Psychological and behavioral factors influencing the adoption of electric vehicles in Indonesia

Ardhy Lazuardy[1,2], Rahmat Nurcahyo[1]*
Industrial Engineering Department, Faculty of Engineering
University of Indonesia
Depok, Indonesia
ardhy.lazuardy@ui.ac.id, *Corresponding Autor: rahmat.eng@ui.ac.id

[2] Industrial Engineering Department, Faculty of Industrial Technology
Gunadarma University
Depok, Indonesia
ardhy_lz@staff.gunadarma.ac.id

Abstract

The popularity of electric vehicles has been on the rise lately. This is evidenced by the large number of manufacturers that present new models of plug-in hybrid vehicles and batteries. However, the revolution's success in the birth of electric vehicles also depends on the presence of consumers, the involvement of many users, and the many psychological mechanisms hindering it. What is the actual user's feeling about this type of electric vehicle? Are people ready for automation and no driver position? The purpose of this paper is to present and discuss the psychological aspects that influence the adoption of electric vehicles in Indonesia. Topics such as charging stations or electric vehicles first and performance anxiety, e.g., range anxiety, will be discussed in this paper.

Keywords
electric vehicles; range anxiety; battery; public perception;

1. Introduction

Research discussing Electric Vehicles (EVs) has existed since 1911. There have been as many as three articles, and until now, there have been 128,644 articles, starting to appear a lot since 1965. This research is limited to social science, business management and accounting, economics, econometrics, and finance. The author took data from 2000. There were about 5,700 yield documents.

The era of electric vehicles is coming quickly, but there are obstacles regarding the sound of electric vehicles. These electric vehicles have no sound. The silence of electric vehicles is still a matter of debate. On the one hand, reducing noise pollution is also feared and will pose a danger to pedestrians, visually impaired people, and other vehicles. (Singh et al., 2014).

Countries in the world, such as in Europe, require electric vehicles to have a distinctive sound, where the regulation is used to protect pedestrians. The result is a device to be adopted, the "Audible Vehicle Alert System" (Commission Delegated Regulation (EU) 2017), the type of sound must not resemble animals, sirens, horns, and music (Ministerial Regulation 33, 2018).

One of the major electric car manufacturers, Bayerische Motoren Werke (BMW) from Germany, asked one of the world's most famous composers and academy award winners, Hans Zimmer, to create a decent electric car sound BMW M IconicSounds Electric and the i4 in the M version. Other car manufacturers, such as Porsche, also developed a new car audio system called the "soundtrack of my life project" that can produce unique sounds and be set for leisurely driving. Porsche also has its library of original music bits or pieces. This can make it easier to develop projects that will then be combined and arranged by the audio system algorithm so that they can be played according to the wishes of Porsche sports cars. One of the luxury manufacturers of sports cars, Maserati, is also not lagging in producing electric sports cars. Even though it is electric-powered, the manufacturer will not remove the smell of

performance, comfort, and luxury of the car. The electric car will still be a Maserati with identic features and a thick culture. The first cars that will adopt 100 percent electric engines are the Maserati GranTurismo and GranCabrio, which will be produced at the Turin plant (Zulkarnain, eka, 2020). Both British brands, Jaguar and Land Rover, have an eco-friendly vehicle lineup with a mundane sound. Jaguar is the first to offer a premium all-electric performance sport utility vehicle (SUV). At the same time, Land Rover has a completely electrified vehicle, especially cars with mild hybrid and PHEV technology. (Priyantoro, Donny, 2022). This has led to a debate as to whether the car's sound should match the sounds of the past or whether electric vehicles have their characteristics.

Based on this, government commissions in every country require using acoustic alarms on electric vehicles. Still, a vehicle's performance is more important than the sound caused. This is the first question in this writing.

The following statement concerns whether the EV market in a particular region can expand with or without the creation of previous electric recharge networks. Various scientific works have been carried out to solve this problem and contributed to this technology's adoption phase(Yang et al., 2017). In the adoption phase starting from users, user concerns, and others. However, there are typical phases before adoption, such as the perception and initial use phases (Purple, 2021).

