

Factors Influence the Purchase Intention of Electric Vehicles in Egypt

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Abstract

The sales rate of Electric Vehicles is growing rapidly worldwide. On the contrary, EVs are not achieving the same rate of popularity in emerging markets like Egypt. Some researchers suggest that developed countries have better infrastructure, governmental frameworks, and policies to support mass adoption, other researchers claim that consumers in developed markets have higher environmental awareness that drives them to adopt cleaner transportation means. In Egypt, research investigating EVs' unpopularity is limited. Therefore, the researchers studied the factors that influence the purchase intention of EVs in Egypt to bridge this gap and accelerate the penetration rate of EVs in the Egyptian market. This study used the TPB model to study the effect of Attitude, subjective norms, and perceived behavioral control on the purchase intention of adopting an EV in Egypt. In addition, the literature review suggested including Environmental knowledge and Governmental Policies & Support to study their effect on the intention of EVs' adoption besides the regular TPB independent variables. The conceptual framework of this study hypothesized several relationships and for that, data was collected through a self-administered questionnaire from a sample of 113 passenger vehicle prospective buyers in Egypt. Results show that Governmental Policies & Support alone can explain 39.1% of the purchase intention of EVs in Egypt, followed by Attitude and Perceived Behavioral Control with 8.1% and 3.2% respectively. The findings highlight the importance of Governmental Policies & Support on the EVs' adoption intention in emerging markets generally and in Egypt specifically.

Keywords: electric vehicles, EVs, purchase intention, Egypt, theory of planned behavior, attitude, subjective norms, perceived behavioral control, environmental knowledge, EVs' governmental policies, EVs support

1. Introduction

Currently, it is estimated that there are around 2 billion vehicles around the world, and it is expected that this number of vehicles will be doubled soon, this tremendous number of vehicles releases unprecedented amounts of green-house gases which have devastating global environmental and economic consequences (Sperling & Gordon, 2008). Environmental Protection Agency (2021) estimates that around 28% of the total greenhouse gases in the U.S. come from the transportation sector alone which makes it the largest contributor of greenhouse gases in the US.

Electric vehicles (EVs) appeared as a cleaner alternative to conventional vehicles and it holds enormous benefits over fossil fuel-dependent vehicles; Firstly, it is more energy-efficient as electric vehicles convert more than 77% of the electric energy from the grid to the wheels, conventional vehicles convert only from 12% to 30% of the energy stored in fossil fuels; Secondly, its performance is better as it provides a smoother and a quieter ride; in addition, it requires less maintenance and provides a stronger acceleration; Lastly, it produces no tailpipe gases and decreases or even eliminates the dependence on fossil fuels as electricity can be generated from environment-friendly alternatives (U.S. Department of Energy, 2015).

There are two types of vehicle emissions, Direct and Life Cycle emissions; Direct emissions are the emissions emitted from the vehicle's tailpipe during traveling, this type contains hazardous pollutants to human health like NO_x and CO₂, all EVs produce zero direct emissions which makes them perfect to improve air quality in urban areas; the second type is the Life Cycle emissions and it is all the emissions produced during manufacturing, processing, distribution, use and disposal/recycling, just like direct emissions, it contains hazardous pollutants; it is widely agreed upon that EVs produce far fewer pollutants during its life cycle compared to Internal

combustion engine (ICE)-powered vehicles, even though, the exact calculation of this type is complex and highly dependent on the geographical area and the electricity mix but overall electric vehicles can significantly reduce both types (Office of Energy Efficiency & Renewable Energy, 2010).

Many countries, states, and municipalities around the globe established frameworks to phase out vehicles that use fossil fuels to encourage people to adopt a cleaner alternative like EVs; For example, the state of California announced that 100% of the newly sold passenger cars must produce zero emissions by 2035 (Executive Department, 2020). Similarly, the United Kingdom has announced two steps plan to phase out conventional vehicles, the first step is not allowing the sale of any new cars using diesel or gas by 2030; the second is obligating all cars and vans on roads to produce zero tailpipe emissions by 2035 (UK Government, 2020).

The world-renowned consultancy firm (Deloitte, 2020) expects electric vehicles market share to achieve a compound annual growth rate of 29% until 2030; even though most of this anticipated growth in the electric vehicles market comes from three regions only, the European Union, the U.S., and China with 27%, 14%, and 49% market share respectively, which leaves only 10% of the electric vehicles market to the rest of the world. Currently, these three regions secure around 70% of the EVs' market share (International Energy Agency, 2020).

The exact number of EVs sales in Egypt is very small to be mentioned in official reports, Habib and Mahmoud (2020) claim that increasing the penetration rate of EVs can help the country on the economic and environmental levels; on the economic level, the petroleum imports to Egypt represent 5% of the country's total imports and the transportation sector alone consumes 18.49% of it, the second-largest petroleum consumer after electricity generation. Understandably, increasing the number of EVs will require increasing the generated electricity capacity which isn't a problem for Egypt because the current total installed capacity is 58,353 MW meanwhile the peak load is only 31,400 MW and the majority of this newly added capacity comes from stations powered by natural gas which is the locally explored (Egyptian Electricity Holding Company, 2020), a transition to EVs can utilize this excess capacity, decrease the country's petroleum dependence, increase the prospect of renewable energy sources and natural gas-powered stations. On the Environmental level, air pollutants in Cairo are much higher than the World Health Organization guidelines, it is estimated that motor vehicles are responsible for 20% of these pollutants, and 12,569 Egyptians die annually due to health complications of the poor air quality in greater Cairo alone and the cost of health effects represents LE47 Billion which is almost 1.4% of the GDP (The World Bank, 2019). As a result, The World Bank (2020) approved a \$200 million project to improve air quality and reduce pollution in Cairo, one of the key strategies of this project is to increase the number of electric vehicles and their supporting facilities in greater Cairo, although, this initiative is limited to public transportation means.

In conclusion, despite the alleged benefits of EVs, its mass adoption is a privilege limited to 3 regions. By far, the international and local independent initiatives to increase the number of EVs in emerging countries like Egypt aren't coming to fruition, understanding the factors that influence the purchase intention of EVs in Egypt will help in accelerating its penetration rate in the local market and guide the international and local institutions efforts.

