Understanding Electric Vehicle Adoption In Bolivia: An Examination Of Consumer Attitudes And Influential Factors

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Abstract

The increasing adoption of environmentally-friendly technology, such as electric vehicles (EVs), is a topic of global interest. However, in less developed regions like Bolivia, it remains a challenge. The successful adoption of EVs in Bolivia depends on understanding the factors influencing consumer adoption intentions. This research aims to identify these factors by examining the impact of EVs' functional, non-functional and attitudinal factors on consumer adoption intentions in Bolivia. The study found that adoption intentions depend on factors such as gender, perceived utility, ease of use, perception of the environment, social influence, perceived behavioral control, emotional value, monetary value, and attitudes. The findings of this study provide valuable insights for marketing strategies and open the door for further research on the acceptance of EVs in developing countries like Bolivia. Additionally, different business strategies are discussed to ease electric vehicle adoption in Bolivia. The research highlights that understanding the factors that drive electric vehicle adoption in developing countries is essential for successfully implementing electric vehicles in Bolivia.

Keywords

Electric vehicle, technology diffusion, consumer attitudes, environmentally-friendly technology.

1 Introduction

According to Mali et al. (2022), the global concern about the depletion of petroleum resources and its unreliable supply has led to a continuous search for alternative transportation technologies that are not dependent on fossil fuels. One promising option in the automotive market is electric vehicles (EVs). However, EV adoption in less developed countries is slower than in developed countries, where safety regulations, infrastructure, and EV design constantly improve.

In less developed countries, various technological, infrastructural, financial, behavioral, and external barriers hinder the widespread adoption of EVs. In Bolivia, EVs are still in their initial stages, and policies to improve EV technology and infrastructure requirements are being implemented. Nevertheless, the knowledge and acceptance of alternative fuels are also critical factors that influence the adoption of new technologies (Jaiswal et al. 2021), (Mali et al. 2022).

Given the lack of specific studies on EV adoption in Bolivia, this research study aims to investigate the influence of perceived usefulness, perceived ease of use, environmental perception, social influence, perceived behavioral control, emotional value, monetary value, attitude, and gender on the intention to adopt them. The study provides valuable theoretical and practical contributions to the EV market development in Bolivia and identifies direct relationships that influence the intention to adopt it.

This research study can also serve as a reference for policymakers and industry players to understand the factors that affect the adoption of EVs in developing countries and to design appropriate strategies to overcome the barriers hindering the adoption of EVs. Ultimately, this study can contribute to promoting sustainable transportation and reducing dependence on fossil fuels, thereby improving the environmental and socio-economic well-being of the country.

1.1 Objective

The main objective of this research study is to investigate the influence of functional and non-functional factors related to EV adoption intentions in Bolivia.

2 Literature review

Li et al. (2017) indicate that the factors influencing consumers' intentions to adopt EVs can be classified into three categories: demographic, situational, and psychological. The demographic category includes individual factors such as gender, age, education level, income, and occupation. Situational characteristics include performance aspects such as the driving range, battery charging time, energy consumption, greenhouse gas reduction, and government policies and incentives. Finally, psychological characteristics include overall experience, attitudes, and emotions.

Attitudes are always considered critical psychological factors influencing adoption intentions. In general, attitudes are defined as individual mental experiences reflecting ingrained likes or dislikes (Li et al. 2017). At the same time, emotions are consumers' expectations to enjoy the overall environment and be relaxed while driving. Emotions are also found in consumers' perceptions of low cost, environmental protection, and fuel economy (Li et al. 2017).

Yeğin & Ikram (2022) investigate the behavioral reasons why consumers do not intend to buy EVs. This research explores the behavioral factors that facilitate EV adoption in Turkey, a developing country with fewer EVs in circulation, after incentives were offered for the use them. Moreover, research conducted by Jaiswal et al. (2021) used the extended technology acceptance model (TAM) and included perceived risk and financial incentive policy variables, to understand and capture the phenomenon of electric vehicle adoption intention in less developed countries. This research found direct relationships between perceived usefulness, which also significantly affected consumers' intentions to adopt EVs.