1.1 Objectives

The purpose of this articles is to present and discuss the behavioral aspects that influence adoption of electric vehicles. Topics such as charging stations or electric vehicles first and performance anxiety, e.g., anxiety about range, will be discussed in this paper

2. Literature Review

2.1 Early Adopters

In 1962, Everett Rogers published a book entitled "Diffusion of Innovations," defining five categories/types of customers, (Rogers, 1983) defining five categories/types of customers, shown in the picture Figure 1.

1. Innovators are small groups of people who explore new ideas and technologies, also tired of the previous ones. This group includes "gadget enthusiasts." In online marketing, there are many specialist blogs and media sites to engage such individuals.
2. Early Adopters. Considered an "Opinion Leader" who can share positive or negative testimonials about new products and services, they can demonstrate EV efficiency.
3. Early Majority. These are the "Followers" who will read reviews by previous users about the new product before buying.
4. The Majority Is Late. In general, they are skeptics who are not interested in change and will only adopt a new product or service if there is a strong feeling of lagging or missing out. They had to buy an EV but were not enthusiastic
5. Late. The descriptor said it all! Usually, they prefer traditional ICE and will adopt a new EV when there is no alternative. Sluggish people are convinced of intrigue and have their ideas in everything, often supported by pseudoscientific reasoning.

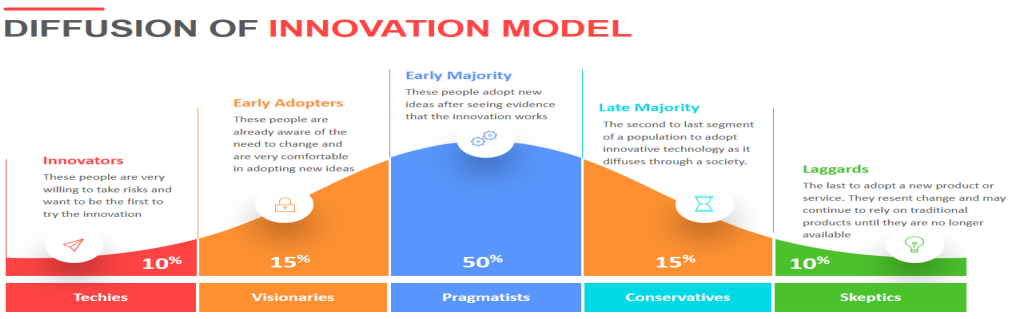

Figure 1. Diffusion innovation model of Rogers

2.2 The adaptive control of range resources framework

Figure 1 outlines how we conceptualize users' administration of EV run assets as a control errand pointed at keeping up certain favored states (e.g., remaining inside an individual run consolation zone), which decipher into person reference values (e.g., comfortable extend level). A person directs these reference values (e.g., extend competence) and natural components (e.g., course profile). This energetic exchange leads to a person's effectiveness level of run utilization for each utilization (Franke & Krems, 2013a)

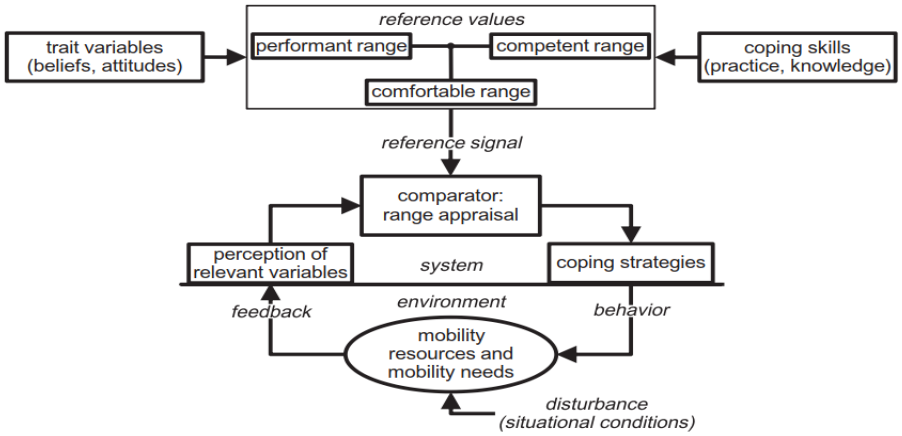

Figure 2 adaptive control of range resources framework

Figure 3. The adaptive control of range resources framework. Users compare the current range situation with their range-level reference values. These are, in turn, driven by certain traits and coping skill variables. As a result of this comparison, coping strategies are adopted (e.g., drive more economically, do not use EVs). This leads to a specific efficiency of range utilization

