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# A framework to explore policy to support the adoption of electric vehicles in developing nations: A case study of Indonesia

Rachmad Hidayat<sup>a,\*</sup>, Jonathan Cowie<sup>a</sup><sup>a</sup> *Edinburgh Napier University, School of Engineering and Built Environment, 10 Colinton Road Edinburgh EH10 5DT, Scotland*

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## Abstract

Electric vehicles (EVs) are gaining popularity as an alternative to internal combustion engines (ICEs). However, the electrification of transport has not progressed equally throughout the world. The transition from ICEs to EVs may face some challenges in infrastructure, technology, economics, and user acceptance. Consequently, market penetration is very low due to the significant dominance of ICE in the automotive market, particularly in developing countries. The role of electric vehicles, considered one of the keys to reducing greenhouse gas (GHG) emissions, has not yet been seen significantly. In line with the commitment to reduce GHG emissions by 2030 and considering substantial contribution that the transport sector substantially contributes to GHG emissions, the Indonesian government has strengthened its support for developing the domestic electric vehicle industry through several policies and regulations. The government has introduced several fiscal and non-fiscal measures to work towards achieving that target. As part of an ongoing study, this paper summarised the published literature review and theoretical framework for policies supporting advancing EV adoption in developing countries. The result of this study is expected to assist in developing future EV programs, contributing to reducing GHG emissions and improving transportation sustainability.

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*Keywords:* Electric vehicle; policy incentive; multi-level perspective; unified theory of acceptance and use technology; user acceptance

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## 1. Introduction

Electric vehicles have recently emerged as a technology that can significantly reduce transportation emissions. Transitioning from ICEs to EVs can potentially reduce greenhouse gas emissions, thereby addressing global warming and climate change and decreasing vehicle environmental impact. Eco-friendly technology for electric cars is of great

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\* Corresponding author. Tel.: +447543321452

E-mail address: [rachmad.hidayat@napier.ac.uk](mailto:rachmad.hidayat@napier.ac.uk)

interest to the automobile industry. Developed and developing countries are in a phase of transition to cut vehicle emissions by implementing near-term efforts focussing on making EVs competitive in the market. Although EVs give many benefits, market penetration is very low, particularly in developing countries. Numerous countries have been developing EV technology for environmental benefits. However, EV use varies by country due to several factors such as government policies, end-user demand, market prices and charging infrastructure availability. Therefore, the question remains why are electric vehicles not widely accepted in developing countries and what policies and regulations should be put in place to encourage their adoption?

This paper presents a literature review to understand the drivers, benefits, and barriers of EV acceptance, followed by the main policies and regulations that accelerate EV adoption in Indonesia. This paper proposes using Multi-Level Perspectives (MLP) to understand and explain current and future dynamics affecting EV usage in Indonesia and the Unified Theory of Acceptance and Use Technology (UTAUT2) for understanding the relationship between factors that influence user acceptance. Furthermore, it proposes a mixed-method framework called the Multi-Level Model of Electric Vehicle Acceptance (MEVA) to describe and predict EVs acceptance.

## 2. Method

A literature review has been conducted to acquire a base for knowledge and research gaps concerning relevant studies on users' acceptance of Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles (HEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) and policy implementation. The collected literature data study was limited to articles published in international peer-reviewed journals written in English and published from 2010 – 2022. The approach takes the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) four-phase flow diagram (Liberati et al., 2009). Identifying studies by conducting a database search with keywords ("transport policy" OR "policy incentives") AND ("adoption" OR "intention" OR "acceptance" OR "public acceptance") AND ("battery electric vehicles" OR "plug-in hybrid electric vehicles" OR "hybrid electric vehicles" OR "electric vehicles" OR "low emission vehicles") AND ("developing countries" OR "emerging economies" OR "lower-middle-income countries"). The main databases used were ABI/INFORM, ScienceDirect, Web of Science and Google Scholar. Boolean operators such as "or", and "and" were implemented to filter the relevant papers. A total of 3,592 studies were identified; after eliminating the duplicate records, 2,766 studies remained. Records with irrelevant titles, journals and subjects were excluded, resulting in 344 retained. Inclusion criteria were finally applied, i.e., the articles must address research related to the adoption of electric vehicles and policies (tax exemptions, waivers on fees, road priority and access to restricted traffic zone), so a total of 133 were retained. The researcher further analysed the 133 papers were then analysed further by employing several classification schemes, i.e., (1) context, (2) theoretical used, and (3) Policies.

