSTRACT

Electric Vehicles (EV) are considered revolutionary in the automotive industry since it solves problems traditional gasoline-fueled cars have, such as air pollution, human safety and economic growth. However the transition to EV is not all simple especially in Indonesia, a third world country that is home to over 270 million people. The problems include the destruction of the landscape of increased mining activities for lithium, the inconvenience in geographical location to build charging spots that is limited to a small number of vehicles per item, and the environmental burden of recycling EV.

This paper uses literature review in order to find the solutions by searching for scientific papers from 2018 onward using FOSS, analyzing the result using critical thinking, writing the result and finally reflecting on the writing.

As a result, a recovery procedure using sawdust is proposed as a water-saving alternative in woodworking. Implementing "swapping stations" for electric vehicle batteries aims to reduce traffic and optimize land use. Government incentives like tax breaks and financial support for startups, such as KUR and Jamkrindo, are suggested to encourage lithium recycling research.

In conclusion, Indonesia is ready to implement Electric Vehicles to align with the country's commitment in the G20 summit to be completely free from population by 2045. However, there just must be some adjustments that need to be considered to ensure the effectiveness of implementation of Electric Vehicles and its sustainability in the automotive market in Indonesia.



## Introduction

Electric Vehicles (EV) cars are considered revolutionary in the automotive industry for several reasons such as human health, air quality and economic growth compared to regular vehicles [1]. This is evident in modern car manufacturers today such

as Tesla, Chrevolet, and Ford that have incorporated electric vehicles into their automotive line throughout the decade [2]. Though the market for EV only represents a small percentage of the overall global fleet of passenger cars, the sales of EV cars have increased in recent years and the numbers are expected to increase as the units become more accessible for lower demographics [3].

This topic of transitioning to environmentally sustainable alternatives becomes very appealing for densely populated countries as challenges in population stabilization contribute to energy poverty rate and carbon emissions [4]. Such as Indonesia, a developed third world country that is home to over 270 million people, the fourth largest population in the world According to Setiawan 2019, the transportation sector is the nation's largest consumer of petroleum products [5]. This is emphasized by Martinsen 2020 that states the importance of targeting the road transportation sector which consumes over 60% of the national oil consumption as the paper [6] and Paminto 2020 believe the use of gasoline and diesel oil will continue to increase in the transportation sector in Indonesia as the demand for private vehicles increases [7]. It is apparent this increase will lead to the degradation of the environment as Nathaniel 2020 explored the ecological footprint in Indonesia and identified urbanization and energy consumption [8].

The problem of ecological carbon footprint is apparent and has been brought up to an international level as the G20 summit includes carbon footprint as one of the main points; discussing the significance of government initiatives and inclusive energy policies in the nation's transition to green energy within the G20 framework [9]. More specifically, the mobilization of private finance for renewable rural electrification [10]. This made the transition to EVs become an appealing choice for the densely populated country as Utami 2020 further identifies other factors that influence the intention to adopt EVs in Indonesia including, financial, technological and macro level factors that in essence lead to prosperity of the country.

However, there are some consequences of replacing regular cars with EV cars. More specifically the challenges with the environmental and economical aspect during the different stages of the product life cycle. According to Zhang 2019, the paper discusses challenges of battery charging infrastructures towards the geography of the country where there is the need for reasonable location and deployment of charging stations based on the demand and travel patterns of the consumers [11].

Varga 2018 also highlights problems associated with the carbon footprints of EV cars that while EV are considered zero-emission vehicles, the product may indirectly contribute to pollution through energy production and poor recycling procedures [12]. This is supported by the findings made by Loganathan 2022 that undermines the environmental burdens associated with recycling lithium-ion batteries used in EV where there is a desperate need for novel technologies in order to combat growing unprocessed waste of battery packs as the demand for EV increases [13]. The topic of EV carbon footprint is also touched upon by Kosai 2020 and Dolganova 2020 that identifies that EV requires higher mineral and metal resources than internal combustion engine vehicles, highlighting increased scale of land disturbance caused by mining activities [14], [15].

The aim of this paper is to determine the combative solutions of electric cars implementation in Indonesia from the lifecycle of the product, namely, the manufacturing: the destruction of landscape due to increased mining activities, the operation: the inconvenience in geographical location to build charging spots, and the disposal: the

environmental burden of recycling EV, as a way for Indonesia to steer away from relying on natural resources and sustainably power the country in the transportation sector. The research will benefit Indonesian citizens as they learn the implications when choosing EV as a mode of transforming to a more environmentally cleaner country.

