The Journal of Technology Transfer
https://doi.org/

Analysis of factors influencing attitude and intention to use electric vehicles for a sustainable future

María García de Blanes Sebastián[1] · José Ramón Sarmiento Guede[1] · Alberto Azuara Grande[1] · David Juárez-Varón[2]

Abstract
Spain is one of the countries that lead the contribution to the growing levels of consumption and environmental impacts. Specifically, it is the fifth most polluting country in the European Union. Given this situation, urban mobility represents one of the main challenges for sustainable development and the electric vehicle one of the most beneficial means of transport. The objective of this research article is to identify the core factors that influence the users of electric vehicles. For instance, a theoretical model based on the Meta-UTAUT Theory has been proposed, which uses the following variables: performance expectancy, effort expectancy, social influence, facilitating conditions, perceived risk, environmental concerns and how these variables influence the use behaviour and attitude towards electric vehicles. Data collection was carried out through a self-administered survey in which 326 responses were obtained. Data have been analysed using Structural Equation Modelling (SEM). The results show that the factors performance expectancy, social influence, and environmental concerns have a significant impact on the adoption of electric vehicles. However, it has been detected that the factors effort expectancy, facilitating conditions, and perceived risk are not significant. These results expand the available theoretical knowledge of the Meta-UTAUT and, from a practical perspective, provide public institutions and automotive companies with relevant information to improve their performance. Finally, this paper facilitates possible new technological developments in the field of transport planning and the use of electric vehicles.

Keywords Meta-UTAUT · Electric vehicles · Use Behavior · Environmental concern · Technology

1 Introduction

Spain is one of the countries that contributes the most to the increasing levels of CO2 emissions generated by consumption with known environmental impact (Higueras-Castillo et al., 2021); specifically, it is ranking as the fifth most polluting country in the European Union (European Enviroment Agency, 2023). This fact rising from the effect of highly den-

Extended author information available on the last page of the article sity urban areas and mobility challenges, presents an area for improvement associated with the implantation of electric vehicles (EVs) as the most idoneous technology-based solution to an everlasting problem, connected to sustainable development (Buranelli de Oliveira et al., 2022; Saura et al., 2023a). Furthermore, EVs are technological devices which could be related to the latest advances in mobility and digital networks, such as Cyber-Physical Systems (for example, unmanned vehicles) or the Internet of Things (IoT) (Bagade et al., 2017; Sedigh & Hurson, 2012; Wanasinghe et al., 2022).

Recently, several studies have identified the main advantages and disadvantages in new technologies adoption (Cunningham et al., 2023; Mahdiraji et al., 2023; Saura, Palacios-Marqués et al., 2023b), also for EVs as a visible improvement for city planning (Di Foggia, 2021; Gunawan et al., 2022; Jain et al., 2022; Manutworakit & Choocharukul, 2022). There are many barriers confronting users and the adoption of a new technology in transportation; mainly, purchase price, as compared to the cost of combustion vehicles (Biresselioglu et al., 2018), limited battery range, autonomy and mileage efficiency (Buranelli de Oliveira et al., 2022), and the limitation of charging points at the level of infrastructure and related technology (Di Foggia, 2021). Among the advantages, we highlight the environmental, economic, and fiscal benefits (Sovacool et al., 2019).

According to 'IV Observatory of Sustainable Mobility in Spain' report (Grant Thornton, 2023), Spain currently has 180,000 electric vehicles circulating on its roads. The study highlights the importance of advancing towards sustainable mobility in relation to the environment, technology, and new population habits. It needs to be considered that the target set in the Integrated National Energy and Climate Plan (PNIEC) aims at reaching five million electric vehicles by 2030, which represents approximately 16% of the total vehicle fleet.

Taking into consideration the increasing number of studies focused on EVs in recent years, few research studies have centered the analysis on the intention to use electric vehicles; particularly, the central focus for the study falls in Spain and applies Meta-UTAUT model. This approach provides added depth and interest in the angle of technology adoption, first, by introducing variables such as attitude (Balakrishnan et al., 2022), perceived risk (Gunawan et al., 2022), and environmental awareness (Bhat et al., 2022). Another innovation, original to this approach, relies in including users of all types of electric vehicles for a wider scope into the EV phenomenon. Additionally, it needs to be noted that electric vehicles should be understood as vehicles powered by one or more electric motors, and therefore, a private fleet of electric vehicles includes cars, motorcycles, scooters, and bicycles (Faiz, A., Weaver, C. S., Walsh, 1996). In the present study, the following research questions and objectives are identified to provide a background for the analysis and discussion:

Q1: What are the factors of the Meta-UTAUT model that affect attitude and intention to use EVs?

Q2: Could factors such as perceived risk and environmental concerns, improve the predictive model of the Meta-UTAUT in attitude and intention to use EVs?

O1: To identify the degree of influence that the factors from Meta-UTAUT model (performance expectancy, effort expectancy, social influence, and facilitating conditions) have on the attitude and intention to use EVs.

O2: To determine which factor has the greatest influence on the attitude and intention to use EVs.

O3: To analyze whether the factors of perceived risk and environmental awareness improve the predictive model of the Meta-UTAUT in the usage of EVs.

O4: To evaluate the relationship between the factors perceived risk and environmental awareness in the attitude and intention to use EVs.

This study is structured into five sections, after this introduction, to address the preliminary research questions and objectives (Saura, Palacios-Marqués, et al., 2023c). The first part, Sect. 2, provides a critical review of the scholarly articles referenced on Meta-UTAUT model and EVs; this introduction into the theoretical framework explores the relationship among factors and variables integrated as part of the model. Next, Sects. 3 and 4, describe the methodology and present the results, respectively. In Sect. 5, we look into the insights from the variables affecting intention to use EVs. Finally, Sect. 6, limits the scope of the analysis and supports a series of academic and practical recommendations, along with future research lines.

2 Framework for the analysis

2.1 A theory framework: scientific research on models UTAUT2/Meta-UTAUT in relation to EVs

The study of technology acceptance and usage through the prediction of certain factors has a long history of scholarly inquiry. One of the theories employed in this field is the UTAUT model (Venkatesh et al., 2003), which, from an integrative and multidisciplinary perspective, incorporates up to eight theories to align within constructs: Innovation Diffusion Theory (IDT) (Rogers, 1962), Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980), Theory of Planned Behavior (TPB) (Ajzen, 1991), Social Cognitive Theory (SCT) (Bandura, 1986), Technology Acceptance Model (TAM) (Davis, 1989), Model of Personal Computer Utilization (MPCU) (Thompson et al., 1991), Motivational Model (MM) (Davis et al., 1992)d TAM; Combined TAM-TPB (Taylor & Todd, 1995). Previous known constructs from UTAUT are Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions. Usage behavior depends on usage intention, which in turn is influenced by the four mentioned variables (Venkatesh et al., 2003).