1.1 Literature Review

Kotler and Armstrong (2018) argue that there are four types of buying behaviors, buying a car comes under what's known as a complex buying behavior, which is a behavior that happens when there is a high involvement rate of the consumer and perceives high differentiation between different brands, the high involvement rate is normal when the product is expensive or an infrequent purchase or possess a high degree of risk; this type of buying behavior requires the consumer to go through a learning process to gain knowledge and develop beliefs before making the purchase choice, buying a new vehicle is a good example of a complex buying behavior.

1.1.1 Approaches to Study the Adoption of EVs

Adnan et al. (2017) specified 5 different approaches to study the consumer adoption behavior of EVs.

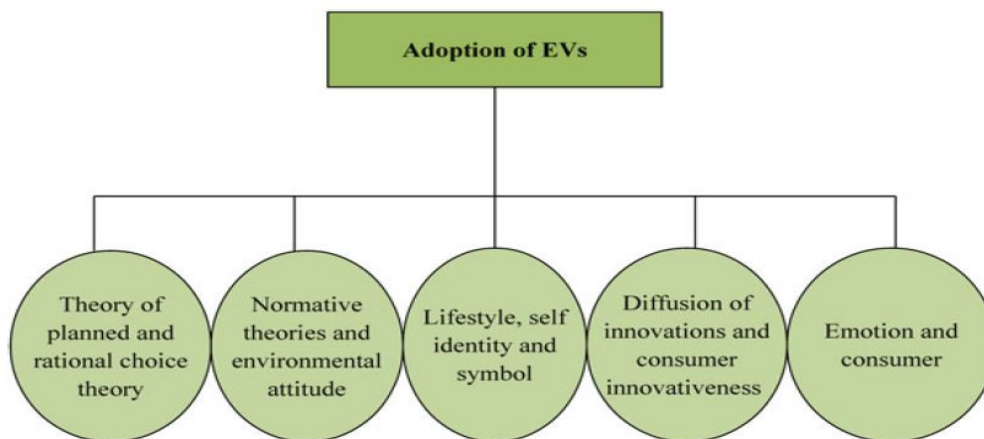


Figure 1. Categories of EVs adoption theories among customers

Source: Adnan et al., 2017.

The first is based on the Theory of planned behavior or TPB which came as an extension to the theory of reasoned action (TRA), TPB suggests that the strongest predictor of a volitional behavior is the behavior intention, as under normal circumstances people can do what they want if they have the resources and the intention to do it (Fishbein & Ajzen, 1980). Interestingly, many empirical studies showed that up to 50% of the purchases made were impulsive where emotions were the main motive behind the purchase behavior, but this wasn't true in complex buying behavior, especially when the product is expensive or associated with high financial risk (MUNTHIU, 2009).

1.1.2 Theory of Planned Behavior (TPB)

TPB came as an extension to the Theory of Reasoned Action (TRA) which suggests that the strongest predictor of a volitional behavior is the behavior intention, as under normal circumstances people can do what they want if they have the resources and the intention to do it. TPB is considered one of the most powerful and widely used theories to assess consumer behavior and its results were undoubted in multiple applications (Tanwir & Hamzah, 2020). TPB was criticized for excluding unconscious influences and emotions (Sniehotta et al., 2014) but many empirical studies found it is nearly impossible to precisely determine the emotions of consumers towards a certain behavior (Ajzen, From Intentions to Actions: A Theory of Planned Behavior, 1985).

Intention can be translated to trying to perform a certain behavior but the actual performing of a behavior is dependent on the degree of control over the various factors that might appear and prevent it from happening (Ajzen, From Intentions to Actions: A Theory of Planned Behavior, 1985). The more specific the assessment, the more accurate the behavior prediction. It is believed that there are three types of salient beliefs, the first is behavioral beliefs which influence attitude, the second is normative beliefs which influence subjective norms and the last is control beliefs which influence the perceived behavioral control (Underwood, 2005).

Attitude towards a behavior is defined as "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question" (Ajzen, The Theory of Planned Behavior, 1991, p. 281). Behavioral beliefs are what form attitude and are defined as "the person's subjective probability that performing a behavior of interest will lead to a certain outcome or provide a certain experience" (Ajzen, The theory of planned behavior: Frequently asked questions, 2020). There are two components to form attitude the first is known as Affective attitude which is the individual's overall evaluation and the second is known as Instrumental attitude and which is others' overall evaluation of the behavior whether it is beneficial or not (Rhodes & Courneya, 2010). According to the Expectancy-Value model, attitude is the sum of the total positive and negative behavioral beliefs about a behavior, each multiplied by its relevant weight to form either a positive or negative overall attitude towards the behavior (Forward, 1997). In their research of EVs adoption, Peter and Düttschke (2014) described that attitude is what holds individual's evaluation to the attributes of an EV either financial or technical attributes.

Subjective norms toward a behavior are defined as the "person's perception that most people who are important to him (or her) think he (or she) should or should not perform the behavior in question" (Kan & Fabrigar, 2017).

There are two types of underlying normative belief, the first is known as Injunctive normative belief and it is the subjective expectation that surrounding people or people who are important to the individual will approve or disapprove the behavior, the second type is known as Descriptive belief and it is the subjective expectation that if surrounding people or people who are important to the individual will perform the same behavior or not, together they form what is known as social pressure (Ajzen, The theory of planned behavior: Frequently asked questions, 2020). Like attitude, what forms the final positive or negative subjective norm is the sum of each element multiplied by its subjective relative weight (Forward, 1997).

Like attitude and subjective norm, perceived behavior control is measured by control beliefs, and it is defined as “beliefs are concerned with the presence of factors that can facilitate or impede performance of the behavior” (Ajzen, The theory of planned behavior: Frequently asked questions, 2020). Two basic elements compose the perceived behavioral control, the first is known as Self-efficacy which is the individuals’ subjective assessment of the ease of performing a behavior, the second is known as Controllability which is the individuals’ perceived control of performing a behavior (Wang et al., 2016).

Perceived behavioral control does not necessarily reflect the actual behavioral control, measuring the actual behavioral control is difficult and that is why most studies depend on measuring the perceived behavioral control rather than the actual one (Ajzen, The theory of planned behavior: Frequently asked questions, 2020). Perceived control behavioral is a sum of internal and external beliefs about the behavior, internal factors are like skills, abilities, and experience; external factors like money, opportunity, and cooperation of others (Kan & Fabrigar, 2017). Financial capacity is one of the most important elements of Controllability when assessing the perceived behavioral control of adopting a green vehicle (Adnan et al., 2017).