Similarly, a study by Wang et al. (2018) claims that the technical performance of EVs is the most critical factor in their acceptance. The results showed that young consumers aware of environmental problems are likelier to adopt EVs. This study also suggest the importance of the economic benefit of adopting an EV. It indicates that the relative advantage of electric vehicle usage depends on each country's fuel and electricity prices, which motivate consumers to adopt them. Finally, it is concluded that the main factors affecting consumers' acceptance of EVs in relation to economic benefits are the purchase price, utility cost, and maintenance cost.

Furthermore, in a study conducted by Bahamonde-Birke & Hanappi (2016), it is claimed that individual sociodemographic characteristics such as gender influence the environmental concern, supporting the idea that young men are less concerned about the environment than their female and older counterparts. Additionally, applying the technology acceptance model proposed by Davis (1989), a positive relationship is suggested between the perceived usefulness of an electric car and adoption intention. Where perceived usefulness is defined as adopting a technology or system that can be useful and facilitate its performance. In the specific case of EVs, key attributes such as the utility to reduce CO2 emissions, improve air quality, and reduce transportation costs are considered within perceived usefulness (Jaiswal et al. 2021). Therefore, the following hypothesis is proposed:

H1: *Perceived usefulness positively influences EV adoption intentions.*

The perceived ease of use refers to the degree to which a person believes using a particular system would be effortless (Karahanna and Straub 1999). Jaiswal et al. (2021) define the ease of use as how easy a person thinks it is to use a particular technology, free from physical and psychological efforts. The perception of ease of use positively affects consumers' attitudes toward the technology and drives their adoption intentions. The previous evidence suggests that consumers are more likely to adopt new technologies or related products in their purchasing choices when they perceive them as simple and convenient to use. Based on the above, the following hypothesis is proposed:

H2: *Perceived ease of use positively influences EV adoption intentions.*

He et al. (2018) define environmental perception as the consumer's perception of the positive outcomes of driving an EV for the environment. With ecological degradation, consumers now pay more attention to the environmental attributes of products and consider how their behavior affects the environment. Therefore, the perception of the environment regarding sustainable innovations is an essential factor in promoting the adoption of EVs (Chen et al. 2021). Based on the above, the following hypothesis is proposed:

H3: *Positive environmental perception positively influences EV adoption intentions*.

Attitude is defined as a function of beliefs about outcomes and the evaluation of those outcomes. Studies by Han et al. (2017) and Schuitema et al. (2013) have shown that in contrast to conventional utility theory, attitudes and personality are essential factors in determining adoption motivation. Specifically, in this case, the intention to adopt is linked to consumers' innovativeness, defined as their tendency to buy new products shortly after they appear on the market. In conclusion, a positive attitude towards the environment and the car's characteristics have been found to increase the likelihood of choosing an EV compared to a conventional one (Bolduc et al., 2008). Based on the above, the following hypothesis is proposed:

H4: *EV positive attitudes positively influence adoption intentions*.

Emotional value is derived from the ability of products to evoke feelings or affective states in consumers (Sheth et al. 1991), emphasizing the experience of pleasure and joy derived from new technologies. In the case of EVs, consumers' intention to adopt them is influenced by the desire to obtain some functional values and specific non-functional values (Han et al. 2017). These non-functional values represent the emotional experience derived from the consumption of products and a sense of self or social identity reflected in the product's possession. Based on the above, the following hypothesis is proposed:

H5: *Emotional value positively influences EV adoption intentions.*

According to Khurana et al. (2020), the high cost of EVs is a deterrent factor in adoption compared to a similar conventional vehicle. However, with the total cost of ownership over the vehicle's lifetime being a key factor, it is argued that low energy consumption and energy tariffs result in lower operating costs. Therefore, the total cost of ownership is lower and offsets the acquisition cost. Most consumers would select an EV only if the price is competitive with existing fuels, where environmental aspects always outweigh the price (Sang and Bekhet 2015). In summary, EV adoption is related to incentives, benefits, or economic convenience. Based on the above, the following hypothesis is proposed.

H6: *Perceived monetary value positively influences EV adoption intentions*.

