Factors Affecting EV Use: A Research Review Using the UTAUT2 Framework

Aisyah Pratiwi[1], Aldila Rizkiana[1], Hasrini Sari[1]

[1] Prodi Teknik dan Manajemen Industri FTI ITB
Email: aisyah.pratiwi@pln.co.id
aldila@itb.ac.id
hasrini@itb.ac.id

Abstract. The global climate crisis has become a severe issue that impacts all facets of human existence. Over half of the world's CO2 emissions are caused by the transportation sector, with road transport contributing roughly one-sixth of all emissions. In order to lessen the sector's negative environmental effects, it is crucial to create a clean and sustainable transportation system. As an alternative to internal combustion engines (ICE), Electric Vehicles (EVs) are becoming more and more popular. They are thought to lessen reliance on energy imports. However, there are a number of obstacles to overcome before transportation electrification can be fully implemented globally, including those related to infrastructure, technology, economy, and user acceptance. The Indonesian government has bolstered its support for EV adoption through policies and laws, including lowering tax incentives and subsidies and building charging infrastructure, in keeping with its pledge to cut Greenhouse Gas emissions (GHG) emissions by 2030. Customers' trust also influences the adoption of EVs in technology since they frequently have concerns about its sustainability, safety, and performance. This study combines technology trust and incentive policy satisfaction and applies the Unified Theory of Technology Acceptance and Use 2 (UTAUT2) to examine the variables impacting EV adoption. This model was created to elucidate the variables that may impact consumers' choices to switch to EVs for daily transportation.

Keywords: *EV, UTAUT2, technology trust, satisfaction with incentive policies.*

1 Introduction

The growing concern about climate emergencies and their negative effects on the ecosystem is the main driving force behind the hunt for more sustainable and ecologically friendly energy sources. Countries worldwide are looking for greener solutions due to these issues, which fuel extreme weather, natural disasters, and rising global temperatures. Both rich and developing countries have made significant efforts to cut carbon emissions through worldwide agreements like the Paris Agreement and nationally determined contributions (NDC) objectives set by each nation. One of the programs started as part of larger energy transition efforts is to speed up the utilization of EVs. In addition to assisting more significant reductions in carbon emissions, EVs are regarded as a crucial

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solution for lowering fossil fuel dependency and hazardous air quality. Increasing the number of EV users in the network is a practical plan for handling climate crises and promoting a cleaner and more sustainable transportation system. In addition to lowering air pollution, this shift can potentially increase national energy independence by reducing dependency on imported energy.

Customers' desire to utilize a technology is one of the primary variables influencing their decisions to adopt or use it. The UTAUT2 is frequently used in consumer behavior studies to examine the factors influencing EV adoption [27]. Compared with similar earlier theories, the UTAUT2 framework is still thought to be relatively new. UTAUT2 is an improvement on the original UTAUT model. The UTAUT model was created by combining eight earlier frameworks or theories: the Theory of Reasoned Action (TRA) was introduced by Ajzen and colleagues in 1975; the Social Cognitive Theory (SCT) by Bandura in 1986; the Technology Acceptance Model (TAM) by Davis in 1989; the Theory of Planned Behavior (TPB) by Ajzen in 1991; the Model of PC Utilization (MPCU) by Thompson and colleagues in 1991; the Motivational Model (MM) by Davis and colleagues in 1992; Rogers introduced the Innovation Diffusion Theory (IDT) in 1995; and Taylor and Todd introduced the Combined TAM and TPB (C-TAM-TPB) in 1995 [26]. In 2012, Venkatesh expanded the UTAUT model into UTAUT2 by adding three new elements. This model provides a more comprehensive and wide-ranging framework for understanding the factors influencing people's intentions to utilize technology.