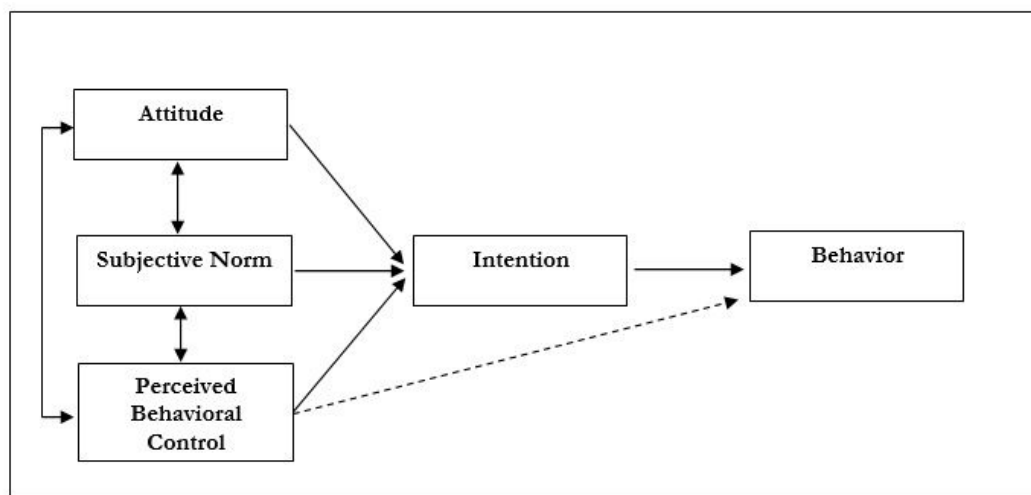


Figure 2. The basic elements of the theory of planned behavior (TPB)

Source: Ajzen, The Theory of Planned Behavior, 1991.

In the scope of EVs, TPB is widely used to study the purchase intention or the actual purchase behavior of low emission vehicles in many countries around the world and by many researchers. Some of the researchers added other independent variables to the TPB original model in their studies, for instance, Tanwir and Hamzah (2020) added environmental knowledge as an independent variable to assess the purchase intention of Hybrid electric vehicles in Malaysia. Ajzen, The theory of planned behavior: Frequently asked questions (2020) confirms that TPB is a principal, and it is open to inclusion of additional independent variables.

Table 1. List of findings of studies used the TPB to assess the purchase intention or the purchase behavior of green vehicles

Author	Country	Vehicle type	Findings			
			Attitude	Subjective norm	Perceived Behavioral control	Purchase intention
Afroz et al., 2015	Malaysia	Environmentally friendly vehicles (HEV & BEV)	Significant	Significant	Significant	Significant
Yong et al., 2017	Malaysia	Green vehicles (HEV & BEV)	Significant	Significant	Significant	-
Tanwir & Hamzah, 2020	Malaysia	Hybrid Vehicles (HEV)	Not Significant (Green Attitude)	Not Significant	Significant	-
Yan et al., 2019, p. 8	China	Electric Cars (BEV)	Significant	Significant	Significant	Significant
Hamilton & Terblanche-Smit, 2018	South Africa	Green vehicles (HEV & BEV)	Significant	Significant	Significant	-
Eneizan, 2019	Jordan	Electric vehicles (BEV)	Significant	Significant	Significant	-

While it is highly agreed upon that purchase intention and purchasing behavior aren't the same, measuring purchase intention holds usefulness to predict the actual purchasing behavior (Jamieson & Bass, 1989). Brown et al. (2003) confirm that the actual purchasing behavior is higher among people who possess the intention of purchasing compared to people who do not possess it. Vazifehdoust et al. (2013) found that purchase intention influence purchasing behavior in the scope of green products. In the scope of green vehicles, Afroz et al. (2015) and Yan et al. (2019) found that purchase intention influences the actual purchasing behavior.

1.1.3 Diffusion of Innovation (DOI)

Diffusion of innovation is one of the oldest theories developed by Rogers (1962) tried to explain how and why a new product diffuses into a market. The author explains that the process of adoption of a new product does not happen among the society simultaneously, but it happens in stages because people have different characteristics that makes them more ready to try something new, while others are not. The author divides the society into five different categories where on the extreme left people who are described as innovators, those are the people who want to try something new and ready to take the risks associated with their behavior; on the extreme right people who are described as laggards and those are very conservative in nature and more resistant to change, between these two categories comes the rest of the population. In the scope of complex buying behavior like buying a vehicle, the key limitation of the DOI that it doesn't take into consideration the individual's personal capabilities or the individual's available resources, or the social influence others may impose on individuals to either perform a certain behavior or to adopt a certain innovation (MacVaugh & Schiavone, 2012).

1.1.4 Other Theories for EVs Adoption Research

Adnan et al. (2017) specified another 3 different approaches beside TPB and DOI to study the consumer adoption behavior of EVs. The first approach is based on normative theories and environmental attitude as the authors explain that positive attitude especially the positive environmental attitude can form enough motivation to convince consumers to adopt green vehicles, although this approach was highly criticized because many empirical studies spotted an attitude-behavior gap where the consumer had a positive environmental attitude towards green vehicles but still did not buy one (Adnan et al., 2017).

The second approach is based on Lifestyle, Self-identity and Symbols as the authors explain that some consumers can find vehicles not a method to fulfill their basic need of transportation but vehicles are an extension to themselves, it can enhance their image and how they are being perceived by the society, for example, if someone considers himself an ecologist, he will be more concerned with environmental consequences of his choice and he will self-sacrifice with his choice of buying an EV to benefit the younger generations, in addition, people can adopt an EV out of their need of being unique rather than their need to transport. Although, these theories were highly criticized for ignoring important the attributes of EVs like the overall performance and cost (Adnan et al., 2017).

The third approach is based on the consumers' emotions as some researchers extended the theory of planned behavior to include emotions and described that emotions are what attracts consumers to EVs' features, design, size and style in the first place; there are two problems in this approach, the first that many empirical studies

found it nearly impossible to precisely determine the emotions of consumers towards a certain behavior (Ajzen, From Intentions to Actions: A Theory of Planned Behavior, 1985). The second, it is true that many empirical studies showed that up to 50% of the purchases were impulsive where emotions are the main motive behind the purchase behavior but this wasn't true in complex buying behavior when the product is expensive or associated with high financial or non-financial risk (MUNTHIU, 2009).