According to behavioral change theories, such as the Theory of Planned Behavior proposed by Ajzen (1985), behavior control refers to an individual's perception of their ability to perform a particular behavior. In the case of EV adoption, this could include their confidence in their ability to charge their vehicle, familiarity with charging infrastructure, and ability to plan their routes effectively (Roehrich 2004). Results show that consumers are more willing to purchase electric vehicles when they express the capacity and confidence to buy them. This approach is often limited in explaining heterogeneous behaviors and is not associated with rational choice (Mohamed et al. 2018). Based on the above, the following hypothesis is proposed:

H7: *Perceived behavior control positively influences EV adoption intentions*.

According to Liao et al. (2017), an individual's decisions are expected to be influenced by the behavior of people in their environment. For example, individuals can be affected by the attitudes and opinions of their family, friends, or colleagues who pressure them to adopt EVs. Social externalities (such as peer pressure, social influences, social norms, and perceived acceptability of adopting EVs) within a community or social group can influence EV purchasing decisions (Sang and Bekhet 2015). In the context of electric vehicles, driving an EV is expected to express maturity, intelligence, a sense of pride, responsibility for the well-being of society, or a desire to use products that demonstrate one's way of being (Han et al. 2017), (Wang et al. 2018). In conclusion, symbolic attributes are related to a sense of social or self-identity reflected or constructed from possessing new technologies (Roehrich 2004). Based on the above, the following hypothesis is proposed:

H8: *Social influence positively influences EV adoption intentions*.

According to Ramprabha (2017), women think differently than men because of biological, neurological, and behavioral variations in their brains. Age, gender, education, income, and family size are correlated with purchase behavior (Sang and Bekhet 2015). Similarly, Sovacool et al. (2018) indicate that women prefer the benefits of an EV, its environmental impact, its economic benefit to fuel, and ease of operation. Another factor influencing gender differences in EV adoption is their perceived performance. For example, the study conducted by Sovacool et al. (2018) found that the limited performance and driving range of an EV was less of a concern for women than for men. In

conclusion, we propose the existence of a significant influence of gender on the intention to adopt an EV, and we expect the intention to be higher for women than for men.

Based on the information presented, we propose our final hypothesis:

H9: *Gender significantly influences EV adoption intentions.*

3 Methodology

We developed an EV consumer survey to explore the hypotheses proposed in the conceptual framework (see Figure 1). The survey was designed to explore the research hypotheses and was divided into six main sections. The first section aimed to gather demographic information about the surveyed participants. The second section evaluated specific questions based on the population's perception and importance of current environmental issues based on the studies of Bahamonde-Birke & Hanappi (2016), Lashari et al. (2021), He et al. (2018), and Schuitema et al. (2013). The following section evaluated participants' perceptions of the usefulness, ease of use, and risks associated with electric vehicles using questions posed in studies by Jaiswal et al. (2021) and Lai (2017). Next, we evaluated the participants' personalities regarding aspects such as social interaction, emotional values, and their innovative personalities and adaptability to new technologies based on the studies of Han et al. (2017), Lashari et al. (2021), and Müller (2019). For the next section, we evaluated the participants' attitudes towards the EVs characteristics, monetary benefits, and behavioral control based on Han et al. (2017), Huang & Ge (2019), Schuitema et al. (2013), and He et al. (2018). The last section evaluated the participants' intention to adopt electric vehicles using questions posed in the study by Ferguson et al. (2018).