## 3. Discussions

Since the era of technological transport has surged, EVs have become an interesting and important topic to be researched. The most active discussion on this topic appeared in the subject area and category of social sciences in transportation, such as Journal of Transportation Research Part A: Policy and Practice (31%), followed by the Journal of Transportation Research Part D: Transport and Environment (27%), The Journal of Transport Policy (7%), The Journal of Case Studies on Transport Policy (4%) and the other Journals in Transportation, Environment, and Energy were set at 3%, 2% and 1 %, respectively. Despite the widespread implementation of EV policy development, the number of publications in the Journal of Transport Policy appears relatively limited. This could be due to the topic of EVs not only examining and analysing transportation policies and their effect, but also a wide range of issues within transportation such as technology, infrastructure, environment, and behaviour.

### 3.1 Classification based on context

The articles were categorised based on the country's geographical locations and economic development levels following the World Bank (2022) classification into high-income, upper-middle income and lower-middle income. This geographical and economic development categorisation. (Most of these studies were conducted in Europe (40%)

and Asia (37%). Notably, most of the articles are dominated by countries with high-income economic development. For example, Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) that have adopted electrification show that barriers are highly interconnected and often linked to consumer knowledge and experience (Noel et al., 2020). While, Canitez (2019) examined the current state of EV adoption in Turkey because the lack of integration across socio-technical elements, such as infrastructure, maintenance, and market conditions, makes transitioning to EVs difficult in developing countries. Thus, there are different challenges faced in developed and developing countries. Thus, more research is needed to support EVs in low- and middle-income countries.

Table is essential because adoption factors from different geographical regions or economic development levels might be different. Most of these studies were conducted in Europe (40%) and Asia (37%). Notably, most of the articles are dominated by countries with high-income economic development. For example, Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) that have adopted electrification show that barriers are highly interconnected and often linked to consumer knowledge and experience (Noel et al., 2020). While, Canitez (2019) examined the current state of EV adoption in Turkey because the lack of integration across socio-technical elements, such as infrastructure, maintenance, and market conditions, makes transitioning to EVs difficult in developing countries. Thus, there are different challenges faced in developed and developing countries. Thus, more research is needed to support EVs in low- and middle-income countries.

Table 1 Summary of the research context

Classification	Category	Number of papers	Percentage
Geographical context	Africa	0	0%
	Asia	50	37%
	Australia	5	4%
	Europe	54	40%
	North America	22	17%
	South America	2	2%
Economic Development	High-income	87	65%
	Upper middle-income	32	24%
	Lower middle-income	14	11%

In addition to the economic development classification used, this study also analysed the research based on the countries used as the case study to understand the adoption heterogeneity (Figure 1). Among Asian countries, China emerged by far as the frontrunner, boasting the highest number of published research articles, totalling 24. India came up with 11 papers, while other research was done on other Asian countries. Following China and India, the USA contributed 20 articles related to EVs, and the UK contributed 12. Several other European countries, such as Norway and Germany, contributed significantly to the research. Hence, the importance of conducting studies in developing countries becomes even more significant, especially within cities characterised by high population density and a significant number of private vehicles, including cars and motorcycles.