1.1.5 Environmental Knowledge Impact on the Purchase Intention of Green Vehicles

EVs adoption is primarily motivated by environmental awareness and knowledge, people who are more knowledgeable about the environmental issues are more likely to transform this knowledge into behavior and adopt a green vehicle (Madahi & Sukati, 2012). The purchase intention of green vehicles can be increased if the consumers were educated about sustainability and environmental wellbeing (Chin, et al., 2019). The higher the environmental knowledge of the consumer, the higher the probability of adopting a green vehicle (Mohiuddin et al., 2018).

1.1.6 Governmental Policies & Support Impact on the Purchase Intention of Green Vehicles

Countries with weak or no EV policies have low adoption rate (Sierzchula et al., 2014). Policy intervention can accelerate the adoption rate of EVs, and policy instruments enable governments to stimulate certain public behavior changes (Tummers, 2019). Many empirical studies found that financial subsidies have significant positive effects on EVs' adoption (Rezvani et al., 2015). Policy support is important to support the penetration of EVs because the initial price of EVs is regularly higher than ICE vehicles; for instance, in the U.S., the price of an EV is 15,000\$ more compared to its conventional counterpart in average and it is expected that both vehicles will not reach to equilibrium before 2025 (Environmental and Energy Study Institute, 2018). Coffman et al. (2017) confirm that governmental subsidies are as important as charging infrastructure to encourage EVs' adoption among the public. As a result, many developed countries around the world have schemes to support the owners of low-emission vehicles and to reduce the Total Cost of Ownership (TCO) of EVs until it becomes feasible to adopt one with no subsidies; Norway for instance uses a progressive tax system where vehicles are taxed based on their emissions and weight which makes heavy vehicles with high emission levels very expensive, this tax system doesn't ban ICE vehicles explicitly but it disincentivize it heavily; While the conventional VW Golf would cost 34,076 € after-tax, its electric counterpart would cost almost 800 € less despite the fact that the electric version initial price tag is 11,000 € higher (Norsk elbilforening, 2021). Studies expect that the battery pack cost which represents 35%–50% of electric vehicles will decrease significantly in the upcoming decade (Lutsey & Nicholas, 2019).

The Egyptian government doesn't provide EVs' owners with any kind of direct subsidies, even though, the Egyptian Customs Authority offers reduced customs to imported EVs compared to ICE vehicles (Egyptian Customs Authority, 2020) and unlike ICE vehicles, (Ministry of Trade and Industry, 2018) allows the importation of used EVs in case they are not more than 3 years old. Overall, the reduced customs on the EVs might not be of great importance because the EVs customs rate is equivalent to the ICE vehicles produced in the European Union customs' rate because of reductions imposed under the General Agreement on Tariffs and Trade (GATT) (Egyptian Customs Authority, 2020). Habib and Mahmoud (2020) argues that the TCO of EVs in Egypt is higher than ICE vehicles, the authors estimate that the TCO of a VW Golf is 538,400 EGP compared to 644,200 EGP for its electric counterpart; the operating costs of the electric version are estimated to be around 60% cheaper but that wasn't enough to cover the high initial price tag of electric vehicles. At the beginning of 2021, the Egyptian government signed two protocols with the Chinese manufacturer Dongfeng Motors Corp., the first protocol is to restructure the state-owned El Nasr Automotive factory to produce a compact sedan BEV with a capacity of 25,000 vehicles per shift and an expected list price of 300,000 EGP per vehicle, and the second protocol is to establish an R&D center for batteries, control units and propulsion controls of EVs (Ministry of Public Business Sector, 2021a, 2021b).

1.1.7 Socioeconomic and Demographics Impact on the Purchase Intention of Green Vehicles

The most common types of individual-related variables used in studies are socioeconomic and demographic characteristics; however, results of their impact on EV preference are mixed (Liao et al., 2017).

Young customers of various ages behave differently, a teenager shopper can act differently than an adult shopper. For example, young people are regularly more concerned with branded products and products' specifications than others (Madahi & Sukati, 2012). Gender can influence the consumer's preferences and needs, for instance, females are more likely to be influenced by family and friends (Madahi & Sukati, 2012). On the other side, males appreciate product attributes more, especially the technical ones as for example, males prefer high-performance vehicles (Liao et al., 2017). Consumers with high income might be more willing to pay an

extra cost to adopt a green product compared to consumers with low income who will not share the same desire; Green products are relatively more expensive and consumers with low income will prioritize other areas to expenditure rather than green products (Rahim et al., 2017). Education level is important when it comes to green products' adoption as highly educated individuals are more likely to be knowledgeable about the benefits of adopting a green product (Rahim et al., 2017). As suggested by Hoen and Koetse (2014) people with low driving mileage are less likely to suffer from the range anxiety associated with the limited range of EVs and will be less resistant to EVs adoption.

2. Theoretical Framework and Research Hypothesis

2.1 Dependent Variable

Intention is defined as to what extent the consumer is willing to perform a certain behavior (Ajzen, The Theory of Planned Behavior, 1991). Purchase intention can be defined as to what extent the consumer is willing to buy a certain product (Peña-García et al., 2020). Hence, in the context of electric vehicles adoption, Purchase intention can be defined as to what extent the consumer is willing to buy an electric vehicle.

2.2 Independent Variables

2.2.1 Attitude

Attitude can be defined as the overall consumer's evaluation of a behavior or a service or a product (Kotler & Keller, 2012). In their research of EVs adoption, Peter and Dütschke (2014) described that attitude is what holds individual's evaluation to the attributes of the EVs and used it to define attitude rather than considering attitude just as an overall evaluation of all the positive and negative behavior consequences. Similarly, Moons and Pelsmacker (2012) used attributes of EVs like cost of purchase and driving range to measure the attitude towards the purchasing behavior of EVs. Other studies extended the use of attributes to include detailed technical attributes like ease of maintenance, range, design, speed, etc. to assess attitude (Rezvani et al., 2015). Sharma and Foropon (2019) found that product attributes are strong and significant to purchase intention in the context of green products.

2.2.2 Subjective Norms

The behavior of people surrounding the individual can influence him/her their decision to either perform or not perform a behavior, social influence was found to be significant to the purchase intention of EVs in multiple studies (Liao et al., 2017). While persuasion is an intentional attempt to change a decision or a behavior. Social influence is the intentional or the unintentional efforts to change another person's beliefs, the closer the influencer to the individual, the higher the impact of his influence, therefore, family and friends are able to influence individuals to change their decision or adjust it (Gass, 2015).