The buildup of UTAUT2 is essential for improving the theory's capacity to handle the intricacies of the changing adoption of technology and for offering a more profound understanding of the variables affecting technology use in diverse settings. This model's increased ability to forecast consumer behavior by adding more pertinent components can facilitate the successful adoption and usage of more sustainable and efficient technology. Furthermore, UTAUT2 can be further developed to assist in adapting the model to the always-shifting needs of the market, whether those needs are at the person, community, or socioeconomic context levels. The UTAUT2 model will become more applicable across a range of technological domains and improve a thorough understanding of the factors that help or hinder consumers' decisions to adopt new technologies, both in the short and long term, by incorporating new constructs more appropriate for the current environment.

It is believed that an individual's satisfaction level with incentive schemes substantially impacts their preference to drive EVs. Comprehensive studies investigating the connection between government incentive programs and drivers' intentions to transition to EVs are lacking [33]. However, the UTAUT2 framework does not specifically address incentives and policy satisfaction influencing user choice. However, since many governments offer incentives to promote the adoption of greener technologies, such as tax subsidies, purchase

discounts, EV rebates, or incentives related to charging infrastructure, satisfaction with incentive policies can be crucial in EV adoption. To encourage the usage of EVs, governments around the world have created a variety of incentive programs. By providing a range of advantages, including tax reductions, purchasing subsidies, and incentives for charging infrastructure, these policies aim to increase the appeal of EVs to prospective buyers. The degree to which prospective customers believe the incentives are helping them will determine how successful these programs are. Customers are more inclined to convert to EVs if they perceive observable advantages like cost savings and convenience. As a result, these incentive programs can support international initiatives to lower greenhouse gas emissions and advance environmentally friendly transportation technology by encouraging the adoption of EVs in various locations. According to a survey of almost 3,400 owners of EVs in Norway, the biggest factor encouraging the adoption of EVs was upfront price reductions.

Additionally, over 80% of respondents cited value-added tax and purchase tax exemptions as significant incentives [4]. The Indonesian government has also offered several incentives to stimulate EV utilization, which are advantageous to consumers in the long run and are a good first step in tackling the country's present environmental issues. The Indonesian government released presidential Regulation No. 55 of 2019 on the Acceleration Program for Battery EV for Road Transportation. This legislation includes numerous financial and non-fiscal incentives to encourage the public to purchase EVs.

Another element influencing people's readiness to embrace new technologies is technology trust. Customers' perceptions of the product's dependability and safety are related to perceived technology trust [28]. Customers' perceptions of EV performance, dependability, safety, and affordability are all included in this technology trust [31]. Even though EVs are considered energy-saving technology, many consumers need to be made aware of how well they perform, their features, and how they work compared to conventional vehicles [21][29]. Due to their incomplete knowledge of battery technology, charging infrastructure, and the lifespan of EVs, most consumers may be reluctant to make the changeover. Their degree of faith in this technology may also be impacted by worries about the short range of EVs and the lengthier charging time when compared to EVs that run on fossil fuels.

Additionally, consumers frequently have concerns about the performance and safety of EVs and need to be made aware of how they contribute to reducing carbon emissions. Wider acceptance of EVs may be hampered by this ambiguity, which may intensify unfavorable opinions about them. Furthermore, consumers would like to wait and watch for more developments since they believe EV use has a higher risk profile, including financial, charging, physical, and psychological threats [14]. They frequently worry about increased upfront expenses, the requirement for battery maintenance or updates, and possible

technological problems. Building customer technology trust through openness, education, and legislation promoting EV sustainability and dependability is therefore crucial to boosting EV adoption.