Based on this line up, applicable and currently being used by researchers up to present (Amofah & Chai, 2022), there are three new variables to consider as part of the model (Venkatesh et al., 2012), expanding the framework into the UTAUT2 model; these variables are Hedonic Motivation, Price/Value, and Habit, which improved the model's predictions(García de Blanes Sebastián et al., 2022, 2023; Venkatesh et al., 2016). At present, the UTAUT2 model is widely recognized in scholarly literature with numerous studies attempting to predict technology acceptance and usage in various fields related to the tourism and leisure industry, while also contributing new factors. Some of the mentioned fields include tourism applications (Kamboj & Joshi, 2021; Palos-Sanchez et al., 2021), travel reviews (Assaker et al., 2020), restaurants (Palau-Saumell et al., 2019), and entertainment (Aranyossy, 2022).

As an update to the UTAUT model, following a key study (Venkatesh et al., 2016) that identified a limited use of the entire model in a significant portion of the previous literature, as well as, neglect of moderators, reviewing of the model using meta-analysis and structural equation techniques (Dwivedi et al., 2019), and it included attitude as a mediating factor. The revised model is known as Meta-UTAUT.

The model Meta-UTAUT has already been applied to assess the acceptance and usage of EVs (Buranelli de Oliveira et al., 2022) in Brazil. In spite of the study's highlight of a positive attitude towards EVs and a positive intention to use the new technology, the study reveals its limitations, as these arise from the periphery of EV technology, aspects such as, charging time, vehicle price, and battery autonomy. In a different geographical area, India, (Jain et al., 2022) have used the UTAUT2 model to identify perception of risk. This factor negatively affects the intention to use electric vehicles in the southeast Asian area, as oppose to performance expectations and facilitating conditions showing a positive influence on the intention to use EVs. (Gunawan et al., 2022) applied the Meta-UTAUT model to electric vehicle users in Indonesia, with a very extensive application of variables and factors. Following Saura et al. (2021) models for the design of tables, Table 1 is shown with a summary of previous research.

2.2 Hypotheses for guided analysis

In relation to the previous section that describes the Meta-UTAUT model and its application in the context of EVs, the following hypotheses develop preliminary to the analysis for up to 6 twofold hypotheses, presenting a dual dimension as it relates, on the one hand, to usage behavior and on the other hand, to attitude towards use of electric vehicles (Fig. 1).

Table 1 Studies preliminary to the proposed model

Authors	Methodology	Dimensions
de Oliveira et al. (2022)	Data collected through an online survey from 488 Brazilian respondents and analyzed using the Structural Equation Modeling technique. It uses Meta-UTAUT theory.	Attitudes; Subjective Norm; Perceived Behav- ioral; Control; Complexity; Relative Advantage; Compatibility; Mass Media; Peers; Self-efficacy. Facilitators; Constraints; Emotions; Intention to use.
Jain et al. (2022)	Quantitative data from 284 customers analyzed using hierarchical linear regression analysis and verified with the analysis of necessary conditions. It uses UTAUT2 theory.	Performance expectancy; Effort expectancy; Social influence; Facilitating conditions; Perceived risk; Environmental concerns; Government support; adoption intention.
Gunawan et al. (2022)	Using Structural equation modeling (SEM) method for data analysis; data collected from 526 respondents in various cities, in Indonesia. It uses Meta-UTAUT theory.	Attitude Toward Use; Effort Expectancy; Facilitating Condition; Habit; Hedonic Motiva- tion; Intention to Use; Per- ceived Behavior Control; Performance Expectancy; Perceived Financial Risk; Perceived Performance/ Functional Risk; Perceived Physical Risk; Perceived Social Risk; Perceived Time Risk; Price Value; Subjective Norm.

Source: authors

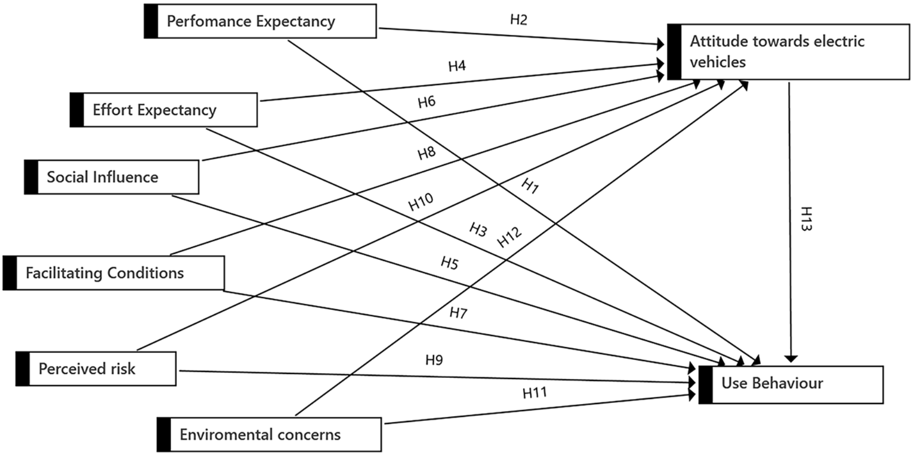

Fig. 1 Proposed model in the research *Source*: Authors

Performance expectancy is understood as "the degree to which using a technology provides benefits to consumers in performing certain activities" (Venkatesh et al., 2003, p. 447) or understood as "the extent to which users believe that using this system will help them utilize innovative technologies in voluntary situations" (Curtale et al., 2021, p. 267). Based on these definitions, we can understand performance expectancy as a variable that measures consumers' opinions about the effectiveness and efficiency of electric vehicles in transportation. Measures of performance in EV include utility and productivity, relative to driving habits or speed around urban areas (Manutworakit & Choocharukul, 2022). Previous research suggests that performance expectancy has a strong influence on usage behavior (Kandemir et al., 2022; Venkatesh et al., 2016). Specifically, in the context of EVs, (Jain et al., 2022) demonstrate that this relationship is due to the perception of EVs by users as vehicles that consume less fuel, use clean energy, and require less maintenance compared to gasoline or diesel vehicles (Di Foggia, 2021). In this context, the following hypothesis is proposed:

H1 *Performance expectancy has a direct and positive influence on the intention to use electric vehicles.*

Performance expectancy is considered one of the most important dimensions in the UTAUT model (Balakrishnan et al., 2022) and the Meta-UTAUT model (Patil et al., 2020). In the context of Meta-UTAUT, (Dwivedi et al., 2019) express a favorable attitude towards technology. In the context of chatbot services, (Balakrishnan et al., 2022) demonstrate that performance expectancy, also, generates a positive attitude towards use. Consequently, the following hypothesis is proposed:

H2 *Performance expectancy has a direct and positive influence on the attitude towards electric vehicles.*