With the immense popularity of social networking sites like Facebook and Instagram, electronic Word of Mouth (eWOM) was proven to be significant to purchase intention (Alhidari et al., 2015; Kunja & GVRK, 2018). eWOM is defined as "any positive or negative statement made by potential, actual, or former customers about a product or company, which is made available to a multitude of people and institution[s] via the internet" (Thorsten Hennig-Thurau, 2004). One of the most interesting key findings in social influence impact on EVs adoption is that the higher the market share of an EV in a market, the higher the probability that new customers will adopt it (Mau et al., 2008).

2.2.3 Perceived Behavioral Control (PBC)

PBC is defined as the consumer's perception of the easiness of performing a certain behavior based on their capabilities and external forces that can facilitate or prevent the behavior from happening; The first subcomponent of PBC is the control beliefs which is the estimation of how multiple factors will facilitate or impede a behavior from happening; The second subcomponent is the perceived power which is perceived strength of the factor to facilitate or impede the behavior from happening (Staats, 2003). Adnan et al. (2017) used financial capacity as a key element of PBC to be assessed in the context of EVs adoption. Financial capacity is the ability to control one's finances independently and in accordance with one's own self-interest and principles (Demakis, 2012).

Yan et al. (2019) confirm that consumers have the right to decide if they have accessibility to charging resources around their work and homes or not, as it is expected that customers who think it is easy to recharge their EVs are more likely to adopt an EV. Most of the studies don't differentiate between slow and fast charging resources, even though, the preference of the consumers was found to be different based on the distance they commute, for example, consumers who commute for a long-distances appreciated charging at the workplace capability but

overall, consumers appreciated the convenience of charging at home and reported that it is impossible to rely on an EV if there is no charging point at home and work (Liao et al., 2017).

While EVs require minimal maintenance, it still requires maintenance, especially in cases of accidents or abnormalities; EVs’ owners can be disappointed with the low number of maintenance centers around them and the shortage of skilled labor as EVs repairs can be more complicated and expensive compared to conventional vehicles (Adhikari et al., 2020).

2.2.4 Environmental Knowledge

Environmental knowledge represents the individual’s knowledge about the environment and the issues surrounding it like climate change, deforestation and sea contamination; It is measured based on the individual’s subjective knowledge which is self-assessed and might differ significantly if it was assessed objectively; In ideal conditions, customers with high environmental knowledge are more likely to understand the environmental consequences of their choices and are more likely to buy green vehicles (Tanwir & Hamzah, 2020).

2.2.5 Governmental Policies and Support

Policies are the strategic programs the government runs or plans to run in the near future to support the penetration of electric vehicles in the local markets, these policies can be but not limited to the regulations of the sold electric vehicles, standardization of electric vehicles connections, the number of intended electric vehicles at a certain date, the number of the intended charging stations at a certain date, the percentage of the electric public transportation means at a certain date, the number of the electric vehicles in the government fleet at a certain date and the support the government gives to manufacturers and R&D institutions to develop electric vehicles (Asia-Pacific Economic Cooperation, 2017).

Due to the regularly more expensive price tag of EVs compared to ICE vehicles, one-time price-reducing policies and reduced tax are of the most popular incentives tools used worldwide; while the reduced sales tax was proven to be significant to the purchase intention of EVs; Non-financial incentives like free parking and reduced toll fees were proven to be insignificant, other non-financial incentives like access to High Occupancy Lanes significance is ambiguous (Liao et al., 2017).

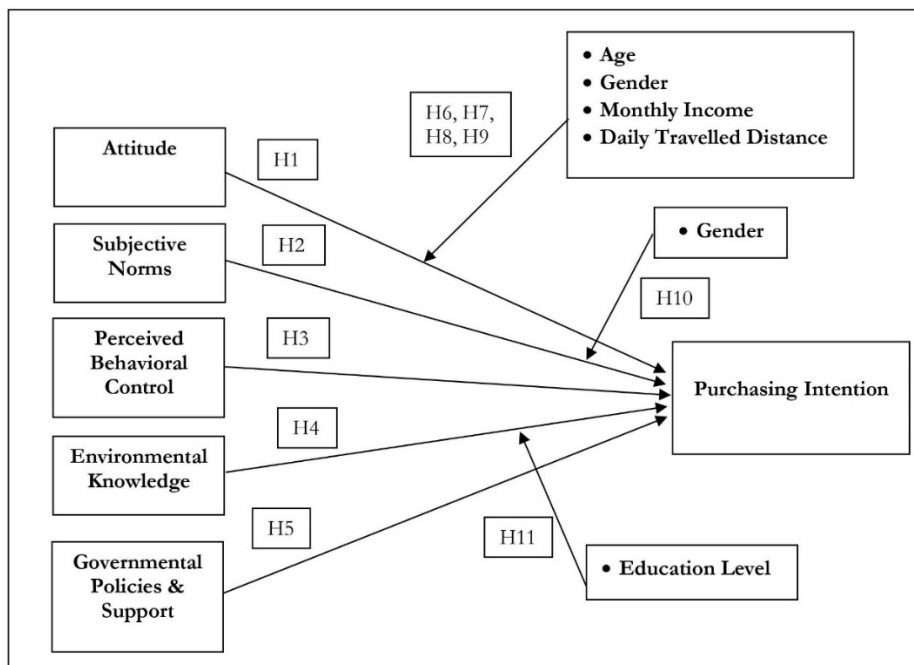


Figure 3. The proposed conceptual model

2.3 Sampling Method and Targeted Participants

The total number of passenger cars sold in Egypt in 2020 was 168,000, around 50% of these cars were licensed in

greater Cairo (AMIC, 2021), which makes the total population is roughly 85,000. By using an online sample calculator based on (Daniel, 1999) recommendation of using the equation of $n = N * X / (X + N - 1)$ where $X = Z_{\alpha/2}^2 * p * (1-p) / MOE^2$ and using a confidence level of 95% and a confidence interval of 10, the needed sample size will be 96. The researcher aims to get responses equivalent or higher than this number.

After granting the needed permissions from different showrooms around the Greater Cairo Area, the researcher ran the questionnaire at showrooms to obtain the highest number of prospective passenger vehicles’ buyers, the survey was hosted on (www.surveymonkey.com) and was available from October 2021 to January 2022. The population of the potential buyers are those who are living in greater Cairo, Egypt, aged between 18 to 65 and willing to buy a new passenger car in the upcoming 12 months.

3. Results

3.1 Descriptive Statistics

The following figures illustrate the descriptive statistics of the primary data as the following.

