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POTENTIAL FACTORS AFFECTING ADOPTION OF ELECTRIC VEHICLE BY INDONESIA MARKET

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Abstract. *This study investigates the potential factors influencing the decision to adopt electric vehicle (EV) by the Indonesian market. EVs are considered essential to improve environmental air quality particularly in big cities where the transportation sector is a great contributor to air pollution. Adopting and influencing the residents of the big cities to switch from traditional gasoline-based cars to EVs is essential. The first step towards the process is to understand the factors considered by them to adopt the new technology. Many existing works had shown the price and the supporting infrastructures were crucial for individuals to purchase EVs. In this study, we categorize influential factors into four dimensions, namely, socio-demographic, technical, economic, and behavioral. Nearly four hundred participants were asked to contribute their opinions about those dimensions. The intention to purchase EV is divided into three levels: low, moderate, and high. We distribute the opinions of the participants opinions about those influencing factors into the three levels of intention and compute the proportions. The dependency between the intention levels and the distributions of participants' opinions are evaluated by the χ^2 statistic. In general, the intention and curiosity are moderate despite their awareness about the environmental air quality and understanding that the vehicle may improve the air quality. Their understanding of EVs is constructed dominantly based on information available online. The price of EVs, as well as tax incentives, is an influential factor affecting their intention of purchasing. From the perspective of EV performance, charging time to the vehicle fuel capacity of fewer than three hours is acceptable to the majority of the participants. SUV and city car types are preferable. The vehicle's durability is also highly regarded. The intention to purchase EV is influenced by the factors of age and education level but not by the factors of sex, marital status, and employment.*
Keywords: Adoption, Consumer response, Electric vehicle, Indonesia market, Influence factors, Intention to purchase

1. **Introduction.** With 1.03 million cars sold in 2019, Indonesia is one of the countries with the largest seller of passenger car vehicles in Southeast Asia [1]. Nearly all cars in the nation run on fossil fuels and only a tiny fraction of 0.01% of cars are non-fossil fuel [2]. As a result, motorized vehicles that contribute as much as 27% are the third-largest contributor of CO_2 emission in the nation, higher than industry and power plants [3].

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We note an important fact that Indonesia contributes as much as 27% of the world's suppliers of nickel, an important ingredient of battery required to power electric vehicles (EV) [4]. With those consideration factors, the Indonesian government seriously considers the development and manufacturing of electric-based vehicles. Recently, the government issued a Presidential Regulation (Perpres) on the acceleration of electric car development.

As a part of the program, the government stimulates EV users with many regulations. The fossil-fueled vehicles are subjected to the odd-even regulation where vehicles with even last-number on their license plates are not allowed to operate on some major road segments on odd dates, and vice versa. EV vehicles are exempted from the regulation. The provision of free parking fees for EV is being discussed.

The government sets targets of 400 000 EVs on the road by 2025 and of 5.7 million EVs by 2035 [5]. For reference, the number of EVs operating in the world is 5.1 million as of the end of 2018 [6].

However, the market of EV as an alternative vehicle in Indonesia has several challenges. The first challenge is related to the availability of charging station infrastructure. Currently, charging station infrastructure in Indonesia is still limited. Due to the limited mileage of electric vehicles, the availability of adequate charging station infrastructure is very important in EV adoption to meet the mobility needs of EV users [7]. The second challenge is the EV purchase price. The high price of the battery makes the purchase price of an EV much more expensive than a gasoline-fueled vehicle. The third challenge is the low environmental awareness of the Indonesian people, especially if it is related to vehicle purchase decisions. The environmental impact of a vehicle is often less important than the purchase price, cost of use, quality, and other vehicle performance attributes [8].