1. Competent range
   The affect of client behavior on EV vitality utilization is more complex and characterized by diverse elements than those in ICE vehicles (e.g., concerning proficient utilize of regenerative braking, assistant buyers like warming, light, etc.)(Frank, 2007)
2. Efficient range
   Optimizing vehicle range demands substantial self-regulation resources and is the only goal when driving a car beside a fast and comfortable journey and enjoying acceleration performance. Hence, in everyday driving, most users will obtain range values below their competent range. We term this performant range: the average or typical available range based on the user's driving motives and habits. The display field indicates the performant range when the EV is fully charged.
3. Comfortable range
   comfortable range as the preferred range safety buffer of a user that is the range buffer that is experienced as not stress-inducing (i.e., enough to avoid range anxiety). This range safety buffer can be expressed in absolute values (e.g., always keep a 10-km range reserve), relative importance (e.g., 20% reserve), or least values (e.g., never go underneath 10 km remaining run). Run buffer values can be surveyed straightforwardly by inquiring clients to supply such matters or indirectly by estimating the experienced stressfulness of specific range buffers.

3. Methods

The methodology of this study is a survey of literature from the Internet (secondary resources). The survey study used was a Systematic Literature Review (SLR). In the process of searching for it, two keywords are used. The first keyword is "Electrical Vehicle," and the second is "psychology." The results that appeared in the search for the first keyword reached more than 129 thousand articles or journals.

Furthermore, the second keyword is 5,797. Some of the sources obtained include journal articles and books. Meanwhile, when focused only on pdf files based on the most citations.

The search focused on articles published in several reputable scientific journals. But besides that, there are also some articles on reliable websites. From the search results, filtering will be carried out to get many essential sources for completing research and writing this topic.

4. Data Collection

The data collection uses a secondary resource from the Internet with the keywords Electrical vehicle and Psychology. The search focused on articles published in several reputable scientific journals. But besides that, there are also some articles on reliable websites. From the search results, filtering will be carried out to get many essential sources for completing research and writing this topic.

5. Results and Discussion

Most surveys are conducted by providing questionnaires to demographics interested in new technologies and analyzing answers with a grouping algorithm to highlight, if possible, the categories that best fit the Early Adopter figure. It is interesting to note how similar surveys define different profiles. Some investigations have a broad spectrum, covering the whole country, but others use narrow bands, as in the first case we will discuss, which is limited to only one city.

One of the barriers to buying an EV is socioeconomic classification, and respondents are grouped by socioeconomic categories such as age, income, car ownership, homeownership, socioeconomic status, and Education. Cluster analysis was applied to Census data to identify potential alternative fuel drivers of the vehicle in Birmingham, England. Nearly 60% of the areas that best fit the driver profile of alternative fuel vehicles were found in the four districts furthest from Birmingham's city, while the rooms with the worst fits were located in the center of the town. Electric vehicles (EVs) were introduced to the South African market in 2013, and the adoption rate is meager. (Campbell et al., 2012) The study findings on barriers to EV adoption in the market highlighted high purchase prices, high battery prices, and a high likelihood of owning a secondary vehicle based on current circumstances as the primary vehicle purchase intention barriers emphasized by respondents in Gauteng Province. (Moeletsi, 2021).

Based on the model Rogers created, early adopters wanted to be the first to own an electric vehicle and be seen in society as a model. The initial majority consisted of those who spent more time considering the purchase of a vehicle. Usually, they waited for a response from the initial user. In contrast to late adopters, they will be more careful in considering the purchase of electric vehicles. Last is the slow ones, those still associated with traditional vehicles, lack money to buy electric vehicles, or lack knowledge and understanding. The research above concentrates on the following: (1) age; (2) homeownership; (3) detached or semi-segregated houses; (4) driving to work; (5) having two cars; (6) income level and socioeconomic status; (7) education. The survey identified profiles of early adopters in Birmingham: people with higher prosperity.