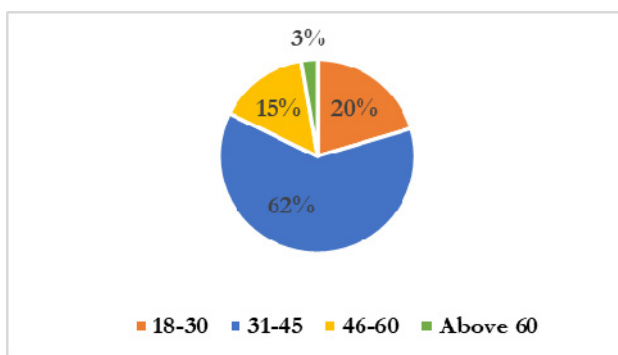


Figure 4. Respondents by age group

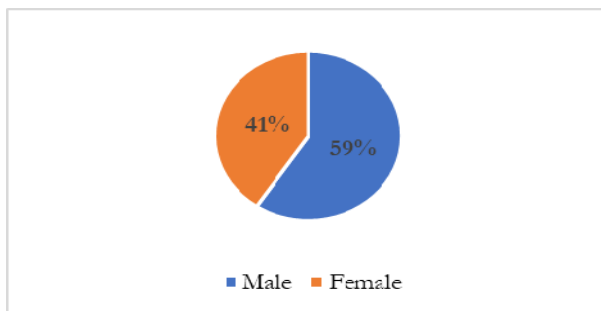


Figure 5. Respondents by gender

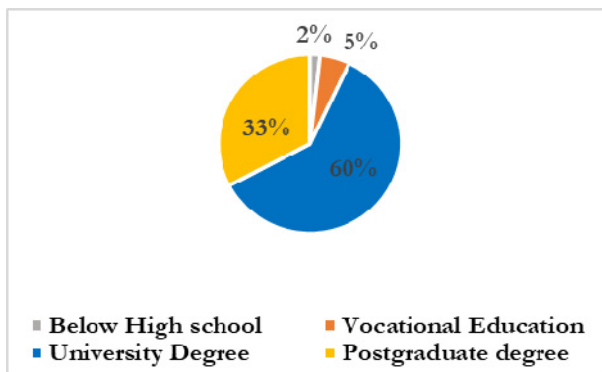


Figure 6. Respondents by educational level

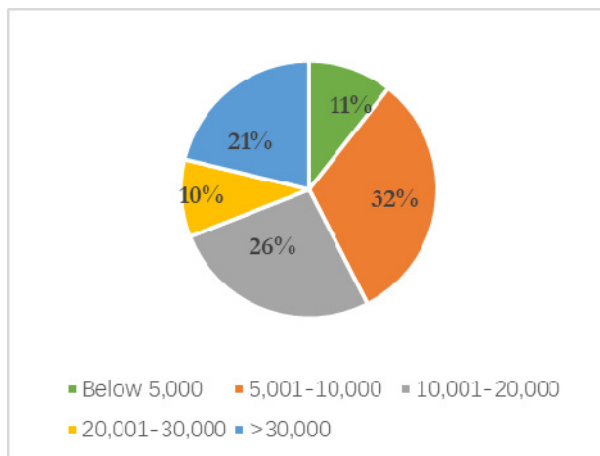


Figure 7. Respondents by the average monthly net income (EGP)

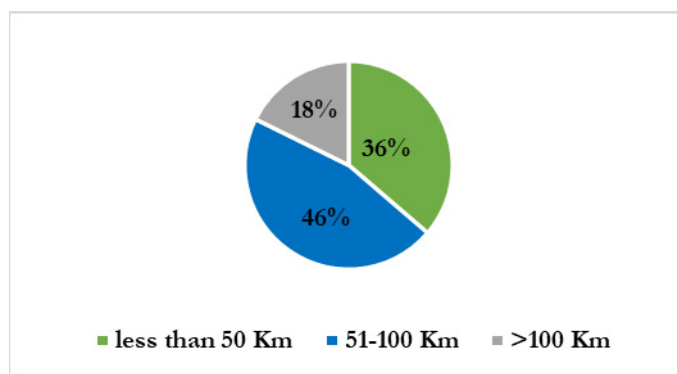


Figure 8. Respondents by the daily travelled distance

- Males represent 59.3% of the sample, while females represent 40.7%.
- 61.9% of the respondents fall in the age bracket 31–45, 20.4% fall in the age bracket 18–30, 15% fall in the age bracket 46–60, 2.7% only of the respondents are aged 60 or more and there were no respondents aged less than 18.
- 60.2% of the respondents hold a university degree, 32.7% hold a postgraduate degree, 5.3% hold a vocational degree and 1.8% do not hold a high school degree.
- 31.9% of the respondents earn from 5,001 to 10,000 EGP monthly, 26.5% earn from 10,001 to 20,000 EGP monthly, 21.2% earn more than 30,000 EGP monthly, 10.6% earn less than 5,000 EGP monthly and 9.7% earn from 20,001 to 30,000 EGP monthly.
- 46% of the respondents travel more than 50 Km but less 100 Km on daily basis, 36.3% travel less than 50 Km on daily basis and 17.7% travel more than 100 Km on daily basis.