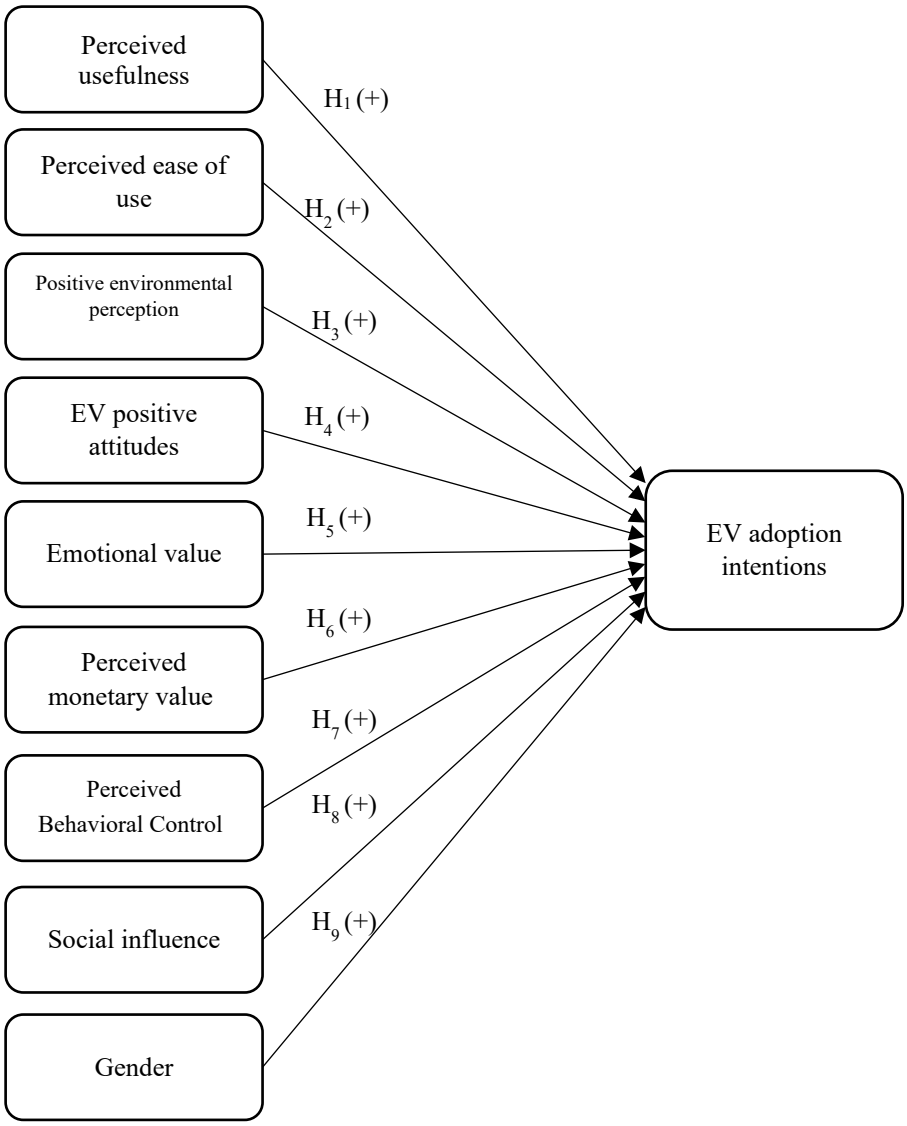

Figure 1. Conceptual framework

4 Data collection

Data collection for this study took place in Bolivia from April to May of 2022, and 222 valid surveys were collected. The sample had the following demographic characteristics: (a) 51% of the sample were women; (b) 36.90% of the respondents were under 30 years old, 39.70% were between 31 and 39 years old, 16.60% were between 40 and 49 years old, and 6.80% were 50 years old or older; (c) 65.80% of the respondents were single, 31.10% were married, and 3.10% were widowed or divorced; (d) 36.90% of the respondents had households of four members or less, 30.60% had households of 5 people, and 32.50% had households of more than five people; (e) 32.90% of the respondents were employed full-time, 10.80% were employed part-time, 5.40% were public sector workers, 28.40% were self-employed, 4.10% were homemakers, and 18.40% were full-time students; (f) 31.00% of the respondents had achieved a maximum educational level of high school, 61.00% had a bachelor's degree, 7.00% had a master's degree, and 1.00% had a doctorate; and (g) 88.00% of the respondents had at least one family car, while only 12.00% did not have a family car.

5 Results and discussion

This section will present the main results to support or reject the hypotheses previously stated.

5.1 Numerical results

We conducted a multiple linear regression analysis testing the proposed hypotheses. Table 1 below describes the results obtained for β and the *p*-value for the model.