Effort expectancy is understood as "the degree of ease associated with using the system" (Venkatesh et al., 2003, p. 450) or as "the degree of ease associated with using electric vehicles by consumers" (Jain et al., 2022, p. 3). Therefore, effort expectancy can be understood as a variable that measures the ease of use and skill in driving an electric vehicle. In the context of electric vehicles, (Jain et al., 2022) demonstrates that the perceived ease of use of an electric vehicle will increase with more usage given its characteristics (Di Foggia, 2021). (Madigan et al., 2016) state that effort expectancy directly influences consumer acceptance of new road transportation systems in European areas (Abbasi et al., 2021). Therefore, the following hypothesis is proposed:

H3 *Effort expectancy has a direct and positive influence on the intention to use electric vehicles.*

This focus on the effort required for an individual to become skilled in using technology (Venkatesh et al., 2016) is like Davis theory on perceived ease of use (Davis, 1989); it is based on the extent to which individuals perceive technology use as effortless, promoting a positive attitude. In the context of electric vehicles, effort expectancy positively affects attitudes towards the use of electric vehicles (Gunawan et al., 2022). Based on this, the following hypothesis is formulated:

H4 *Effort expectancy has a direct and positive influence on the attitude towards electric vehicles.*

Social influence is understood as "the extent to which consumers perceive those important others (i.e., family and friends) believe they should use a particular technology" (Venkatesh et al., 2003, p. 451) or as "the social status gained by owning an electric vehicle" (Jain et al., 2022, p. 4). Intention to use in this area is affected by social influence because it is often believed that a technology product or service conveys the consumer's self-image as well as their external image (Bhat et al., 2022). Therefore, since EVs are considered one of the most sustainable innovations, consumers could be more inclined to adopt electric vehicles in order to enhance their social image. Previous research in the context of EVs links social influence and intention to use (Bhat et al., 2022; Chen et al., 2016; Kapser & Abdelrahman, 2020; Patil et al., 2020). In this context, it is considered that:

H5 *Social influence has a direct and positive relationship with the intention to use electric vehicles.*

(Dwivedi et al., 2019) identifies that social influence has a strong link to attitude, specifically indicating that individuals can modify their attitudes positively or negatively based on the comments of acquaintances who have used the same technology (Yakubu et al., 2020). In the context of the Meta-UTAUT model, it is confirmed that the significant relationship between social influence and attitude and shows the need to make this relationship accessible for an improved explanatory model (Patil et al., 2020). Therefore, this study proposes that:

H6 *Social influence has a direct and positive relationship with the attitude towards electric vehicles.*

Facilitating conditions are considered as "consumers' perceptions of the resources and support available to perform a behavior" (Venkatesh et al., 2003, p. 453) or as "the availability of technology, organizational systems, and resources in terms of infrastructure, software system" (Manutworakit & Choocharukul, 2022, p. 4). Compatibility with other technological resources such as navigation use, smartphone connectivity, and the availability of charging stations are considered dimensions that facilitate the use of electric vehicles (Anderson et al., 2018). Previous studies point to a direct relationship between facilitating conditions and intention to use EVs (Bhat et al., 2022; Junquera et al., 2016; Kapser & Abdelrahman, 2020). Thus, we assume that:

H7 *Facilitating conditions have a direct and positive influence on the use of electric vehicles.*

(Buranelli de Oliveira et al., 2022) state that the higher the compatibility of EVs with other technological resources, the more positive the attitude towards them (Higueras-Castillo et al., 2021). Similarly, (Kapser & Abdelrahman, 2020) argue that the greater the access to knowledge and assistance for using EVs, the greater the influence and development of a positive attitude can be measured towards usage. Following these arguments, the following hypothesis is proposed:

H8 *Facilitating conditions have a direct and positive influence on the attitude towards the use of electric vehicles.*

Risk perception is considered as "consumers' perceptions of the barriers associated with the use of electric vehicles" (Balakrishnan et al., 2022, p. 4). Spain, as many other nations in the process of developing a sustainable transportation strategy, EVs face multiple challenges such as autonomy (Jain et al., 2022; Junquera et al., 2016), privacy issues (Saura et al., 2022), or charging time (Shukla et al., 2014), which lead consumers to resist using EVs. Additionally, consumers tend to compare combustion vehicles with EVs in terms of the distance traveled after a full charge (Jensen et al., 2013), the speed they can reach (Jain et al., 2022), safety concerns (Wang et al., 2018), the loss of economic resources (Degirmenci & Breitner, 2017), or charging waiting time (Weldon et al., 2018). Previous research in the context of EVs has shown that risk perception negatively influences the intention to use EVs (Jain et al., 2022), however, other studies have demonstrated that the perceived benefits influence the intention to use electric vehicles positively (Bhat et al., 2022). Therefore, we propose the following hypothesis:

H9 *Risk perception has a direct and negative influence on the use of electric vehicles.*

Risk perception is formed by dimensions related to performance, social, physical, financial, psychological, psychosocial, and time associated risks (Dowling, 1986). (Sanaye & Bahmani, 2012) state that users who perceive physical risk in using EVs may develop a negative attitude, but over time, it will turn positive according to Al-Majali's work (Al-Majali, 2020). (Gunawan et al., 2022) identified that consumers perceive EVs for their edge technology and, as such, innovations may not function properly so that consumers may not obtain the expected financial benefits. This leads to a negative, and so the proposed hypothesis weight in an oscillation in the context of perceived risks:

H10 *Risk perception has a direct and negative influence on the attitude towards the use of electric vehicles.*

Environmental concerns are defined as "awareness of the ongoing environmental degradation among consumers" (Bhat et al., 2022, p. 3)(Bhat et al., 2022, p.3) or as "the extent to which an individual holds values or consciousness towards the environment" (Schuitema et al., 2013, p. 41). These values influence the consumer decision-making process regarding the intention to use EVs (He et al., 2018). In this context, EVs are considered an eco-friendly technology (Jinliang et al., 2023; Pagiaslis & Krontalis, 2014), and previous studies have demonstrated a direct and positive influence between environmental concerns and the intention to use EVs (Bhat et al., 2022; Sinnappan & Rahman, 2011). Therefore, the guideline proposed for these variables state that:

H11 *Environmental concerns have a direct and positive influence on the use of electric vehicles.*

(Liu et al., 2021) finds in their study that environmentally concerned consumers develop a positive attitude towards the use of electric vehicles, which indirectly leads to the behavior of using electric vehicles (Lohana et al., 2023; Wang et al., 2016). Other studies have shown that consumers who are more environmentally concerned tend to purchase EVs instead of gasoline or diesel vehicles (Sinnappan & Rahman, 2011). Therefore, the thesis presented follows that:

H12 *Environmental concerns have a direct and positive influence on the attitude towards the use of electric vehicles.*