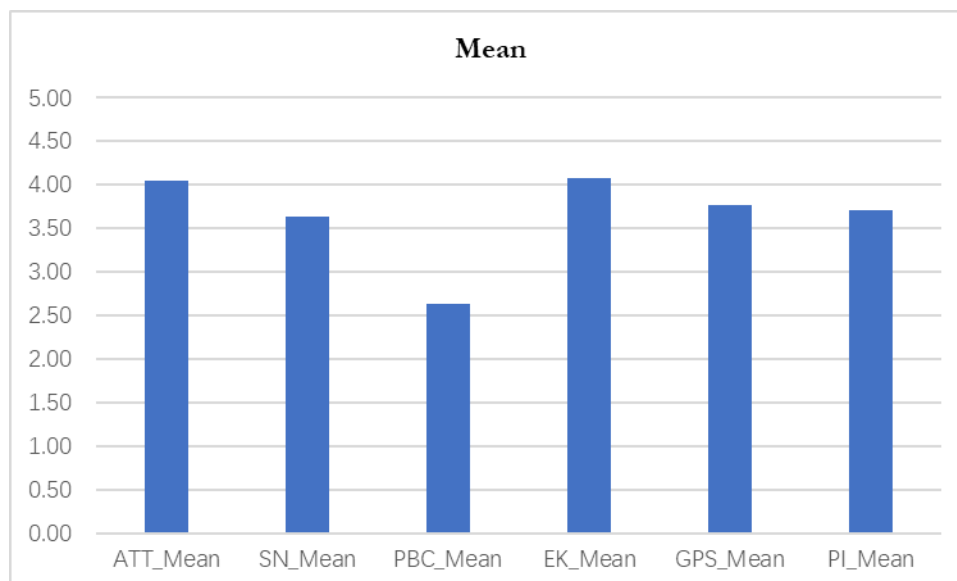


Figure 9. Column chart of the variables mean

In conclusion, the respondents evaluated the behavior of purchasing an EV positively and find its financial and technical attributes appealing to make the average score of Attitude 4.05. Moreover, they find the opinion of their family & friends and the WOM & eWOM are important and can be influential to make the average score of Subjective Norms 3.64. While the respondents were neutral about their financial ability to adopt an EV with an average score of 3.36, they evaluated the charging and maintenance accessibility negatively with average scores of 2.24 and 2.28 respectively, to make the total average score of the Perceived Behavioral Control 2.63. Respondents were knowledgeable about the EVs' positive impact on the environment with an average score of to make the average score of Environmental knowledge 4.08. Furthermore, Respondents believe that governmental policies are important with an average score of 3.51 but governmental incentives were considerably more critical with an average score of 4.01 to make the total average score of governmental policies & support 3.76. Lastly, respondents believe that they will adopt an EV in the near future to make Purchase Intention score 3.71

3.2 Inferential Statistics

3.2.1 Reliability Analysis

Cronbach's alpha measurement was used to measure the internal consistency of the survey, to make sure that the survey is consistent and free of random errors, the recommended value of Cronbach's alpha is from 0.70 to 0.95 (Tavakol & Dennick, 2011).

Table 2. Reliability analysis of the Survey constructs

Constructs	Cronbach's Alpha	Items	Deleted item	Cronbach's Alpha after deletion
Attitude	0.853	Behavior Evaluation 1, Behavior Evaluation 2, Behavior Evaluation 3, Financial Attribute 1, Financial Attribute 2, Financial Attribute 3, Technical Attribute 1, Technical Attribute 2, Technical Attribute 3, Technical Attribute 4, Technical Attribute 5, Technical Attribute 6		
Subjective Norms	0.708	Family & Friends Influence 1, Family & Friends Influence 2, Family & Friends Influence 3, WOM & eWOM 1, WOM & eWOM 2, WOM & eWOM 3		
Perceived Behavior Control	0.815	Financial Independence 1, Financial Independence 2, Financial Independence 3, Perceived charging easiness 1, Perceived charging easiness 2, Perceived charging easiness 3, Perceived maintenance easiness 1, Perceived maintenance easiness 2, Perceived maintenance easiness 3		
Environmental Knowledge	0.677	Environmental knowledge 1, Environmental knowledge 2, Environmental knowledge 3	EK1	0.876
Governmental Policy & Support	0.801	Governmental policies 1, Governmental policies 2, Governmental policies 3 Governmental incentives 1, Governmental incentives 2, Governmental incentives 3		
Purchase intention	0.894	Purchase Intention 1, Purchase Intention 2, Purchase Intention 3		

Source: SPSS Data Analysis.

As seen in Table 2, all constructs' Cronbach's alpha values are above of 0.7, except for the environmental knowledge, deletion of EK1 was a must to surpass the desired threshold value of 0.7.

3.2.2 Pearson's Correlation

Correlation coefficient is a dimensionless number that varies from -1 to +1, where -1 indicates a perfectly negative relationship and +1 indicates a perfectly positive relationship (Schober et al., 2018).

Table 3. Pearson's correlation coefficient values between Purchase Intention and other variables.

		ATT_Mean	SN_Mean	PBC_Mean	EK_Mean_2	GPS_Mean	PI_Mean
PI_Mean	Pearson	.565**	.516**	.453**	.291**	.625**	1
	Correlation						
	Sig. (2-tailed)	.000	.000	.000	.002	.000	
	N	113	113	113	113	113	113

Note. **. Correlation is significant at the 0.01 level (2-tailed).

Source: SPSS Data Analysis.

As shown in Table 3, the Pearson's coefficient values vary from 0.291 to 0.625 which means that all the variables are positively correlated to the purchase intention of EVs. Governmental Policies & Support scored the highest the correlation coefficient value with 0.625, followed by Attitude with 0.565, Subjective norms came third with 0.516, Perceived Behavioral Control came fourth with 0.453 and lastly, came the Environmental knowledge with 0.291.

3.2.3 Simple Linear Regression Test

Simple linear regression models study the relationship between one independent variable X and the dependent variable Y, represented by the equation $Y = \beta_0 + \beta_1 X$, where β_0 is known as the intercept and it is the point that intersect the Y-axis and β_1 is known as the slope and it indicates the amount of change on the Y-axis for every 1 unit of change on the X-axis (Bangdiwala, 2018).

Table 4. Summarizes the statistically significant variables to Purchase intention of EVs in Egypt.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.361	.569		-0.635	.527
	ATT_Mean	1.006	.139	.565	7.224	.000
1	(Constant)	.630	.492		1.281	.203
	SN_Mean	.847	.133	.516	6.346	.000
1	(Constant)	1.996	.330		6.051	.000
	PBC_Mean	.653	.122	.453	5.356	.000
1	(Constant)	2.144	.496		4.322	.000
	EK_Mean_2	.367	.114	.291	3.210	.002
1	(Constant)	.661	.368		1.797	.075
	GPS_Mean	.811	.096	.625	8.444	.000

Note. a. Dependent Variable: PI_Mean

Source: SPSS Data Analysis.

As shown in Table 4, all the independent variables were proven to be statistically significant since $p < 0.05$.

3.2.4 Stepwise Multiple Regression Test

Stepwise regression is popular technique that after each step a variable is added to check if it affects the overall significance or not, non-significant variables are removed (Olusegun, Dikko, & Gulumbe, 2015).