Some of the previous and relevant studies are of the following. Similar studies had been performed for China's market by [9] and the Nordic market by [10]. The two studies identified the influencing factors within three categories, namely, socio-demographic, technical, and economic and behaviors. Meanwhile, [11] studied the case from the perspectives of promotion, word of mouth, financial benefits, EV quality performance, and infrastructure readiness. [12] studied from the perspectives of personal networks and previous EV experiences. The environmental consideration on adoption was studied by [13]. [14] studied the hybrid energy storage systems of battery and supercapacitor for optimum performance by applying an adaptive control method.

In this study, we pursue the research to understand the factors affecting the decision of Indonesian citizens to purchase EVs. We adopt the framework proposed by [9] and collect relevant data from five major regions in Indonesia. Despite the similarity of these frameworks with [9], this study combines several factors such as technical and behavior factors based on the adaptation from [10]. Moreover, this study takes place in Indonesian market which considerably has different characteristics with the observation conducted in the previous studies. These settings let the study can provide insight to the knowledge pool related to EV market studies. We set two objectives. The first is to understand the level of the intention of Indonesians to buy EVs. The second is to examine the importance of the underlying micro- and macro-level factors influencing the purchase intention of Indonesian citizens.

The remainder of this paper is organized as follows. In Section 2, we briefly describe the research method. In Section 3, we present the research findings statistically and discuss their implications. Finally, we conclude the research with Section 4, which summarizes the major findings.

2. Research Methods.

2.1. Supporting theory.

2.1.1. *Socio-demographic factors.* Socio-demographics factors, such as sex, education, occupation, and age, were well-known to affect purchase intentions [15]. In regards to EV purchase-intention, many factors of socio-demographic characteristics had been identified, and a few are inconclusive. In general, the early EV users were characterized by having high-income, middle-age, tertiary-level education with awareness on environmental issues, and technologically inclined [16, 17]. According to post-materialist theory, individuals with higher incomes and education were more concerned with post-materialist goals, such as environmental issues, and they were more likely to purchase EV [18]. Many studies found the majority of EV users were high in income and price-insensitive [17, 19, 20]. [21] found younger individuals also had an interest to own EV but they were constrained by the price. EV drivers tended to have higher education and were driven by the awareness of the environmental impacts, and they were ready to bear the additional cost [22].

Regarding gender, the previous findings were inconclusive. [23] found that more women valued higher EV than men in Sweden. However, [24] and [25] found no correlation between gender and the intention to buy EV.

2.1.2. *Technological factors.* The previous researchers had also identified several technical and important factors determining EV purchase intention. They could be categorized into supporting infrastructures, car performance, and ownership cost [26, 27, 28, 29, 30].

The supporting infrastructure should be accessible easily and freely or at a low cost. The vehicle should be able to cover a driving range, on a single charge, on a par with petrol vehicles. [31] found that experienced EV drivers tend to have lower anxiety about the driving range than their inexperienced counterparts.

[32] asserted that 71.7% of respondents would be more likely to adopt EV if the charging station was located along their journey. For the consumers in China, the availability of charging at home was the main factor affecting the intention to buy electric vehicles [33]. As for the ownership cost, consumers regarded that EV required minimal maintenance and generally lower cost [34, 35].

2.1.3. *Economic factors.* This category includes the traditional economic factors influencing adoption interest, including expected costs, intention to purchase a new vehicle, and planned future purchase timing, as well as special privileges and policy incentives for electric vehicles.

Many authors suggest that vehicles, especially EVs, had experienced economic or utilitarian benefits that were still rooted in the consideration of a more conventional or functional decision by users to move from point A to point B [36, 37].

Most studies had analyzed financial benefits and other government policy incentives, including subsidies [38], financial discounts [39], and policy privileges, such as exemptions from number plate lotteries. The study found a positive correlation between special privileges and purchase intentions.

2.1.4. *Behavioral factors.* This last category incorporates sustainability values such as commitment to low carbon innovation, or environmental values such as sustainability or the future. [40] and [41] found a positive association between environmental concern and EV adoption. [42] asserted that many EV drivers admitted to pro-environmental practices. EV consumers showed greater care on environmental issues [19] and energy security [33]. In general, consumers with environmental awareness were more likely to purchase EVs and to adopt environmentally sustainable behaviors.