2 Methodology

By combining the concepts of technology trust and satisfaction with incentive policies, this study employs UTAUT2 to examine the variables impacting the adoption of EVs. The goal of the UTAUT2 model is to comprehend how customers' desire to adopt EVs is influenced by various elements, including price value, habit, hedonic motivation, social influence, facilitating condition, performance expectancy, effort expectancy, technology trust, and satisfaction with incentive policies. To create a knowledge base and pinpoint research gaps in studies on customer interest in EV, a study of the literature was carried out. Google Scholar, Scopus, and ScienceDirect were the primary databases used. Only articles from international publications published between 2020 and 2024 were included in the collection. This approach uses the four-phase flow diagram of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [15]. The PRISMA approach, a defined process for conducting systematic reviews and meta-analyses, ensures comprehensiveness and openness in reporting. Identification, screening, eligibility, and inclusion are its four stages. We searched journals using keywords like "EV technology acceptance model," "EV customer behavior," "EV usage intention," and "UTAUT model with EV." A total of 97 items were found in the first search. 22 papers were found after titles and abstracts had been reviewed for relevancy, and studies that were not relevant were eliminated. 14 papers were found after full-text reviews were carried out using inclusion criteria for complete access to the articles. In light of the energy transition, these 14 articles were selected and used to investigate the factors influencing EV use intention.

3 Result and Discussion

According to the literature assessment, a number of intricate and interconnected factors, such as technological, social, psychological, and economic aspects, affect interest in EVs. Intentions to utilize technology, especially EVs, can be effectively analyzed using the UTAUT2 paradigm. The paper also revealed gaps in the literature, particularly about the connection between government incentive policies and technology trust in EV technology.

Incentive programs, such as tax exemptions, purchase discounts, and incentives for charging infrastructure, significantly contribute to the utilization of EVs. If consumers are pleased with these measures, they might be more likely to switch to EVs. Consumer technology trust in EV's dependability, performance, and safety also has a big impact on adoption decisions. Customers are more likely to

support EVs when they are aware of this technology's financial and environmental advantages.

The UTAUT2 model includes several significant aspects that affect users' intentions and behaviors when accepting new technologies: performance expectancy, effort expectancy, social influence, facilitating condition, hedonic motivation, price value, and habit. Recent studies suggest that adding the dimensions of technology trust and satisfaction with incentive policies to the UTAUT2 framework could provide a more complete understanding of the factors influencing the use of EVs. Thus, this revised model can assist the auto industry and politicians create more efficient plans to lessen the consequences of the climate problem, encourage the use of EVs, and facilitate a more ecologically responsible energy transition.

Implementing effective incentive programs and boosting public trust in EV technology can accelerate the adoption of EVs. Further work is required to allay consumer worries about upfront prices, charging infrastructure, and other technological difficulties. The switch to EVs can be accelerated by providing more incentives and ensuring that buyers have faith in its dependability and efficiency. The increasing adoption of EVs will help solve the world's environmental problems.

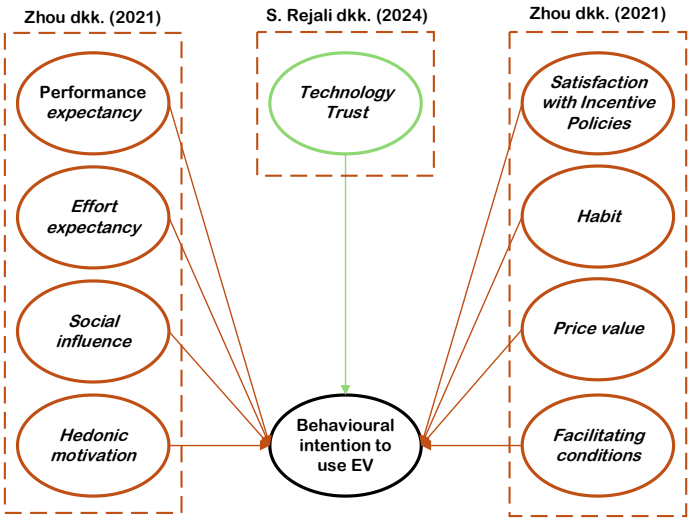

Figure 1 Existing Research Conceptual Framework

3.1 Performance Expectancy (PE)

Several studies have shown that PE significantly affects the decision to use EVs. The advantages buyers obtain from EVs, such as lower fuel consumption and maintenance expenses compared to traditional fossil fuel vehicles, are included