### 3.2 Classification based on research method

The most prominent research methodology used in the literature is quantitative methods 73%, while qualitative methods have been used in 34 articles (25%), and only 2% used mixed methods. Kumar and Alok (2020) include an integrative review of 239 articles and the most utilised is quantitative methods (224), while qualitative methods have been used in only 15 articles. The relatively low percentage of studies using mixed methods indicates that researchers who employ both quantitative and qualitative are relatively rare and might not necessarily require the integration of both approaches. This is important because a novel technology must engage with the whole social, physical, and institutional system. Hence, articulating multiple approaches can lead to a more comprehensive and useful chain of assessments to support policymaking and policy implementation. Furthermore, understanding large-scale transitions requires analytical frameworks that address the interaction between policies, actors, and market development. One of the mixed research methods that can facilitate this, is the multi-level perspective (MLP). MLP or socio-technical

transition is a prominent transition framework developed by (Rip and Kemp, 1998) and further refined by (Geels, 2002). The MLP provides structured way to understand how innovations emerge, develop, potentially lead to systemic changes and distinguished at three analytical levels: niches (micro) represent technologies or innovation emerge and develop, socio-technical regimes (meso) encompasses the established system and socio-technical landscape (macro) represent the broader societal, cultural, economic and environmental factors. Van Bree et al. (2010) used MLP to examine the institutionalised relationship between carmakers and consumers that can shape a potential transition to BEV and Fuel Cell Electric Vehicles (FCEVs). The results show the rise in energy costs based on fossil fuels and emission regulations and found that when manufacturers offer a wider range of products for alternative fuel vehicles, they give consumers a choice, which increases their market share considerably. Lin and Sovacool (2020) investigated the drivers, benefits, and barriers of BEV development and ongoing BEVs transition in Iceland from a socio-technical perspective. As a result, the social benefits of BEV adoption in Iceland were environmental friendliness and energy security. However, barriers preventing the transition of BEVs, such as charging availability or range, are both technical and societal.

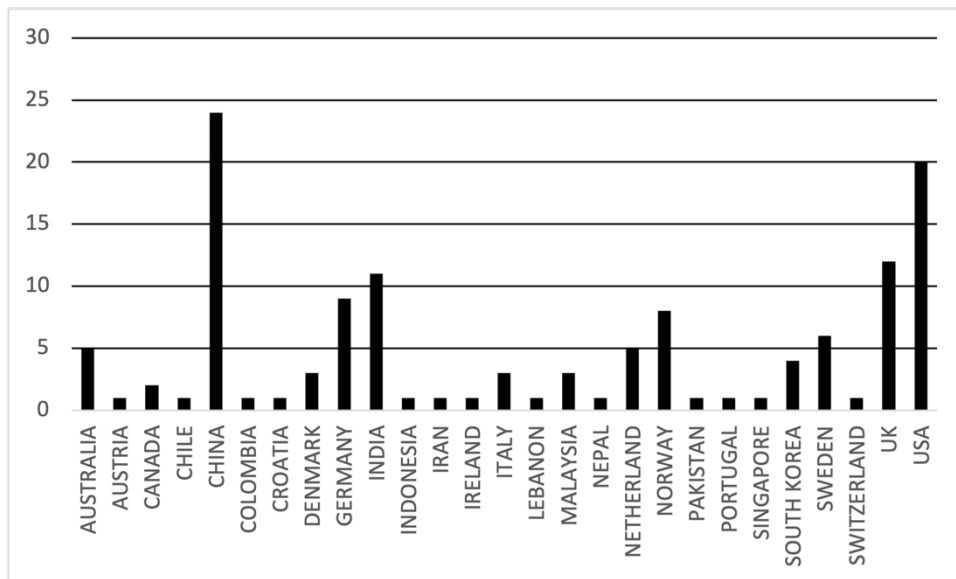


Figure 1: Country wise research study.