Table 1. Estimates for the coefficients of the regression model

Model relations	β	*p*	Hypotheses
Perceived usefulness → Adoption intentions	0.23**	0.00	H_1
Perceived ease of use → Adoption intentions	0.01	0.73	H_2
Positive environmental perception → Adoption intentions	-0.08**	0.00	H_3
EV positive attitude → Adoption intentions	0.26**	0.00	H_4
Emotional value → Adoption intentions	0.27**	0.00	H_5
Perceived monetary value → Adoption intentions	0.05	0.17	H_6
Perceived Behavioral Control → Adoption intentions	0.22***	0.00	H_7
Social influence → Adoption intentions	0.11*	0.02	H_8
Gender → Adoption intentions	0.06	0.07	H_9

Note: $^{\dagger}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 2 displays the values of β and *p* for the linear regression model after removing the independent variables that did not reach the required confidence level.

Table 2. Estimates for the coefficients of the regression model

Model relations	β	*p*	Hypotheses
Perceived usefulness → Adoption intentions	0.24**	0.00	H_1
Positive environmental perception → Adoption intentions	$-0.07^{\dagger}$	0.09	H_3
EV positive attitude → Adoption intentions	0.25**	0.00	H_4
Emotional value → Adoption intentions	0.27**	0.00	H_5
Perceived Behavioral Control → Adoption intentions	0.22**	0.00	H_7
Social influence → Adoption intentions	0.13**	0.00	H_8
Gender → Adoption intentions	$0.06^{\dagger}$	0.06	H_9

Note: $^{\dagger}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

The final model obtained has an adjusted R2 value of 0.77, which indicates the percentage of variance that the independent variables can explain, while the beta β values indicate the strength of the relationship between the independent and dependent variables. The model was obtained through an analysis conducted in the SPSS software.

5.2 Hypotheses tests

After verifying the model's predictive validity, hypotheses were evaluated to determine the impact of independent variables. The hypotheses were analyzed using the β coefficient and the *p*-value shown in Table 1. The results indicated that the perceived usefulness (H1: $\beta = 0.24$, $p < 0.01$) positively impacted the intention to adopt EVs. This result means that functionality, a utilitarian value, is vital when adopting this technology. This finding is consistent with a study by Jaiswal et al. (2021), which identified usefulness as a critical characteristic influencing the intention to adopt EVs. Hypothesis 2 was found to have no statistically significant value (H2: $\beta = 0.01$, $p > 0.1$), indicating that the perception of easy use of electric cars does not significantly impact the intention to adopt them. We hypothesize that these results are due to the low experience of Bolivian consumers with EVs. For hypothesis 3, we found it to be marginally statistically significant (H3: $\beta = -0.07$, $p < 0.1$), suggesting that the impact of the perception of the environment on adoption intentions was not as strong as we initially predicted. This result will be further analyzed through quadratic terms. Nevertheless, the results for this hypothesis align with the study by Ng et al. (2018), which indicates that while the perception of environmental benefits is essential, the lack of economic benefits related to using electric cars can have a more significant impact. For hypothesis 6, we did not find statistically significant results (H6: $\beta = 0.05$, $p > 0.1$), suggesting that monetary value, or perception of economic benefits, is not essential in the intention to adopt EVs. This situation is relevant in countries such as Bolivia, which has enjoyed fuel subsidies since 2004. Therefore, the perception of the economic benefits of adopting EVs is less relevant in countries with subsidized fossil fuels.

Hypotheses 4 and 5 also presented statistically significant relevance (H4: $\beta = 0.25$, $p < 0.01$; H5: $\beta = 0.27$, $p < 0.01$), with both independent variables having a significant positive impact on EV adoption intentions. This result suggests that the attitude toward EVs and the emotional value respondents attach to them are essential to their adoption intentions. In the case of hypotheses 7 and 8, we found them to be statistically significant (H7: $\beta = 0.22$, $p < 0.01$; H8; $\beta = 0.13$, $p < 0.01$), suggesting that considering the opportunity and the economic capacity to own an EV, and believing that the social circle surrounding the respondent supports the use of the technology, will have a considerable impact on adoption intentions. Both results are consistent with the studies by Huang & Ge (2019) and Mohamed et al. (2018), which indicate that EVs will have higher adoption intentions among people who perceive them as a social symbol. Finally, hypothesis 9 (H9: $\beta = 0.06$, $p < 0.1$) suggests that women are more likely to have the intention to adopt an electric car. This result is consistent with the studies conducted by Sang & Bekhet (2015) and Wang et al. (2018), confirming that women have a higher intention to adopt EVs.