in PE. PE is the most influential construct and positively influences people's willingness to use EV [6][8][10][12][22][33]. According to this survey, people are more inclined to convert to EVs if they believe they are more accessible, pleasant, energy-efficient, and efficient. The primary drivers of EV adoption include fuel cost reductions, ease of usage, and carbon emission reduction. Therefore, by clearly educating and informing consumers about the performance expectations of EVs, manufacturers, and governments can guarantee that consumers completely comprehend these benefits. Giving consumers concise, understandable explanations of these advantages can ease their hesitancy and hasten the adoption of EVs. Customers will be more confident in their decision to adopt EVs if they have a greater grasp of their advantages. Additionally, this will raise demand for EV, which could hasten the shift to a more environmentally friendly transportation system.

H1: The intention to utilize EV is positively and strongly impacted by PE.

3.2 Hedonic Motivation (HM)

HM refers to intrinsic utility, including excitement, entertainment, fun, and enjoyment [7][17]. In addition to external utilities like practicality, efficiency, and performance expectations, HM substantially impacts customers' perceptions of new technology. Pleasant driving experiences, such as quick acceleration, seamless deceleration, and low noise levels, may impact hedonic motivation in the context of EVs. Compared to ICE vehicles, which may produce higher noise and vibration levels, these aspects are frequently thought to be more enjoyable. Driving pleasure, which is thought to be more enjoyable than vehicles with internal combustion engines, is one psychological factor influencing drivers' inclination to switch to EVs. A few earlier studies identify HM as the second most important component in the model under study, highlighting the pleasure and enjoyment consumers experience when using EV [6][10][22][32][33]. Because these elements make the journey more pleasant and pleasurable overall, customers may have a more restful and pleasurable experience when driving an EV. Because they can increase customers' emotional attraction to EVs, these hedonic aspects become even more significant in the context of EV adoption. Most buyers will probably pick an EV because of its usefulness and efficiency, as well as the enjoyable feelings that come from driving one. Therefore, EV makers can use these hedonic factors to attract more customers and hasten the uptake of this technology.

H2: The intention to utilize EV is positively and strongly impacted by HM.

3.3 Effort Expectancy (EE)

EE refers to users' assessment of how simple it is to operate EV [1][8]. Another element influencing people's readiness to adopt EVs is how simple they are to

use. Clear communication, ease of learning, convenience of usage, and competence in driving EVs are all components of EE. As a result, the utilization of EVs will be accelerated by the sense of ease of use. Several studies indicate that consumers' intention to use EVs is significantly influenced by their perception of how easy EVs are to use [6][32]. These results illustrate how consumers' perceived ease of use might lower the obstacles to switching from traditional to EV. In other words, customers are more likely to adopt an EV if it is practical and easy to use, particularly if they feel capable of doing so without complicated learning or technical issues.

H3: The intention to utilize EV is positively and strongly impacted by EE.

3.4 Facilitating Condition (FC)

FC is the degree to which a potential customer thinks there is the infrastructure or technical assistance required to adopt a technology [12]. some studies state that consumers are concerned about the infrastructure facilities, services, expertise, resources, and compatibility with other technologies that EVs may offer [6][33]. Access to crucial services like charging stations, EV guides, maintenance facilities, EV compatibility with other equipment, and parking spaces with charge stations increases the likelihood that users will embrace the technology. Several previous studies indicate that FC strongly predicts the intention to embrace technology [5][6][8][22][33]. FC significantly influences Drivers' EV experiences, such as parking spots and charging stations [30].

Consequently, FC affects the decision to purchase EVs. Adoption of EVs is influenced by several factors, including ease of access to charging stations, the availability of sufficient maintenance facilities, and dependable infrastructure. If this infrastructure is sufficient and convenient, more people may be encouraged to convert to EVs.

H4: FC positively and strongly impacts the intention to utilize EV.