2.2. **Research framework.** Based on an extensive survey on literature discussing the adoption of EVs, we construct a research framework depicted in Figure 1. The framework has four dimensions, namely, socio-demographic, technical, economic, and behavioral. The socio-demographic dimension has six components of the following: age, gender, education, marital status, profession, and residential region.

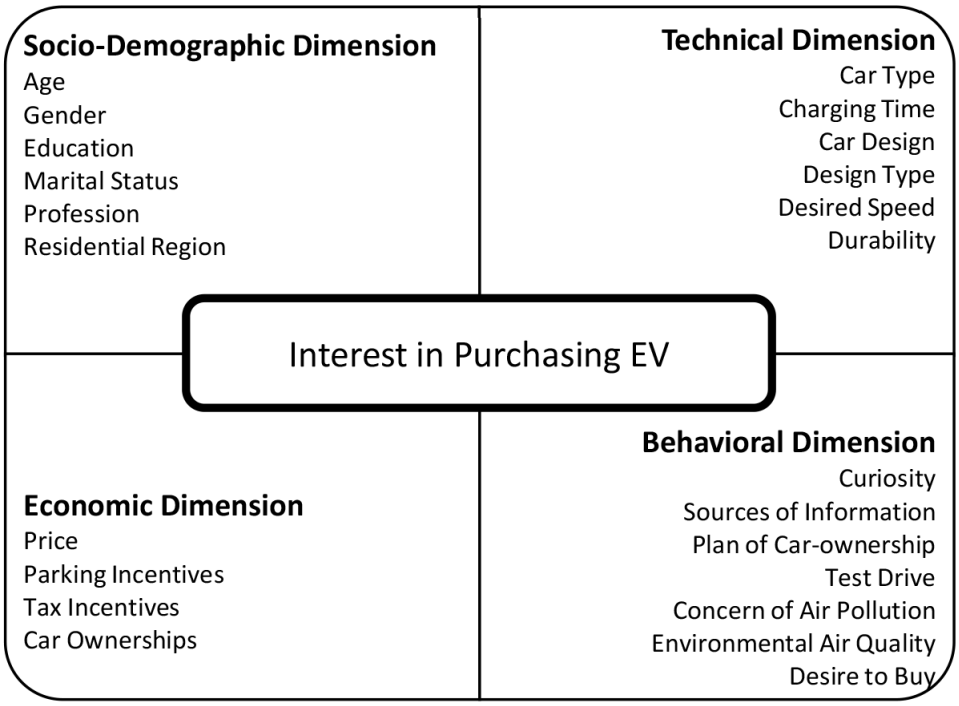

FIGURE 1. The adopted research framework

As for the technical dimension, we take account of six components: car type, charging time, car design, design type, desired speed, and durability. Four components are assessed for the economic dimension including price, parking incentives, tax incentive, and car ownership. Finally, we consider the behavioral dimension of EV adoption.

2.3. **Data.** According to an Indonesian transportation management agency, the total number of vehicles in the five residential regions focused in this research is more than 9 million as of 2016. At the prevision level of 5%, the study requires a sample size of about 400 samples. Those car owners in the sampling are communicated online to fill questionnaires having 31 questions. The data are collected on 4-10 May 2020.

2.4. **Statistical analysis methods.** For many aspects, we compute the sample proportions to determine the inclination of the respondents towards the research aspects. The dependency of the intention to purchase EV and relevant factors are evaluated by the χ^2 statistic, which is computed by the following:

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}. \tag{1}$$

The symbol f_o denotes the observed frequency and f_e denotes the expected frequency.