### 3.3 Classification based on research theoretical framework

Many researchers have defined consumers' acceptance of innovation as a behavioural response to the purchase and use of innovation (Schuitema et al., 2013, Jansson, 2011). Furthermore, based on the literature review, the Theory of Planned Behaviour (TPB) model by Ajzen (1991) has been widely utilised to understand the intention and acceptance of EVs. This model suggests that attitudes, subjective norms, perceived behavioural control and intention to perform can influence the outcome behaviour. Adnan et al. (2017) found that in Malaysia, where EVs have been widely recognised as the best alternative for the reduction of GHG, consumers' attitudes towards adopting EVs are positive when environmental concerns are considered. Therefore, consumers who are more concerned about the environment are more likely to adopt EVs. Mehdizadeh and Shariat-Mohaymany (2021) used TPB to analyse the effects of low-emission charging zones (LECZ) on the intention to adopt hybrid and electric vehicles based on voting for/against in Iran. The people in Iran would be more likely to adopt LECZ if the price, maintenance, and repair were affordable. A TPB model was used to study the motivations and barriers of small and medium-sized firms to introduce electric commercial vehicles (ECVs) into commercial vehicle fleets in Austria, Denmark, and Germany (Kaplan et al., 2016). Moving on, the Diffusion of Innovation (DOI) by Rogers et al. (2014) has been commonly used to identify and profile

early EV adopters. When it comes to emerging technologies, innovation does not spread quickly, and many of the studies on PEV adoption focus on the early adopters (Carley et al., 2013, Coffman et al., 2017). In an extension of the widely used theory in research of EVs, The Technology Acceptance Model (TAM) was extended by Jaiswal et al. (2021) by incorporating perceived risks and financial incentives policies to study and predict Indian consumers' intention to adopt electric vehicles. The results indicate that the intention to adopt EVs is directly and indirectly impacted by factors such as attitude, perceived usefulness, perceived ease of use, and perceived risk, and the presence of financial incentive policies moderates this relationship. Other study used extended TAM model was by Wang et al. (2018) taking into account perceived risk, perceived usefulness, and current financial incentives in China as a predictor of consumer adoption of EVs. Surprisingly, the results show that the financial incentive policy does not significantly affect consumer intention to adopt electric vehicles. Additionally, perceptions of the high risk associated with electric vehicles could be psychological barriers to acceptance. The contradictory results are because this study did not directly measure the actual adoption behaviour of EVs; rather, it used a proxy, which is the adoption intention of EVs.

Nevertheless, the Unified Theory of Acceptance and Use Technology (UTAUT) is the least used theory in the previous study, with only seven papers based on the literature review. UTAUT is the integration and synthesis of eight models (Venkatesh et al., 2003) including TAM, the Theory of Reasoned Action (TRA), the Motivational Model (MM), TPB, combining TAM-TPB, Model of PC utilisation (MPCU), Innovation Diffusion Theory (IDT) and Social Cognitive Theory (SCT). It aims to overcome the drawbacks of the previous models. UTAUT has four core determinants: performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC). While the original UTAUT has distilled the key factors related to the prediction of behavioural intention to use technology primarily in the organisational context, Venkatesh et al. (2012) developed UTAUT2 to pay more particular attention to the consumer use context and identified three additional constructs, such as hedonic motivation, price value and habit. Prior literature has found that certain factors such as social influence, techno philia and perceived environmental knowledge are linked to the sustainability perspective, which contributes to reducing transport greenhouse gas emissions, and the results showed that these factors were effective enough to motivate the consumer to purchase EV (Abbasi et al., 2021, Jain et al., 2021). Akinuwaesi et al. (2022) developed a modified UTAUT model adding several factors such as data security, public awareness (PA), organisation influence (OI) and government expectancy (GE) for Covid-19 digital tackling technologies (CDTT). The findings indicate that PE, FC, and SI significantly impacted an individual's intention to accept and use CDTT, while other added factors showed a statistical significance to users' intention to use CDTT. Many theories have been widely used to understand the intention and acceptance of EVs. The theories that are commonly used are the TPB, DOI, and TAM. Nevertheless, the application of UTAUT is lacking. Even though UTAUT also gives benefits of its holistic approach taken in describing and underlying relationships among several psychological and social elements. Singh et al. (2020) identified the theoretical framework of consumer's intention of electric vehicle adoption (CAVIE) that investigated 211 peer-reviewed articles and concluded that UTAUT had not been extensively used for understanding purchased intents and acceptance behaviour towards EVs. Hence, this study proposes UTAUT2 application as one of the future research agenda.