3.5 Social Influence (SI)

When discussing EV, SI refers to how the opinions of close friends, family, or coworkers affect how valuable EV use is seen to be. Interpersonal influence from these groups significantly impacts people's intentions to buy alternative fuel vehicles [9]. SI is a critical component of technology adoption since it can promote good behavioral intentions toward using new technology by integrating social factors into it [23]. Numerous studies emphasize the crucial social impact of making EV purchases. For example, social influence (SI) from friends and family may have an impact on Malaysians' intentions to buy an EV [1]. SI significantly impacts people's intentions to buy EVs [11][28]. Because people are frequently swayed by the suggestions and opinions of their social circle while contemplating new technologies, SI becomes especially significant in the context

of EV adoption. People are more inclined to embrace EVs when their friends, family, or coworkers favor the technology. Furthermore, social influence can reinforce people's inclinations to conform their behavior to their social group as societal views on sustainability and environmental responsibility shift, particularly when EVs are increasingly viewed as a desired and responsible option.

H5: The intention to utilize EV is positively and strongly impacted by SI.

3.6 Price Value (PV)

When comparing the total cost of ownership of modern technology to antiquated systems, consumers' perspectives on value are referred to as PV in the EV case. When the advantages of new technology are thought to outweigh the disadvantages, PV has a favorable impact on usage behavior [27]. According to studies, the cheaper initial cost of EVs is one of the primary factors propelling their acceptance. For instance, value-added tax and purchase tax deductions were mentioned as important incentives by almost 80% of EV owners in Norway [4]. Furthermore, the adoption of personal EVs and the shift to electric public transportation are significantly influenced by operating costs [16]. The purchase price of EV in comparison to EV with internal combustion engines, the advantages of EV use, and their worth at current pricing are all included in PV from the consumer's viewpoint [33]. If a product's advantages surpass individual expectations, it is deemed more valuable and may increase consumer satisfaction [3]. PV has a beneficial impact on the intention to use EV [2][5][6][22][33]. PV is concerned with how customers view the benefits and drawbacks of driving an EV, particularly in contrast to an automobile powered by an ICE vehicle. Several variables, including the purchase price, ongoing expenses, incentive availability, and opinions about the vehicle's performance, might affect this PV. Customers are more likely to convert from a conventional vehicle to an EV if they believe it offers greater value.

H6: PV positively and strongly impacts the intention to utilize EV.

3.7 Habit (HB)

A person's prior behavior, which is considered to be an HB, is used to evaluate their beliefs over a logical length of time. Depending on one's level of engagement and familiarity with the targeted technology, logical time or experience can induce varying degrees of habit-building. A reasonable amount of time spent regularly using new technology forms a habit, which leads to a more positive intention to utilize it [24]. Regular use of EV technology causes drivers to form habits related to EV-specific actions, like maintaining the vehicle, charging the battery, and changing their driving style. They are more inclined to embrace and stick with the technology as these routines become more ingrained.

In order to switch to EVs, drivers must alter their current work habits, including battery replacement, vehicle maintenance, driving strategies, and mileage estimation, according to [33]. Making the switch to EVs requires changing habits, which might be difficult. Adoption rates may be slowed down by the difficulty of this transition for drivers who have never dealt with an EV.

Nonetheless, this shift is made simpler for people already familiar with EVs. Similarly, drivers who had previously driven an EV are more willing to buy and use one [25]. HB directly impacts behavioral intention and is a significant predictor of technology adoption [2][5][13][24][33]. Users are much more likely to want to keep using the technology after it becomes second nature and is incorporated into their daily lives. Thus, promoting consistent EV use is crucial to hasten its adoption.

H7: The intention to utilize EV is positively and strongly impacted by HB.