3. **Results and Discussion.** The distributions of the intention to purchase EV factored by socio-demographic factors are shown in Table 1. The intention is categorized as low, medium, and high. The relationship between each factor and the intention is statistically evaluated by the χ^2-statistic test. The test assesses the following hypotheses:

H0: There is no dependency between the two-considered factors, and

Ha: There is a dependency between the two-considered factors.

TABLE 1. The distribution of the participants' willingness to adopt electric vehicle factored by socio-demographic characteristics

Item	Option	Willingness to adopt EV			Participants	
		Low	Medium	High	n	%
Age (year)	21-30	10	57	31	98	29.7
	31-40	11	49	15	75	22.7
	41-50	16	60	21	97	29.4
	51-60	10	36	10	56	17.0
	> 60	3	1	0	4	1.2
Gender	Male	32	127	56	215	65.2
	Female	18	76	21	115	34.8
Education	Vocational	5	53	9	67	20.3
	Undergraduate	36	136	53	225	68.2
	Graduate	9	14	15	38	11.5
Marital status	Married	38	157	50	245	74.2
	Single	12	46	27	85	25.8
Profession	Housewife	5	20	7	32	9.7
	General employees	31	117	43	191	57.9
	Gov. employees	1	18	8	27	8.2
	Student	3	9	6	18	5.4
	Entrepreneur	3	32	10	45	13.6
	Other	7	7	3	17	5.2
Area	Bekasi	6	38	12	56	17.0
	Bogor	1	6	2	9	2.7
	Depok	3	5	3	11	3.3
	Jakarta	13	48	22	83	25.2
	Tangerang	23	93	28	144	43.6
	Outside above	4	13	10	27	8.2

Table 2 presents the results of the tests including the values of the χ^2-statistic and conclusion. The results conclude that the intention to buy EV depends on age and education level, but does not depend on sex, marital status, employment status, and residential region.

In general, the level of the intention to buy EV is moderate across all age groups but 60 years old or more. Those in the last age-group tend to have low intention to buy EVs. For the age groups 31-40, 41-50, and 51-60, around 20% show a high interest in purchasing EV. However, for the age group 21-30, the proportion jumps to 32%. Among those with a graduate degree, 40% show high willingness to adopt EV. Meanwhile, among those with a vocational degree, only 13% show a similar intention.

The importance of the technical aspects in the EV adoption is presented in Table 3. SUV car type is highly desirable by the respondents followed by city car and MPV. As for the charging time, a duration of less than three hours is acceptable to the majority of the respondents. However, around 36% participants would adopt when the charging time is within 0-1 hour.

The car design is also crucial to the majority, particularly vehicles with elegent and sport types. As for the desired speed, 70% participants are happy with EVs with moderate speed level. High durability is also highly desirable.

TABLE 2. The results of the statistitical tests concerning the relationships between the intention to buy EV and socio-demographic aspects

Socio-demographic aspect	χ^2-stat (p-value)	Relationship
Age distribution	17.7534 (0.0232)	Related
Sex	2.5754 (0.2759)	Not related
Education level	18.7812 (0.0009)	Related
Marital status	4.5873 (0.1001)	Not related
Employment status	7.1757 (0.7088)	Not related
Residence region	4.6958 (0.9106)	Not related

TABLE 3. The distribution of the participants' willingness to adopt electric vehicle factored by technical characteristics

Item	Option	Willingness to adopt EV			Participants	
		Low	Medium	High	n	%
Car type	SUV	15	68	28	111	33.7
	City Car	10	49	21	80	24.2
	MPV	10	43	12	65	19.7
	Sedan	10	25	11	46	14.0
	Commerce	1	10	3	14	4.2
	Other	4	8	2	14	4.2
Charging time	0-1 Hour	32	35	52	119	36.0
	1-3 Hours	60	75	18	153	46.4
	3-6 Hours	7	24	27	58	17.6
	$>$ 6 Hours	0	0	0	0	0.0
Car design	High	11	74	47	132	40.0
	Moderate	13	111	27	151	45.8
	Low	26	18	3	47	14.2
Design type	Elegant	23	84	28	135	40.9
	Sport	12	68	25	105	31.8
	Futuristic	5	31	15	51	15.5
	Classic	7	13	6	26	7.9
	Other	3	7	3	13	3.9
Desired speed	Low	26	13	1	40	12.1
	Moderate	22	161	46	229	69.4
	High	2	29	30	61	18.5
Durability	Low	6	6	0	12	3.6
	Moderate	10	42	8	60	18.2
	High	34	155	69	258	78.2