## Method

When researching, Leite 2019 highlights the need for academic dissertations through a five step approach which is defining the main topic where an objective must be clearly stated, searching the literature by using trusted software, analyzing the result by utilizing critical thinking, writing the result then reflecting on the writing [16]. The flowchart below represents the paper method to achieve Leite's ideal researching process.

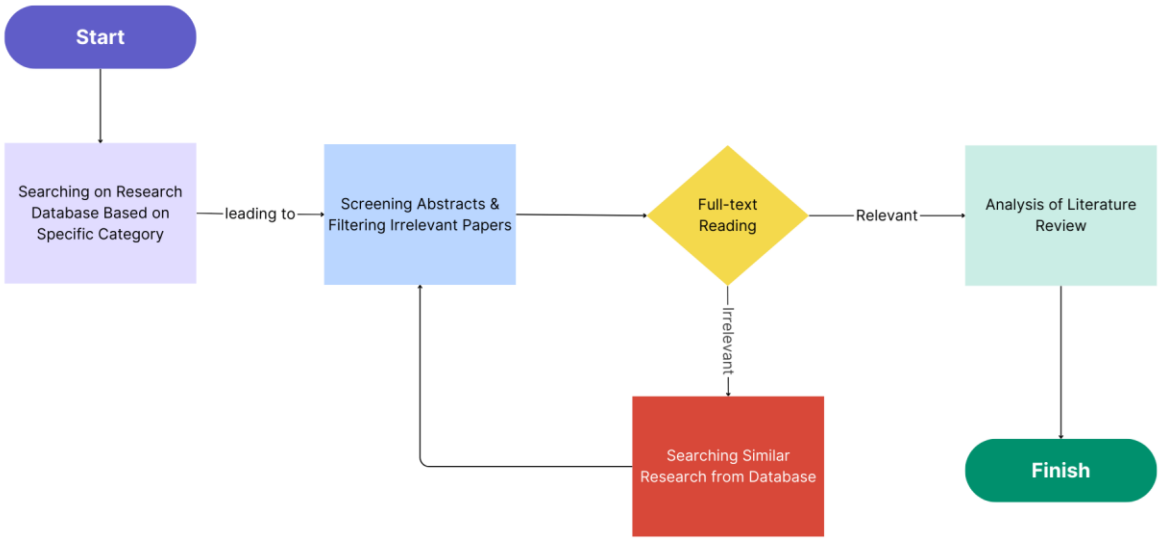


*Figure 1. Method Flowchart*

In terms of technicality to obtain the solution to the problems, the study will be conducted by doing literature review across papers. This research type is a paper review where this paper synthesizes and collects previous data from authors to find the solution for the research. The paper decided to use a literature review as it is a systematic and efficient method of tackling the paper research multiple key points in finding the solution. Data for this research was collected by examining the various environmental and economical related issues in Indonesia. Furthermore, the paper reviews scientific papers published by 2018 onwards and the paper did not consider any paper published prior that year to ensure relevance of the data. Pearce 2018 also emphasizes the use of free and open-source software (FOSS) to improve the quality of literature reviews and addressing challenges such as limited access to literature [17]. So this paper uses a combination of high profile journals that are obtained from open source website Elicit.com, complete with DOI link to avoid accident utilization of biased data. This means data obtained from news sites, youtube videos, and non-journal articles are not considered. Finally, the topic is narrowed down to encompass the data that are relevant at the present stage of Indonesia, 2023, with the aim to ensure research synthesized in this paper is useful and can be utilized immediately in the modern age.

## Result and Discussion

### a) The manufacturing: the destruction of environment due to increased mining activities

The negative impact of mining activities on the landscape and environment leads to significant degradation of ecological and aesthetic values of the landscape including land degradation, loss of biodiversity, soil contamination, air and water pollution. In lithium mining, Flexer 2018 emphasizes the chemical and water intensive nature of the ore extraction [18]. The mobility of lithium in soil and potential contamination of groundwater and surface water can also have adverse effects on human health and ecosystems [19]. This raises concerns about the environmental impact of metal mining for lithium-ion battery production for EV and calls for the need for recovery procedures after mining.

Song 2019 highlights the potential of NBS in designing resilient landscapes and cities such as phytoremediation and conversion of greenspaces for recovery after the mining activity. According to Jourgholami 2020, several rehabilitation treatments can be done to mitigate water contamination from mining such as the use of sawdust. As proposed by Öter 2023, sawdust's porous structure makes it effective at absorbing contaminants from water. This means that when sawdust is added to the contaminated water, it can absorb the contaminants, lithium, effectively removing them from the water [20]. Sawdust is also readily available as a byproduct of the woodworking industry and is typically low cost or even free, making it an attractive option for water treatment. Especially when woodworking in Indonesia is considered a popular means to produce shipyards such as in Aceh Besar [21], and house building for civilians in North Sulawesi [22].