Attitude is defined as "the degree to which individuals have a positive or negative evaluation of the behavior in question" (Ajzen, 2020, p. 318) and behavioral intention as "the willingness of a person to perform a specific behavior." According to Ajzen's definition attitude is often the most powerful predictor of behavioral intention (Ajzen, 2020). Therefore, consumers who develop a positive attitude towards EVs will have the intention to use EVs, while those who develop a negative attitude towards these will have a lower measured degree in their intention. In the context of Meta-UTAUT, there are many studies showing attitude as a direct and positive influence on behavioral intention (Balakrishnan et al., 2022; Dwivedi et al., 2019; Patil et al., 2020). The present study evaluates whether attitude towards the use of EVs influences the intention to use the new technology and thus proposes the following hypothesis:

H13 *Attitude towards electric vehicles have a direct and positive influence on the use of electric vehicles.*

3 Research methodology

The present study adopts a quantitative approach to describe our focus on EV adoption (Cooper & Schindler, 2014). The quantitative analysis is based on the collection of data from empirical research. From the previously laid ground for a theoretical foundation, this methodology adds a background overview, before the discussion centering the obtained results (Cooper & Schindler, 2014). The objective of this study is to identify the factors influencing the attitude and intention to use EVs; an empirical based approach roots on the collection of primary data relative to Spain. To calculate the necessary sample, Hair et al. (2014) instructions have been followed and Soper's calculator has been used. Considering that, current research questionnaire has 32 observed items, 8 latent concepts, an anticipated effect size of 0.25 and a desired statistical power level of 0.8, with a 0.05 probability level, a minimum sample size of 271 completed questionnaires was obtained. Finally, a total of 326 respondents with varied demographic characteristics are interviewed, following a convenience sampling method for economical and temporal reasons. The questionnaire technique is employed to gather the data; the questionnaire is distributed both in-person and online to the respondents between January 15, 2023, and March 15, 2023, consisting of 32 statements measured on a five-point Likert scale, addressing the antecedents of EVs in line with the theoretical basis from the Meta-UTAUT model. The respondents rated their agreement with the statements on a scale from 1 (strongly disagree) to 5 (strongly agree). The statements are drawn from previous academic works and grouped into eight variables. Additionally, the questionnaire includes seven questions related to the respondents' identifying information. The analysis of the collected primary data is conducted using the statistical software SPSS v. 28. The table below shows the sample structure set out for the statistical analysis and demographic bands (Table 2).

The sample representation is composed of 53.1% men respondents, while women represent 46.9%. This indicates a balanced assigned-sex distribution. The most representative age group is in the category "2000–2009," comprising 35.6% of the participants, followed by the groups "1965–1979" with 26.4%, and "1980–1999" 23.3%; only a 14.7% enters the "prior to 1965" age group. These results reveal a predominant group participant of young individuals, born after the millennial.

In terms of educational level, 34.4% of the participants have completed compulsory secondary education, while 65.6% have university or equivalent studies. Thus, participants with a higher educational level predominate. All of the participants, 100% claim to have used an electric vehicle on some occasion. It is observed that 2.1% of the participants have used an EV in the last 6 months, with 63.8% of them having accessed this technology up to 4 times. This suggests a high degree of familiarity and experience with this type of transportation. Additionally, 47.2% of the participants use an electric car for commuting, while 52.8% use other types of electric vehicles. There is an underlying diversity for a nuanced analysis of transportation options used by the participants. While 22.1% of the participants indicate that they have used an electric vehicle because it was an only option; 77.9% state

Table 2 Sample Structure

Characteristics		Frequency	Percent
Gender	Male	173.00	53.01
	Female	153.00	46.09
Age	Anterior 1965	48	14.7
	1965–1979	86	26.4
	1980–1999	76	23.3
	2000–2009	116	35.6
Education	High school or below	112	34.4
	Bachelor's	214	65.6
Have you ever used an electric vehicle?	Yes	326	100.0
	No	0	0
What type of electric vehicle do you use for transportation?	Electric vehicles	154	47.2
	Others	172	52.8
How many times have you used an electric vehicle in the last 6 months?	1	7	2.1
	2	37	11.3
	3	74	22.7
	4 or more times	208	63.8
Have you used the electric vehicle because it was the only means of transportation available?	Yes	72	22.1
	No	254	7.9

Source: Authors

that they have used it for other reasons. This indicates that most participants have access to transportation alternatives besides electric vehicles.

4 Results

The proposed model is evaluated using Structural Equation Modeling (SEM), which involves assessing both the measurement model and the structural model. The measurement model depicts how the measured variables combine to represent the theoretical constructs, while the structural model illustrates how these constructs relate to one another (Hair et al., 2010). The statistical software SPSS AMOS v27 is employed for this study. Confirmatory Factor Analysis (CFA) is conducted to test the measurement model.

4.1 Measurement model for the analysis

In the measurement model, the relationship between observable variables, indicators, and latent variables, constructs, is evaluated to determine the validity and reliability of the indicators used to measure the theoretical constructs (Bagozzi & Yi, 1988). Ten items are eliminated due to cross-loadings. After the new specification, 22 items are analyzed. Constructs are considered to have convergent validity when they meet certain criteria. Convergent validity is established when the coefficient of reliability (CR) exceeds the threshold of 0.70 (Heinzl et al., 2011). Additionally, the average variance extracted (AVE) should be greater than 0.50 (Hair et al., 2010), and the item loadings on each factor should be above 0.70 or at

Table 3 Measurement Model Results

Constructs	Items	Loadings	AVE	CR
Performance Expectancy	PE1	0.701	0.526	0.816
	PE2	0.751		
	PE3	0.732		
	PE4	0.714		
Effort Expectancy	EE1	0.686	0.567	0.722
	EE2	0.814		
Social Influence	SI1	0.771	0.569	0.726
	SI2	0.738		
Facilitating Conditions	FC1	0.721	0.505	0.671
	FC2	0.7		
Risk perception	RP1	0.75	0.558	0.791
	RP2	0.743		
	RP3	0.748		
Environmental concerns	CE1	0.753	0.567	0.839
	CE2	0.783		
	CE3	0.723		
	CE4	0.751		
Attitude	AV1	0.964	0.695	0.82
	AV2	0.930		
	AV3	0.921		
Behaviroual Intention	UB3	0.871	0.861	0.949
	UB4	0.795		

Source: Authors

Table 4 Heterotrait-Monotrait Ratio of Correlations

	PE	EE	FC	RP	CE	UB	AV
PE							
EE	0.71						
FC	0.877	0.873					
RP	0.753	0.653	0.71				
CE	0.734	0.473	0.813	0.554			
UB	0.86	0.566	0.748	0.789	0.672		
AV	0.822	0.725	0.896	0.564	0.844	0.865	

Source: Authors

least 0.50 (Hair et al., 2010). These criteria are used to evaluate and ensure the reliability and validity of the constructs to align with the research study. Most of the item factor loadings are above 0.7, and both the Average Variance Extracted (AVE) and the Construct Reliability (CR) for each construct are above 0.5 and 0.7, respectively, indicating good convergent validity in the measurement model (Table 3).