5.3 Quadratic terms

Following Shalabh (2011), we used polynomial models to study whether the relationship between the dependent and independent variables is nonlinear. We evaluated quadratic terms to improve the proposed model to verify a nonlinear relationship between the study variables. This analysis allowed us to identify a positive nonlinear relationship for perceived usefulness. Specifically, this result suggests that EVs when a consumer does not perceive the usefulness of an EV, such as low vehicle range, their intentions to adopt it reduce nonlinearly up to a point. On the other hand, clear consumer benefits, such as an extensive number of functionality features compared to a fuel-powered vehicle, increases EV adoption intentions.

We also found significant negative nonlinear relationships between emotional value, social influence, and perception of the environment with EV adoption intentions. This result suggests that these variables are interrelated and can reinforce each other. For example, a positive environmental attitude can lead to a greater emotional connection to EVs, which can influence social norms and create a virtuous adoption cycle. However, this virtuous adoption cycle is limited by the long-term costs of owning an EV, availability of charging infrastructure, limited driving range compared to traditional fossil fuel-powered vehicles, market availability, and familiarity. Hence, nonlinearly negatively influencing EV adoption intentions.

6 Conclusion

The study in Bolivia revealed a multiple linear regression model that explains the influence of specific functional and non-functional variables of electric cars on the intention to adopt this technology. The variables with the most significant impact on adoption intention were emotional value, social influence, perceived usefulness of the car, perceived behavioral control, attitude, gender, and positive environmental perception, supporting seven of the nine hypotheses proposed at the beginning of the study. However, we did not find statistically significant evidence to support hypotheses 2 and 6. Specifically, it was determined that a positive perception of usefulness, social acceptance, and pleasure in driving an electric car are reasons that would increase the intention to adopt the technology, which is in line with studies conducted by Jaiswal et al. (2021) and Schuitema et al. (2013). Similarly, we found that women in Bolivia would have a higher intention to adopt this technology, a finding that is consistent with other research, such as the one conducted by Sovacool et al. (2018). Another critical study result relates to the non-significant impact of the perception of an economic benefit in using an electric car. In the particular case of Bolivia, the savings represented by switching from a petroleum-dependent mode of transportation to an EV are less critical than in other countries where fuel prices are not subsidized. Similarly, it is important to note that a study by Ng et al. (2018) identifies the importance of the perception of an economic benefit in encouraging the adoption of an electric car.

The study also found the significant importance of emotional value in the intention to adopt, consistent with the findings of a study conducted by Moons & de Pelsmacker (2012), which indicates that reflective emotions toward driving play an essential role in the formation of the intention to use. Marketing proposals provided by companies should highlight the specific attributes that electric cars have compared to conventional ones. This study identified that social influence and emotional value play an important role in incentivizing adoption, emphasizing the characteristics of self-image, social identity, and the feelings that will be achieved when using this type of car. This statement is consistent with the study conducted by Noppers et al. (2015), which states that sustainable innovations' symbolic and social influence attributes reflect the perceived outcomes of ownership and use of sustainable innovation

for self-image and social status. For example, owning an EV can indicate who or what a person is and its place in the social hierarchy. Moreover, we also found significant nonlinear relationships between perceived usefulness, emotional value, social influence, and perception of the environment with EV adoption intentions. Some limitations of the study are related to the surveyed sample. The study only covered the urban areas in Bolivia. Future research should expand sampling rural areas and other countries. Finally, as James Campbell said, *"transportation is transforming, and we need to get ready."* Electric cars are the future of the automotive market, and it is vital for companies that want to establish themselves in this market to understand the factors that drive their adoption.

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