### b) The operation: the inconvenience in maximizing geographical location to build charging spots

Prasetyo 2020 analyzed the readiness of Jakarta in terms of public EV charging stations but concluded that the ease of usage should be reassessed due to traffic [23]. This is supported by Pareek 2020 that emphasizes the challenges of grid overloading and load forecasting as well as traffic crowd management at charging stations. In metropolitan areas with a large number of residents such as BPPT Thamrin station in Central Jakarta, the region is prone to influx in demand for electric charging stations and thus traffic. From January 2020 to April 2020, it is the busiest charging station in Java with a complete filling of 1545 times [23]. This is likely due to customers from conventional taxis, online taxis, private and public vehicles considering that Thamrin Street is the center of the government and business.

In order to tackle the problem of traffic, the paper suggests solutions to this using Battery Management System (BMS) and introduction of lithium ion batteries charging strategies. This is emphasized by Arfeen 2020 that explores an energy management scheme utilizing grid power storage packs and photovoltaic generators that demonstrates the feasibility of local stationary storage for fast charging. As a real-life reference, Better Place (BP), a startup in Palo Alto, CA, has adopted this approach of readily available stationary storage. They introduced "swapping stations" along highways in addition to home, workplace, and mall charging. These stations allow depleted EV batteries to be

quickly exchanged for fully charged ones, demonstrating a refueling process in under two minutes [24]. Though the success of EV solutions using battery swapping depends on charging service providers like BP creating a cost-effective infrastructure network with extensive coverage, it will significantly reduce traffic and maximize use of land resources.

**c) The disposal: the environmental burden of recycling EV**

Even though lithium ion batteries are the optimal choice for electric transportation due to greater energy density, compact size and extended life cycles, the recycling of lithium batteries is at an infant stage with most lithium batteries ending up in landfills after a few years of service [25]. In the European Union, where there is relatively advanced regulation on battery recycling, there is only less than 20% of the product that is collected. In other words, battery manufacturing needs to become more "socially responsible, environmentally and economically sustainable and innovative" as mentioned by Beaudet in 2020 [26]. A circular economy model for battery manufacturing can offer the possibility to reduce both the environmental impact of batteries and reliance on raw mineral extraction. This could mean the implementation of government policy to more often check up and restrict the type of product that can harm the environment. Such as the "Ganjil Genap" in Indonesia that aims to reduce traffic by only allowing even plate cars on even dates and odd plate cars on odd dates.

Another method is to extend government incentives that can increase research of lithium recycling in public. From Masinde 2021, the paper suggests the combination of finance incentives and creative flexibility to boost R&D of a country [27]. This is similar to Indonesia's current goal to foster entrepreneurship and innovation of the younger generation to boost economic growth of the country by using KUR (Kredit Usaha Rakyat), Jamkrindo (SME Financing Guarantee) and PUPUK (Pembiayaan Usaha Produksi Kecil) that provides loans, financing, as well as working facilities. Thus a possible implementation is to have similar financing and backup programs like this specifically target towards the recycling of lithium ion batteries.

## Conclusion

Electric Vehicles (EV) are considered revolutionary in the automotive industry since it solves problems traditional gasoline-fueled cars have, such as air pollution, human safety and economic growth. However the transition to EV is not all simple especially in Indonesia, a third world country that is home to over 270 million people. The problems include the destruction of the landscape of increased mining activities for lithium, the inconvenience in geographical location to build charging spots that is limited to a small number of vehicles per item, and the environmental burden of recycling EV. The paper uses the five step method in order to find the solutions which is defining the main topic for a clear objective, searching for the literature using FOSS, analyzing the result using critical thinking, writing the result and finally reflecting on the writing. The paper also reviews scientific papers from 2018 onward and the paper did not consider any paper published without DOI links to avoid accidental use of biased data. Nonetheless the solutions are to:

1. Use recovery procedure by utilizing sawdust, since Indonesia has plenty woodworking activity for building, as a substitute to water to reduce water consumption and contamination,

2. To implement “swapping stations” to allow depleted EV batteries to be quickly exchanged with fully charged ones that are readily available in stations to minimize traffic and poor utilization of land resource in high demand areas,
3. As well as to extend government incentives such as tax incentives and creative flexibility, namely KUR and Jamkrindo that provides finance and facility, for startups as a way to boost interest in researching lithium recycling in Indonesia.

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