3.8 Satisfaction with Incentive Policies (SIP)

An individual's contentment with the incentives offered by the government to promote the use of EVs is referred to as SIP [33]. This feeling of satisfaction concerns how people assess the incentives provided (such as tax breaks, purchasing subsidies, lower charging costs, or other incentives) to facilitate their switch to EVs as their primary form of transportation daily. Tax subsidies, purchasing discounts, price reductions for EVs, or incentives for charging infrastructure are just a few of the incentives many nations offer to encourage the adoption of more ecologically friendly technologies. Governments worldwide have implemented incentive programs to encourage the usage of EVs [19][20][33]. Depending on how they view the benefits of utilizing EVs, these rules can help prospective buyers in different places [33]. Therefore, in this regard, the Indonesian government has issued Presidential Regulation No. 55 of 2019 on the Acceleration Program for Battery EV for Road Transportation. Several financial and non-fiscal incentives are included in this regulation to encourage the public to switch to electric-powered vehicles. Tax exemptions, financial aid for buying EVs, and the infrastructure expansion for charging them are some examples of these incentives. By implementing these regulations, the government intends to decrease reliance on fossil fuels, hasten the adoption of EVs, and aid in the fight against carbon emissions. Because it might affect EV purchase decisions, the degree of satisfaction with these incentives is crucial. People are more inclined to purchase EVs if they believe that the government's incentives are advantageous and lower their cost. On the other hand, the community's adoption of EVs may be hampered if the incentives are viewed as insufficient or challenging to get. As a result, SIP significantly impacts customer intents and choices regarding the adoption of new technology, such as electric vehicles.

H8: SIP positively and strongly impacts the intention to utilize EV.

3.9 Technology Trust (TT)

Another important aspect affecting people's readiness to adopt new technologies is TT. Customer's opinions of the dependability and security of the goods they select are related to this trust [28]. This aspect covers the opinions of consumers regarding the performance, dependability, safety, cost, and environmental friendliness of EVs [31]. Many consumers need to be made aware of EVs' performance, features, and operation compared to conventional vehicles, even though they are energy-saving technologies [21][29]. This ignorance frequently doubts EVs' safety and performance and undervalues their ability to cut carbon emissions.

Furthermore, prospective purchasers frequently question if EVs can equal conventional vehicles in terms of comfort and dependability. Due to perceived hazards connected with EVs, including financial expenditures, infrastructure for charging, and physical and mental health, they tend to wait for future developments [14]. Thus, TT plays a significant role in influencing EV adoption. If consumers believe that EVs are safe, reliable, and perform well, they are likelier to adopt the technology. However, with sufficient trust in the reliability and effectiveness of the technology, EV adoption is likely to be faster despite the long-term environmental benefits and cost savings it offers.

H9: The intention to utilize EV is positively and strongly impacted by TT.

4 Conclusion

Given the global climate crisis and the move to more environmentally friendly energy sources, it is imperative to understand the factors affecting EV adoption. According to the research assessment, a complex interaction between technological, economic, social, and psychological factors shapes EV adoption intentions. The UTAUT2 model is helpful in researching EV adoption intentions, even if there are gaps in the literature, especially with regard to the impact of public faith in EV technology and government incentive programs. To promote EV adoption, incentive programs, including tax rebates, purchase discounts, and incentives for charging infrastructure, are crucial. Adoption decisions are significantly influenced by consumer satisfaction with these regulations and confidence in EV's dependability, effectiveness, and safety.

Nonetheless, there are many holes in the existing study. More research is needed to determine the impact of public confidence in EV technology and the efficacy of government incentive programs. According to this study, the UTAUT2 framework can better understand the determinants influencing EV adoption by incorporating elements like satisfaction with incentive policies and technology

trust. This method can fill in the gaps in the literature and offer a more comprehensive view of how consumers behave when it comes to EVs.

By filling in these gaps, this approach can facilitate the shift to renewable energy, encourage the use of EVs, and assist governments and the automobile industry in tackling the problems brought on by the climate crisis. In order to create more effective frameworks and regulations that encourage the widespread use of EVs and ultimately contribute to a more robust and sustainable transportation system, future research should concentrate on these understudied areas.

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