A national survey in the U.S. identified early adopters as young people with very high incomes, homeowners with the perception that EVs are environmentally friendly, who own their car and drive 100 miles per week, in line with research. In addition, the survey contains questions about psychological problems, car features, and other items that ask about socioeconomic factors and driver mobility characteristics. (Deloitte Consulting, 2012.)(Rodríguez-Brito et al., 2018) Likewise, with research conducted in Indonesia, those who have electric vehicles have environmental awareness(Putri, A. I. A., & Gunawan, J, 2020.) On the contrary, "nonadopters" have low incomes and do not have garages, creating challenges for safe and secure home replenishment.

Early adoption as being young to middle-aged, having a Bachelor's degree or higher, anticipating higher gasoline bills in the following years, being environmentally minded, having a garage or space to charge at home, and tending to buy new items coming on the market.

Ultimately, the ideal users for electric vehicles may not exist because there is no link between ownership and age, gender, or Education. Perhaps a trend already went from early adopters to the early majority. The following research shows that higher Education often correlates with environmental sensitivity. However, the tendency of research shows that the ownership of EV vehicles as vehicles is only possible for the rich.

2.3 Anxiety Range

Consumer attitudes towards EV car performance and anxiety range proved to be a barrier to adopting EV cars. Articles that talk about anxiety quite a lot, and some have funny titles Fast-charging station here, please! (Philipsen Hotels et al., 2016) , Is range significant? Fear and hatred of electric vehicles: Reactionary rhetoric of outreach anxiety. Connection with constrained versatility assets: Mental extend levels in electric vehicle utilize, Running on empty – Users' charging behavior of electric vehicles versus traditional refueling some of them are cited.(Schneidereit et al., 2015), (Noel et al., 2019a)(Franke & Krems, 2013b) (Philipsen Hotels et al., 2018)

Range Anxiety is one of the things that consumers fear most about electric cars. They are worried that electric cars will not be able to be used at the ideal distance given the less-than-optimal supporting infrastructure of electric vehicles.

The anxiety range is about not successfully achieving the goal and battery performance. This is one of the main obstacles to the acceptance of electric vehicles. Batteries are seen as weak components, and divert from the advantages of electric vehicles, such as little energy consumption, a small number of parts, reduced maintenance, no direct emissions, etc.

Reach anxiety is the psychological and behavioral anxiety experienced by electric car users over the response to the limited range of abilities of the battery (Noel et al., 2019b). in this writing, the range is divided into three: competent, performant, and comfortable. The first and second are based on the user's technical knowledge of the vehicle and its driving skills; competence can be attributed to independent learning. The performance also uses a subjective sub-score due to the idea of range starting with a fully loaded vehicle and the possibility of achieving a new goal. Finally, the "comfortable" range is the psychological range. The relationship between the levels of reach generates user information. A higher "comfortable" range can allow drivers to reduce their efforts to increase the range available for daily driving(Franke & Krems, 2013b).

Figure 3 is most of the mileage requirements of daily activities are 0-80 km, with an average daily mileage of 72 km, with a median of about 48 km. The orange line indicates that a journey of 160 km or more in one day usually occurs only 24 times per year (Pearre et al., 2011).