As for the economic factors, the distribution of the participants' opinions is presented in Table 4. Nearly all participants consider price as a determining factor for the adoption. A similar distribution also appears in regards to the tax-relief incentives factor. We note that about three-quarters of the respondents have already owned a car. The salary distribution is centered around 5 to 10 million Indonesian Rupiah.

The distribution of the behavioral characteristics of the respondents is shown in Table 5. In general, the desire to buy an EV is moderate. Only about half of the participants are

TABLE 4. The distribution of the participants' willingness to adopt electric vehicle factored by economic characteristics

Item	Option	Willingness to adopt EV			Participants	
		Low	Medium	High	n	%
Price is crucial	Agree	47	194	72	313	94.8
	Disagree	3	9	5	17	5.2
Parking incentives	Agree	25	175	67	267	80.9
	Disagree	25	28	10	63	19.1
Tax incentives	Agree	37	194	73	304	92.1
	Disagree	13	9	4	26	7.9
Current car ownership	Have car	36	129	73	238	72.1
	Do not have car	14	50	28	92	27.9

TABLE 5. The distribution of the participants' willingness to adopt electric vehicle factored by behavioral characteristics

Item	Option	Willingness to adopt EV			Participants	
		Low	Medium	High	n	%
Public curiosity about electric cars	Interested	9	105	14	128	38.8
	Not Interested	41	98	63	202	61.2
Information sources	Online Media	28	171	68	267	80.9
	TV, Newspaper, ...	6	10	5	21	6.4
	Other	16	22	4	42	12.7
Future plan of car ownership	Add New	16	100	36	152	46.1
	Change	34	103	41	178	53.9
Interest in doing a test drive	High	1	42	2	45	13.6
	Moderate	13	143	17	173	52.4
	Low	36	18	58	112	34.0
Concern of air pollution	Always	18	62	30	110	33.3
	Often	29	128	45	202	61.2
	Never	3	13	2	18	5.5
Environment air quality	Good	19	80	22	121	36.7
	Fair	28	105	45	178	53.9
	Bad	2	16	5	23	7.0
	Very Bad	1	2	5	8	2.4
Electric car improve air quality	Agree	45	196	76	317	96.1
	Disagree	5	7	1	13	3.9
The desire to buy an elective car		50	203	77	330	100.0

curious about EV or have a plan in the future to own one. However, nearly three quarters show an interest to test-drive EV. On the other hand, they aware and concern about the environmental air quality and believe that EV can improve air quality. Nearly, all participants gather information about EV from online resources.

4. **Conclusion.** We collect and analyze opinions of Indonesian citizens living in some highly-populated regions regarding the intention to purchase EVs. In general, the intention and curiosity are moderate despite their awareness about the environmental air quality and understanding that the vehicle may improve the air quality. Their understanding of EVs is constructed dominantly based on information available online. The price of EVs, as well as tax incentives, is an influential factor affecting their intention of purchasing. From the perspective of EV performance, charging time to the vehicle fuel capacity of fewer than three hours is acceptable to the majority of the participants. SUV and city car types are preferable. The vehicle's durability is also highly regarded. The intention to purchase EV is influenced by the factors of age and education level but not by the factors of sex, marital status, and employment. For a potential future research topic, we propose an analysis of the supply chain management to support the potential proliferation of EVs, particularly for the Indonesian market.

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