Table 5. Results of stepwise multiple regressions test

Coefficients ^a									
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	.661	.368		1.797	.075			
	GPS_Mean	.811	.096	.625	8.444	.000	.625	.625	.625
2	(Constant)	-.902	.512		-1.761	.081			
	GPS_Mean	.590	.105	.455	5.643	.000	.625	.474	.391
	ATT_Mean	.591	.143	.332	4.119	.000	.565	.366	.285
3	(Constant)	-1.021	.500		-2.041	.044			
	GPS_Mean	.549	.103	.423	5.330	.000	.625	.455	.359
	ATT_Mean	.470	.147	.264	3.205	.002	.565	.293	.216
	PBC_Mean	.292	.108	.202	2.699	.008	.453	.250	.182

a. Dependent Variable: PI_Mean

Excluded Variables ^a						
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ATT_Mean	.332 ^b	4.119	.000	.366	.737
	SN_Mean	.282 ^b	3.522	.001	.318	.774
	PBC_Mean	.276 ^b	3.713	.000	.334	.890
	EK_Mean_2	.050 ^b	.611	.542	.058	.840
2	SN_Mean	.170 ^c	1.947	.054	.183	.613
	PBC_Mean	.202 ^c	2.699	.008	.250	.806
	EK_Mean_2	-.019 ^c	-.244	.808	-.023	.801
3	SN_Mean	.124 ^d	1.416	.160	.135	.583
	EK_Mean_2	-.002 ^d	-.027	.979	-.003	.795

a. Dependent Variable: PI_Mean
b. Predictors in the Model: (Constant), GPS_Mean
c. Predictors in the Model: (Constant), GPS_Mean, ATT_Mean
d. Predictors in the Model: (Constant), GPS_Mean, ATT_Mean, PBC_Mean

Source: SPSS Data Analysis.

As shown in Table 5 the R square of the Governmental Policies & Support is 39.1% which means that behavior evaluation alone can explain 39.1% of the purchase intention of EVs in Egypt. Moreover, Attitude & Perceived Behavioral Control represent 8.1% & 3.2% respectively of the purchase intention of EVs in Egypt. Altogether, they can explain 50.6% of the purchase intention of EVs in Egypt. The p value of the third model is 0.000 which proves that the model is statistically significant since $p < 0.05$. Using the values in the coefficient sector of the third model, $PI = -1.021 + 0.549 * GPS + 0.470 * ATT + 0.292 * PBC$

3.2.5 Moderating Variables Hierarchical Linear Regression Test

Hierarchical linear regression test will be carried out to test the moderating factors impact on the relationships between variables and the dependent variable; Hierarchical linear regression can be used to test for moderators where the interaction term between two variables or between their Z-scores -to standardize data- is used as a third predictor variable to conclude if there is a moderation effect or not (Elliott & Woodward, 2019).

Table 6. Hierarchical linear regression test Results Summary.

Moderator	Relationship	Interaction p-value	Comment
Age	Attitude-Purchase intention	.285	Failed to Reject H0 ($p > 0.05$)
Gender	Attitude-Purchase intention	.972	Failed to Reject H0 ($p > 0.05$)
Monthly Income	Attitude-Purchase intention	.480	Failed to Reject H0 ($p > 0.05$)
Daily Travelled Distance	Attitude-Purchase intention	.880	Failed to Reject H0 ($p > 0.05$)
Gender	Subjective Norms-Purchase intention	.304	Failed to Reject H0 ($p > 0.05$)
Education Level	Environmental Knowledge-Purchase intention	.983	Failed to Reject H0 ($p > 0.05$)

Source: SPSS Data Analysis.

Since p-value for the intersections between different elements is >0.05 , we can conclude that the suggested moderating variables are insignificant.

4. Conclusion, Recommendations & Future Work

4.1 Conclusion

In this study, Attitude, Subjective Norms, Perceived Behavioral Control, Environmental knowledge, and Governmental policies & support were proven to be significant variables to the purchase intention of EVs in Egypt. In particular, Governmental policies & support was proven to be the most significant independent variable followed by Attitude and Perceived Behavioral Control but to a lesser extent. The suggested moderating variables like Age, Gender, Monthly income, Daily-travelled-distance were proven to be insignificant.

4.2 Recommendations

Melton et al. (2020) suggest a multicriteria evaluation framework to assess the efficiency of the governmental policies taking into consideration five major factors, the first is the policy effectiveness in increasing the number of plug-in vehicles in the long term; the second is the optimization of the governmental spending rate; the third is the optimization of the public support; the fourth is the policy simplicity and the last is the transformational signal which is defined as the commitment towards electrifying the transportation methods; the authors included different policies approaches, for instance, building codes that impose creating recharging spots in the newly built building, carbon pricing that increases the price of fuel based on the carbon emissions and Zero Emission Vehicles (ZEV) mandate that require manufacturers to make a certain percentage of their sales electric. Therefore, and as proven by this study, the Egyptian government should develop its own policy framework that takes into consideration these major five factors in its EVs' framework to increase its penetration rate in the local market.

Tiwari et al. (2020) found that battery, in terms of range confidence, Environmental performance, technology in terms of reliability, and resale value to be major enablers to influence the adoption of EVs in the UK, which aligns with the findings of Larson et al. (2014), Wang et al. (2017) and Egbue and Long (2012); The authors agree with Egbue and Long (2012) that incentives will have little or no effect on the EVs adoption rate if the consumer is not confident with the current EVs technologies; Therefore, the authors suggest that educating the consumers about EVs and increase their exposure to EVs can increase the adoption rate of EVs. Teaching people about the latest breakthroughs in the field of EVs on social media, in showrooms, and in auto shows will be reflected positively on the consumers' Attitude and EVs' adoption rate in the Egyptian market.

Improving charging infrastructure has more impact on the EVs sales in emerging markets than in developed markets but increasing the number of charging stations doesn't necessarily improve the sales of EVs if it is not coordinated with other policies as for example, increasing the number of home charging spots can enhance the sales of EVs more than the fast-charging stations (Oua et al., 2020). Choosing the optimal place for a charging solution is not an easy task as it requires applying different optimization algorithms and approaches to deal with the complexity of the problem and it cannot be separated from the governmental policies as it is highly dependent on the transition scenario (Deb et al., 2017). Moreover, Wang et al. (2019) suggest using mobile charging stations to improve the optimization. Running different optimization algorithms to optimize the locations of the charging solutions including fast-charging stations, public charging stations, home charging stations, and mobile charging stations will be reflected positively on the Perceived behavioral control and EVs adoption rate.

4.3 Future Work

- An independent research should be made to design policies framework suitable for Egypt with a simulation to see how it will affect EVs adoption hypothetically.
- Studying participants from other geographical areas would be interesting to see if the results align with participants from the Greater Cairo Area or not.
- This study focused on the quantitative analysis only, performing a qualitative analysis might give new inputs.

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