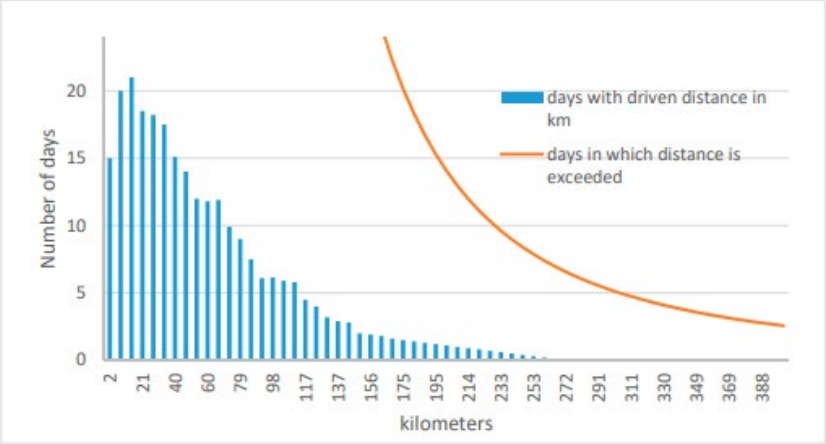

Figure 4. Average daily distance distribution. Blue bars represent the number of days a given distance is covered, while the orange line represents the number of days that length is exceeded. (Pearre et al., 2011).

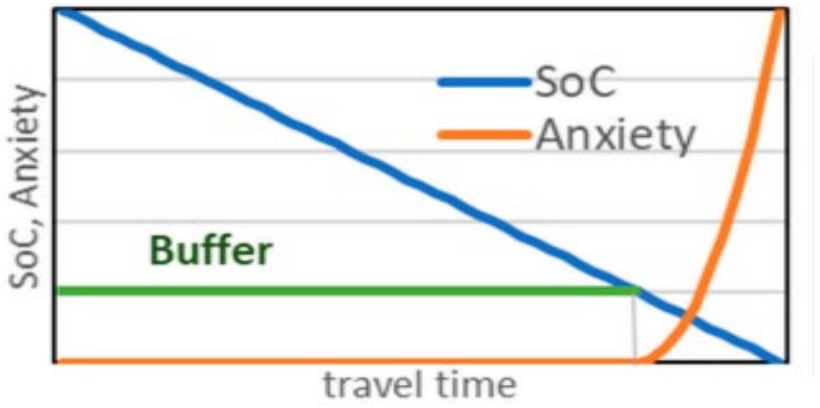

Figure 5. Profile of SoC

In Figure 4 EV drivers feel uncomfortable when the battery SOC drops below the threshold caused by the fear of being stranded in the middle of the journey (Franke & Krems, 2013)—for example, using an electric vehicle with with an autonomy of 300 km based on the manufacturer. With a buffer consideration of 20% as a comfort level, so EV has 240 km of autonomy if it starts with a full SoC. Based on the Figure, such trips are usually carried out no more than 5 per year. If the manufacturer then considers increasing the battery capacity in the future, suppose reaching 400 km of autonomy in the next three years, the days of anxiety will be halved to 2 or 3.

The conclusion is that range anxiety can be said to be more rhetorical or just a concern, to some extent that the body allows. Users who are still pessimistic about electric cars and do not want to switch to EVs will say that their wishes are out of reach.

6. Conclusion

The conclusion in this writing is the primary attitude most influential in the transition from conventional to electric vehicles. The primary purpose is to consider users' reactions to new electric vehicle products. Some studies describe the characteristics of early adopters, but subsequent studies determine general characteristics, for example, addition to socioeconomic conditions and high incomes. This is also because electric vehicles at the embryonic stage are still expensive compared to conventional vehicles, which are not too expensive.

Such fears belong to a wider range of anxiety. This anxiety was discussed, and attempts were made to evaluate it numerically, suggesting that although similar situations can occur several times per year, it is still one of the main obstacles to the use of EVs precisely because of the theory of reactions to innovations, which does not allow a person to abandon the certainty of the present

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Biography

Ardhy Lazuardy is a doctoral student majoring in Industrial Engineering, University of Indonesia. He completed his master's degree at Gunadarma University, Indonesia, majoring in Industrial and organizational Psychology and Bachelor's Education at Gunadarma University with a major in Industrial Engineering. He has 4 years of experience as Quality Assurance in a calibration and testing service company. He continues his career as a lecturer at Gunadarma University until now.

Rahmat Nurcahyo is a senior lecturer in Management Systems in the Industrial Engineering Department, Universitas Indonesia, Depok, Indonesia. He earned a Bachelor's in the Mechanical Engineering Department, Universitas Indonesia, Depok, Indonesia, and a master's in the University of New South Wales, Australia. Then he obtained his Doctoral degree from Universitas Indonesia. His research interests include management systems and business management.