Next, discriminant validity is examined to verify that the latent variables are distinguishable from each other (Hair et al., 1998). It is assessed through the HTMT measure (Heterotrait-Monotrait Ratio of Correlations). The HTMT indicates that the indicators of a construct are correlated with each other, more than with the indicators of other constructs. According to (Henseler et al., 2015), there are two different thresholds: one for strict assessment (0.85) and another for a more liberal assessment of discriminant validity (0.90). If this condition is met, it is considered to have good discriminant validity. The results (Table 4) show that the HTMT values are below 0.9, indicating that the average correlation between different constructs is lower than the average correlation within the same construct. This confirms that the constructs are distinguishable from each other and have good discriminant validity.

Finally, once the model parameters have been analyzed, different fit measures are used to assess how well the model fits the observed data. The model fit evaluated are shown in Table 5; it is found that these indices are within the recommended values.

4.2 Structural model analysis

To assess the validity of the sample used in the structural equation analysis, the critical N index by Hoelter is applied with a significance level of 0.05, corresponding to a confidence level of 95% (Bollen & Liang, 1988; Hoelter, 1983). For a significance level of 0.05 and a confidence level of 95%, the required sample size would have been 177. The sample size used, 304 questionnaires, implies that the sample size used in the analysis is sufficient to obtain reliable and significant results within the context of structural equations.

Also, the fit of the structural model is examined (CMIN 2.171, CFI 0.948, RMSEA 0.06, PClose 0.022). The fit indicators are comparable to those of the measurement model for evidence of a good overall fit of the model. The coefficient of determination, R^2, is calculated to determine the predictive ability of the model on attitude and intention to use electric vehicles. The obtained result is an R2 of 58.5% for attitude and R^2 of 55.7%, for intention to use EVs.

The causal relationship between the constructs is evaluated using the structural equation model proposed by Hair et al. (Hair et al., 2010). The results of the research hypotheses and their relationship with attitude and intention to use EVs are presented below.

According to the results of the structural equation model, the following findings observed provide a line of analysis for tackling one of the research questions guiding the study: What are the factors of the Meta-UTAUT model that affect attitude and intention to use EVs? For this preliminary approach we formulate up to nine hypotheses (H1, H2, H3, H4, H5, H6, H7, H8, and H13) from Sect. 2 that are showcased in the contrast analysis (Table 6).

A second research question introduced risk perception as a factor of consideration along with environmental concerns; how these variables enhance the predictive model of Meta-UTAUT regarding attitude and intention to use EVs? The four hypotheses (H9, H10, H11, H12) formulated are aligning with the results, as follows in Table 6:

5 Discussion

By looking at attitude and intention of use from a theoretical lens, the results arising from the model, extended Meta-UTAUT, along with the empirical data from the model, the coefficient of determination (R^2) 58.5% confirms that environmental consciousness is the vari-

Table 5 Model Fit Summary

Measure	Estimate	Threshold	Interpretation
CMIN/DF	2.171	Between 1 and 3	Excellent
CFI	0.948	>0.95	Acceptable
RMSEA	0.06	<0.06	Acceptable
PClose	0.022	>0.05	Acceptable

Source: Authors

Table 6 Results of the structural analysis of the Meta-UTAUT model

Hypotheses	*β*	*t value*	*p* value	*Interpretation*
H1: Performance expectancy to Use Behavior	-0.075	-0.237	0.812	Unsupported
H2: Performance expectancy to attitude towards EVs	0.421	1.266	0.205	Unsupported
H3: Effort expectancy to Use Behavior	-0.419	-2.352	0.019	Supported
H4: Effort expectancy to attitude towards EVs	0.005	0.029	0.977	Unsupported
H5: Social influence to Use Behavior	0.477	1.483	0.138	Unsupported
H6: Social influence to attitude towards EVs	-0.636	-1.252	0.211	Unsupported
H7: Facilitating conditions to Use Behavior	-0.266	-0.793	0.428	Unsupported
H8: Facilitating conditions to attitude towards EVs	0.488	1.322	0.186	Unsupported
H9: Perceived risk to Use Behavior	0.464	3.028	0.002	Supported
H10: Perceived risk to attitude towards EVs	-0.005	-0.032	0.975	Unsupported
H11: Environmental concerns to Use Behavior	-0.825	-3.243	0.001	Supported
H12: Environmental concerns to attitude towards EVs	0.414	2.632	0.008	Supported
H13: Attitude towards electric vehicles to Use Behavior	1.984	3.797	***	Supported

Note: Significance in the correlation values: † p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

Source: Authors

able predominant around attitude. Additionally, intention of use around an R^2 coefficient of 55.7%, shows that more than half of the variability in the intention to use EVs can be explained by four variables, as shown above: attitude, effort expectancy, perceived risk, and environmental consciousness. These results support the theoretical model underlying bases for understanding and predicting intention of use in technology, and, in the new area of electric vehicles.

Among the independent variables, performance expectancy (PE) does not present a significant relationship with attitude toward electric vehicles (β = 0.421, p = 0.205) nor with usage behavior (UB) (β=-0.075, p = 0.812). With the specific context of Spain, as set, it is noticeable that the lack of electric vehicle charging infrastructure provides a link to a lower interest as the overall concept expands to the overall upgrade (Egbue & Long, 2012; Falchetta & Noussan, 2021; Hall & Lutsey, 2020; Verma et al., 2020). Although users may have positive expectations about the performance of electric vehicles, concerns about the availability and accessibility of charging points can outweigh these expectations. This lack of extended access to infrastructure generates uncertainty about the convenience and viability of acquiring an electric vehicle, which negatively affects the measured attitude and intention to use. The limited range and prolonged charging time are features in the network that raise concerns about the electric vehicle's ability to reach the level of service expected for the use of vehicles and automobile; this is more obvious in habits for everyday movements in urban area as well as longer road trips, as these planning will have to align with the charging infrastructure that is compatible and provided for the areas. Overall, the concerns relative to EVs and charging technology can override positive performance expectations as well as influence the attitude and intention to use.