### *3.4 Classification based on policies*

Policy-driven financial and non-financial measures are essential factors for the adoption of EVs. Financial incentives are mainly purchased subsidies, rebates and tax exemptions provided by governments in order to make EVs more competitive in current markets (Hayashida et al., 2021). Many countries have taken actions to promote EVs, Santos and Davies (2020) evaluated the perceived impact of incentives for the uptake of EVs based on 143 experts and stakeholders from the Netherlands, the UK, Germany, Austria and Spain. The most important policies by more than half of the respondents are purchase subsidies, pilot/trial/demonstration, and tax incentives, hence suggesting a heavy weighting towards financial measures. Nevertheless, it is widely recognised that non-financial incentives to promote EVs represent a key focal point in EV policy discussion. A clear case in point is Beijing, where despite being one of the world's megacities facing severe traffic congestion, the promotion of EVs does not solely rely on financial incentives. To promote the purchase and usage of EVs, The Beijing government have split the number of vehicle purchase permits into two parts for ICE and EV applicants, respectively. The License Plate Lottery (LPL) policy and subsidy programs boosted EV adoption in Beijing, accounted for 7.10%, 14.52% and 8.35% of national EV adoption

in 2015, 2016 and 2017, respectively. Addressing transportation issues such as traffic congestion and sustainable transportation in developing countries requires a multifaceted approach that goes beyond just financial incentives for EVs. Non-financial incentives play a crucial role in creating a comprehensive strategy to promote sustainable transportation. Nevertheless, not many researchers have measured this non-financial incentive that would positively affect the increase of EV adoption intention in developing countries.

#### 4. Results

The discussion section has demonstrated the need for more studies in developing countries, one of the potential case studies in the future is Indonesia. Indonesia has ratified its national commitment to GHG emissions reduction in the Nationally Determined Contribution (NDC) by 2030. Indonesia aims to reduce GHG emissions by 31.89% without international support or 43.2% with international assistance (UNFCCC, 2022). Even though the role of electric vehicles (EVs) is considered one of the keys to reducing GHG emissions, it is still absent from Indonesia's NDC. The Indonesian government has solidified its support for developing the domestic EV industry through several policies and regulations. The most notable regulation is Presidential Regulation No 55/2019 on electric vehicles, which aims at enabling battery electric vehicles to be made and deployed in the country (PP, 2023). This is followed by various regulations issued by different agencies. Even though several policies have been implemented, further research is needed to determine if these policies can effectively advance the long-term adoption of electric vehicles. Therefore, more insights from the government and citizens' perspectives are needed. This is why Indonesia is relevant for future studies.

Policy implementation financial and non-financial incentives are two regulations commonly used by the government to promote large-scale EV adoption. Financial incentives are often coupled with other non-financial incentives (e.g., road priority and traffic restriction) to attract more users. Even though it is one of the primary focus points of EV policy discussions, not all countries offer non-financial incentives to encourage EV adoption.

In geographical coverage, a review of Southeast Asian countries, particularly Indonesia, would have been ideal since these are directly relevant. This is primarily since consumer preference and EV usage tend to be more empirically supported in countries with large markets. Most studies occurred in Europe and North America, while Asia, predominantly China and India, came up with the highest number of research articles. Therefore, further research is needed into policy support for EVs, particularly in countries with lower-middle incomes.