Price becomes an obstacle for mass adoption of electric vehicles as it is known their cost represents a higher price point, as it compares to traditional gasoline/injection vehicles. In this regard, it has been noted that effort expectancy (EE) does not influence electric attitude towards EVs ($\beta = 0.005$, $p = 0.977$), but there is an association with use behavior (β=-0.419, $p = 0.019$), a guideline for adoption that concurs with our approach. Social influence (SI) also did not show a significant relationship with attitude toward electric vehicles (β=-0.636, $p = 0.211$) nor with usage behavior (UB) ($\beta = 0.477$, $p = 0.138$). The lack of social influence on attitude toward electric vehicles and usage behavior can be attributed to ingrained cultural values, lack of social interactions related to electric vehicles, and unfamiliarity with this technology. Since electric vehicles still represent a minority of the carpool share, prospective drivers may not have access to experienced drivers and/or to direct testimonies from people with more exposure. This could limit and impact the outcomes of social network and the influence of a circle of users with experience; thus, prompting attitudes and behaviors in user intention. Adoption of EVs is influenced by individual factors such as personal beliefs and environmental consciousness rather than direct social influence. This line of connection to technology as it integrates with an everyday context of use, confirms that social influence has no impact, what is coinciding with the results and consistent with previous studies (Jain et al., 2022).

Facilitating conditions (FC) are not significant in the attitude toward adoption of new technology around electric vehicles ($\beta = 0.488$, $p = 0.186$) nor with user behavior (UB) (β=-0.266, $p = 0.428$). Despite the importance of having favorable conditions such as fiscal incentives or access to restricted areas exclusively for this type of vehicles in certain cities in Spain, these variables do not seem to have a significant impact on attitude formation or usage behavior of electric vehicles in this study. These conditions may be related to information availability and education. Lack of awareness and understanding of the benefits and features of electric vehicles can limit the influence of enabling conditions on attitude formation and usage behavior. If users are not well-informed about the environmental benefits, performance, and availability of electric vehicles and perceive the fiscal benefits as scarce or limited, enabling conditions are less likely to have a significant impact on attitude and on usage. These findings are supported by other studies (Lashari et al., 2021; Salari, 2022).

The lack of significant influence of perceived risk factor on attitude towards electric vehicles can be explained by technological advancements and increased consumer familiarity with electric vehicles, which may have diminished the perceived risk associated with attitude. However, users perceive more risk in usage, due to the perception of a relatively new technology in contrast to a established carpool based on gas injection vehicles. The novelty creates uncertainty and adds concerns regarding areas in performance, durability, and reliability. Perceived risk (PR) showed a significant relationship with use behavior (UB) ($\beta = 0.464$, $p = 0.002$) but not with attitude towards electric vehicles ($\beta = -0.005$, $p = 0.975$). Furthermore, since perceived risk is associated with unknown/unmeet user expectations in terms of range, charging time, or availability of charging stations, and access to fair points of charge, EVs seem to justify the higher cost, which brings in additional concern for the maintenance, autonomy, battery replacement, etc. Higher costs are perceived in the area of generated risk for consumers, regardless of their needs and expectations which does affect user intention around EVs.

Another aspect related to perceived risk is charging infrastructure. The availability and accessibility of charging stations for electric vehicles can raise concerns about the convenience and feasibility of using these vehicles. Consumers may fear running out of charge in the middle of a journey or not being able to easily find a charging point when needed. The lack of adequate charging infrastructure can increase perceived risk and decrease intention to use electric vehicles. These results are supported by previous research specific to this field (Jain et al., 2022; Jensen et al., 2013; Kapser & Abdelrahman, 2020; Shukla et al., 2014).

Concern for the environment has a significant relationship with attitude towards electric vehicles ($\beta = 0.414$, $p = 0.008$) and usage behavior (UB) ($\beta = -0.825$, $p = 0.001$). Users with a deeper concern for environmental issues and the negative impact of CO2 emissions, have a positive attitude towards electric vehicles, perceiving them for the advantages around sustainability and development. Environmental concerns relate to awareness of the effects of greenhouse gas emissions, air pollution, and depletion of natural resources. Consumers who value rules that protect the variety of habitats and natural environment aim at reducing their own carbon footprint; obviously users conscious of degraded environment in relation to climate change, tend to have a greater inclination towards electric vehicles. This attitude of more accepting disposition towards a new technology, translates into a higher intention to use EVs. It can be said that individuals who are concerned about the environment and actively pursue transformative change and adapting to more sustainable uses of technology, promotes a behavior that is aligning with alternatives to mainstream market options (Jain et al., 2022).

Awareness and consciousness regarding environmental issues aligns with Spanish social concerns at any level and status. From the standpoint of scientific dissemination and media spread of relevant content, the campaigns contributing to express concerns and to mobilize citizens shows a commitment towards environmental matters, including the 2015's Paris Agreement on Climate Change. International pacts have generated a bottom ground in order to provide a framework that can be referred and adopted when implementing concrete measures at any level; also, the existence of extensive environmental legislation and policies in Spain contributes to extend real actions around effective respond after environmental hassle and planning for containment in emissions and any matter relative to environmental degradation.

Extreme weather events are not exclusive to this geographic area; however, events like droughts, wildfires, and air pollution have raised environmental concern for a long time. Only recently the increased magnitude of some of these events have generated greater awareness on the need to protect natural resources and preserve the quality of the environment. According to the Barometer of the Center for Sociological Research (CIS), 88.9% of Spanish people consider that we are witnessing climate change, and, over that, 89.4% express a deep commitment and active concern to act upon it (April 2022). This demonstrates that overall, Spanish society increased awareness over the urgency to address climate change and the importance of taking decisive action to prevent it.

Regulatory measurement and environmental policy seek to protect natural resources, reduce pollution, and promote sustainable practices in industry sectors, including, but not limited to energy, waste management, and biodiversity conservation. Attitude influences users' intention to acquire new technology and electric vehicles because it is linked to a positive or negative evaluation from the person towards such vehicles. A favorable attitude towards electric vehicles can generate a greater willingness to use them, while a negative attitude can reduce the intention to use them.

6 Conclusions

After applying the Meta-UTAUT model from a dual perspective, expanded to examine attitude and usage intention, the model shows its productivity is various contexts to understand technology adoption. In our study, by applying it specifically to EVs in Spain, where there are limited research opportunities, the framework provides a deeper understanding on the key constructs from the model and how this work specifically in the EV context. This can help strengthen and validate the Meta-UTAUT model and its applicability in diverse domains by providing empirical evidence of its usefulness and relevance. By extending the Meta-UTAUT model with the environmental awareness factor, the theoretical framework is broadened to consider aspects beyond the traditional factors of technology adoption.

6.1 Theorical contributions

This research was proposed in order to verify which factors of the Meta-UTAUT model affected the attitude and intention to use EVs, and whether factors such as perceived risk and environmental concern improved the predictive model. The results presented in support of the analysis for the adequacy of the theoretical extended Meta-UTAUT model, in the context of attitude and intention to use electric vehicles show a coefficient of determination (R^2) of 58.5% for attitude and 55.7% for usage intention, indicating that more than half of the variability of these factors can be explained from an empirical standpoint. Performance expectancy, social influence, and facilitating conditions do not display a significant relationship with attitude towards electric vehicles or usage behavior intention. This can be attributed to factors such as the lack of adequate charging infrastructure in Spain, limited social interactions related to electric vehicles, and lack of familiarity with this technology.

Environmental concerns influencing attitude towards electric vehicles and usage intention are factoring in for users who showed a greater concern due to negative environmental impact; these factors are inducing a positive attitude towards EVs and a clear intention from users to try the new electric vehicles. This aligns with the growing environmental awareness and concerns present across different Spanish areas, after environmental disasters and scientific dissemination regarding climate change have become more prevalent.

Finally, the present research demonstrates the versatility of the Meta-UTAUT model, as it can be enhanced and expanded by the inclusion of new variables, which enable specific actions based on the original model, thereby improving the specific knowledge of technologies that are crucial in addressing the challenge of Climate Change.

6.2 Practical contributions

The results of the study demonstrate that environmental concerns are positively related to attitude towards EVs and usage behavior. Therefore, it shows how important is to effectively communicate the environmental benefits of electric vehicles, such as emission reduction and contributions to sustainable development. Awareness and education campaigns can help promote these benefits and foster a positive attitude towards electric vehicles. Since facilitating conditions did not show a significant relationship with attitude and usage behavior, fiscal incentives, and government policies to promote EV adoption in Spain should be reviewed, as these conditions have an impact in consumers' decision to use electric vehicles and will open a path to a competitive advantage in the promotion and marketing of these vehicles.

Additionally, performance expectancy and social influence did not show a significant relationship with attitude and usage behavior in the EV area; for this reason, training and awareness programs developing to increase understanding and knowledge about its benefits and operation will be an advantage in opening opportunities for business and industry. The outlined findings provide a solid foundation for the development of policies and strategies aimed at promoting the adoption of electric vehicles in Spain. By understanding the key factors driving the intention to use electric vehicles, decision-makers can design specific measures to address the identified barriers and promote adoption of this technology.

6.3 Limitations and future research

This research has been conducted within a set time frame, but a longitudinal study over time would provide a better understanding of changes in attitude and usage intention regarding the factors influencing the use of electric vehicles, as technology and consumer preferences evolve over time. The results may be limited to a specific context, making it difficult to generalize these findings to other populations, environments, or situations.

As seen, the adoption of electric vehicles is influenced by cultural and socioeconomic factors, so it would be interesting to investigate how these factors influence attitude and intention. Finally, a more detailed analysis of the psychological and behavioral factors influencing the adoption of electric vehicles, such as perceived barriers, beliefs, and attitudes towards technology, could be explored. In future research, the impact of fiscal incentives, traffic restrictions, and other government measures on attitude and usage intention of electric vehicles could be analyzed.

Economic factors play a noticeable role in technology adoption that will be significant around EVs as well. Studying the impact of acquisition costs, energy prices, financial incentives, and economic trends on consumers' decision to adopt them is a valuable approach for business insights and for designing effective policies and strategies.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

References

Abbasi, H., Johl, S., Shaari, Z., Moughal, W., Mazhar, M., Musarat, M., Rafiq, W., Farooqi, A., & Borovkov, A. (2021). Consumer motivation by using Unified Theory of Acceptance and Use of Technology towards Electric vehicles. *Sustainability*, *13*(21), 12177. https://doi.org/10.3390/su132112177.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Ajzen, I. (2020). The theory of planned behavior: Frequently asked questions. *Human Behavior and Emerging Technologies*, *2*(4), 314–324. https://doi.org/10.1002/hbe2.195.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and Predicting Social Behavior*. Prentice Hall.

Al-Majali, M. M. (2020). Influence of perceived risk dimensions on consumers' attitudes towards buying electric vehicles (EVs) in Jordan. *Jordan Journal of Business Administration*, *16*, 445–472. https://journals.ju.edu.jo/JJBA/article/download/101445/11346.

Amofah, D. O., & Chai, J. (2022). Sustaining consumer E-Commerce adoption in Sub-saharan Africa: Do Trust and Payment Method Matter? *Sustainability (Switzerland)*, *14*(14), 1–20. https://doi.org/10.3390/su14148466.

Anderson, J. E., Lehne, M., & Hardinghaus, M. (2018). What electric vehicle users want: Real-world preferences for public charging infrastructure. *International Journal of Sustainable Transportation*, *12*(5), 341–352. https://doi.org/10.1080/15568318.2017.1372538.

Aranyossy, M. (2022). Technology Adoption in the Digital Entertainment Industry during the COVID-19 pandemic: An extended UTAUT2 model for Online Theater Streaming. *Informatics*, *9*(3), https://doi.org/10.3390/informatics9030071.

Assaker, G., Hallak, R., & El-Haddad, R. (2020). Consumer usage of online travel reviews: Expanding the unified theory of acceptance and use of technology 2 model. *Journal of Vacation Marketing*, *26*(2), 149–165. https://doi.org/10.1177/1356766719867386.

Bagade, P., Banerjee, A., & Gupta, S. K. S. (2017). Validation, Verification, and Formal Methods for Cyber-Physical Systems. In *Cyber-Physical Systems* (pp. 175–191). Elsevier. https://doi.org/10.1016/B978-0-12-803801-7.00012-2.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, *16*(1), 74–94. https://doi.org/10.1007/BF02723327.

Balakrishnan, J., Abed, S. S., & Jones, P. (2022). The role of meta-UTAUT factors, perceived anthropomorphism, perceived intelligence, and social self-efficacy in chatbot-based services? *Technological Forecasting and Social Change*, *180*, 121692. https://doi.org/10.1016/j.techfore.2022.121692.

Bandura, A. (1986). *Social foundations of Thought and Action: A cognitive Social Theory*. Prentice Hall.

Bhat, F. A., Verma, M., & Verma, A. (2022). Measuring and Modelling Electric Vehicle Adoption of Indian Consumers. *Transportation in Developing Economies*, *8*(1), 6. https://doi.org/10.1007/s40890-021-00143-2.

Biresselioglu, M. E., Kaplan, D., M., & Yilmaz, B. K. (2018). Electric mobility in Europe: A comprehensive review of motivators and barriers in decision making processes. *Transportation Research Part A: Policy and Practice*, *109*, 1–13. https://doi.org/10.1016/j.tra.2018.01.017.

Bollen, K. A., & Liang, J. (1988). Some properties of Hoelter's CN. *Sociological Methods & Research*, *16*(4), 492–503. https://doi.org/10.1177/0049124188016004003.

Buranelli de Oliveira, M., Ribeiro da Silva, M., Jugend, H., De Camargo Fiorini, D., P., & Paro, C. E. (2022). Factors influencing the intention to use electric cars in Brazil. *Transportation Research Part A: Policy and Practice*, *155*, 418–433. https://doi.org/10.1016/j.tra.2021.11.018.