In the future, a mixed method approach could be applied by incorporating MLP and UTAUT2, as shown in (**Error! Reference source not found.**). The theoretical framework introduced includes higher and individual-level factors. On the higher-level factor, qualitative research is needed to understand and establish contextual relationships among the factors. The socio-technical transition of EVs will be used to understand and explain current dynamics as well as explore the factors impacting the transition to EVs to analyse the affecting EV usage in Indonesia at three analytical levels: niches, socio-technical regimes, and socio-technical landscape. This approach will allow the main policy implication of EV adoption to be identified. In-depth interview techniques will target national government ministries, agencies, and departments; local government bodies; regulatory authorities; police departments; universities; automobile manufacturers; and researchers in EVs. Moreover, on the individual level context, the research will extend into the quantitative research by applying UTAUT2 as the theoretical basis for understanding the relationship between factors that influence user acceptance.

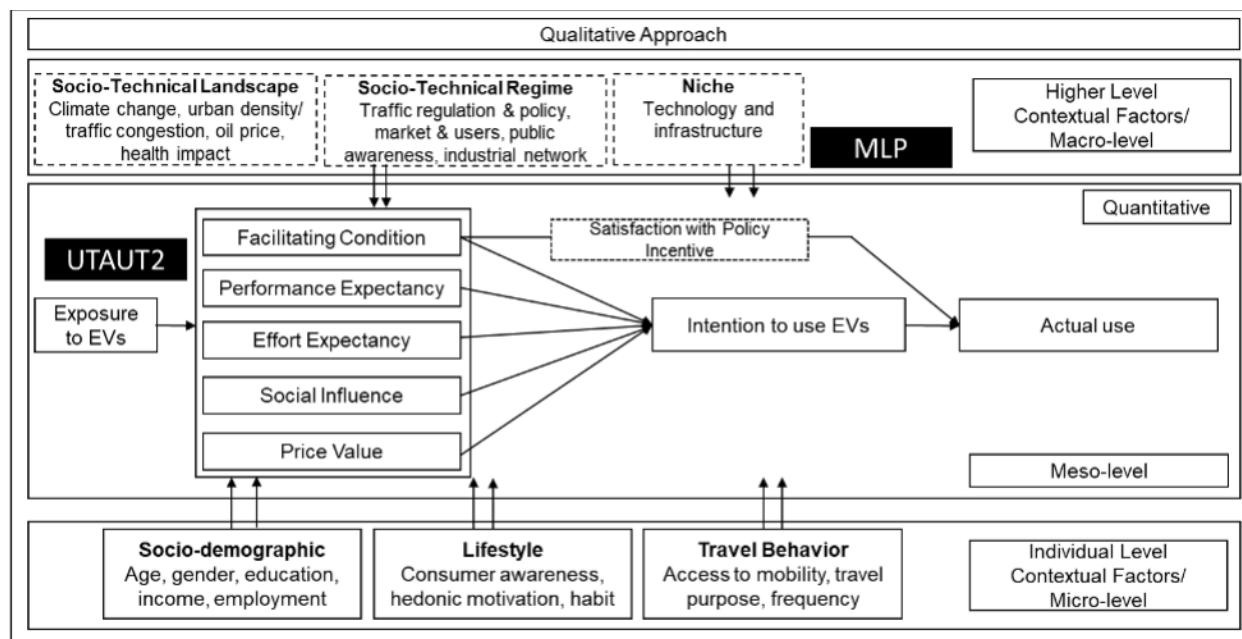


Figure 2: Theoretical framework

## 5. Conclusion

This paper presents the literature review gathered from various scientific databases. We have categorized articles according to their context, methods, theoretical frameworks, and policies. Based on the existing theories that have been applied, it is evident that only a limited number of studies have bridged the gap between higher-level and individual contexts. We introduce a mixed-method framework, the Multi-level Model of Electric Vehicle Adoption (MEVA) framework, to address this gap.

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