Chen, C., Xu, X., & Frey, S. (2016). Who wants solar water heaters and alternative fuel vehicles? Assessing social–psychological predictors of adoption intention and policy support in China. *Energy Research & Social Science*, *15*, 1–11. https://doi.org/10.1016/j.erss.2016.02.006.

Cooper, D. R., & Schindler, P. S. (2014). *Business Research methods* (12th ed.). McGraw Hill International Edition.

Cunningham, J. A., Damij, N., Modic, D., & Olan, F. (2023). MSME technology adoption, entrepreneurial mindset and value creation: A configurational approach. *The Journal of Technology Transfer*, *48*(5), 1574–1598. https://doi.org/10.1007/s10961-023-10022-0.

Curtale, R., Liao, F., & van der Waerden, P. (2021). User acceptance of electric car-sharing services: The case of the Netherlands. *Transportation Research Part A: Policy and Practice*, *149*, 266–282. https://doi.org/10.1016/j.tra.2021.05.006.

Davis, F. D. (1989). Perceived usefulness, perceived ease of Use, and user Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319. https://doi.org/10.2307/249008.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to Use computers in the Workplace1. *Journal of Applied Social Psychology*, *22*(14), 1111–1132. https://doi.org/10.1111/j.1559-1816.1992.tb00945.x.

Degirmenci, K., & Breitner, M. H. (2017). Consumer purchase intentions for electric vehicles: Is green more important than price and range? *Transportation Research Part D: Transport and Environment*, *51*, 250–260. https://doi.org/10.1016/j.trd.2017.01.001.

Di Foggia, G. (2021). Drivers and challenges of electric vehicles integration in corporate fleet: An empirical survey. *Research in Transportation Business & Management*, *2021*, 100627.

Dowling, G. R. (1986). Perceived risk: The concept and its measurement. *Psychology and Marketing*, *3*(3), 193–210. https://doi.org/10.1002/mar.4220030307.

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2019). Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a revised theoretical model. *Information Systems Frontiers*, *21*(3), 719–734. https://doi.org/10.1007/s10796-017-9774-y.

Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. *Energy Policy*, *48*, 717–729. https://doi.org/10.1016/j.enpol.2012.06.009.

European Enviroment Agency (2023). *Europe's air quality status 2023*. Europe's Air Quality Status 2023. https://www.eea.europa.eu/publications/europes-air-quality-status-2023.

Faiz, A., Weaver, C. S., & Walsh, M. P. (1996). *Air pollution from motor vehicles: standards and technologies for controlling emissions*.

Falchetta, G., & Noussan, M. (2021). Electric vehicle charging network in Europe: An accessibility and deployment trends analysis. *Transportation Research Part D: Transport and Environment*, *94*, 102813. https://doi.org/10.1016/j.trd.2021.102813.

García de Blanes Sebastián, M., Guede, S., J. R., & Antonovica, A. (2022). Application and extension of the UTAUT2 model for determining behavioral intention factors in use of the artificial intelligence virtual assistants. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.993935.

García de Blanes Sebastián, M., Antonovica, A., & Sarmiento Guede, J. R. (2023). What are the leading factors for using Spanish peer-to-peer mobile payment platform Bizum? The applied analysis of the UTAUT2 model. *Technological Forecasting and Social Change*, *187*(November 2022), 122235. https://doi.org/10.1016/j.techfore.2022.122235.

Grant Thornton (2023). Mano a mano en la movilidad del futuro.

Gunawan, I., Redi, A. A. N. P., Santosa, A. A., Maghfiroh, M. F. N., Pandyaswargo, A. H., & Kurniawan, A. C. (2022). Determinants of Customer Intentions to Use Electric Vehicle in Indonesia: An Integrated Model Analysis. *Sustainability*, *14*(4), 1972. https://doi.org/10.3390/su14041972.

Hair, J. F., Tathom, R. L., Anderson, R. E., & Black, W. C. (1998). *Multivariate Data Analysis with readings*. Prentice Hall.

Hair, J., Black, W., Babin, B., & Anderson, R. (2010). *Multivariate Data Analysis* (7th ed.). Pearson Prentice Hall.

Hair, J., Sarstedt, M., Hopkins, L., & Kuppelwieser, G., V (2014). Partial least squares structural equation modeling (PLS-SEM). *European Business Review*, *26*(2), 106–121. https://doi.org/10.1108/EBR-10-2013-0128.

Hall, D., & Lutsey, N. (2020). *Charging infrastructure in cities: Metrics for evaluating future needs*.

He, X., Zhan, W., & Hu, Y. (2018). Consumer purchase intention of electric vehicles in China: The roles of perception and personality. *Journal of Cleaner Production*, *204*, 1060–1069. https://doi.org/10.1016/j.jclepro.2018.08.260.

Heinzl, A., Buxmann, P., Wendt, O., & Weitzel, T. (Eds.). (2011). *Theory-guided modeling and Empiricism in Information Systems Research*. Physica-Verlag HD. https://doi.org/10.1007/978-3-7908-2781-1.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8.

Higueras-Castillo, E., Guillén, A., Herrera, L. J., & Liébana-Cabanillas, F. (2021). Adoption of electric vehicles: Which factors are really important? *International Journal of Sustainable Transportation*, *15*(10), 799–813. https://doi.org/10.1080/15568318.2020.1818330.

Hoelter, J. W. (1983). The analysis of Covariance structures. *Sociological Methods & Research*, *11*(3), 325–344. https://doi.org/10.1177/0049124183011003003.

Jain, N. K., Bhaskar, K., & Jain, S. (2022). What drives adoption intention of electric vehicles in India? An integrated UTAUT model with environmental concerns, perceived risk and government support. *Research in Transportation Business & Management*, *42*, 100730. https://doi.org/10.1016/j.rtbm.2021.100730.

Jensen, A. F., Cherchi, E., & Mabit, S. L. (2013). On the stability of preferences and attitudes before and after experiencing an electric vehicle. *Transportation Research Part D: Transport and Environment*, *25*, 24–32. https://doi.org/10.1016/j.trd.2013.07.006.

Jinliang, W., Chau, K. Y., Baei, F., Moslehpour, M., Nguyen, K. L., & Nguyen, T. T. H. (2023). Integrated perspective of eco-innovation, green branding, and sustainable product: A case of an emerging economy. *Economic Research-Ekonomska Istraživanja*, *36*(3), https://doi.org/10.1080/1331677X.2023.2196690.

Junquera, B., Moreno, B., & Álvarez, R. (2016). Analyzing consumer attitudes towards electric vehicle purchasing intentions in Spain: Technological limitations and vehicle confidence. *Technological Forecasting and Social Change*, *109*, 6–14. https://doi.org/10.1016/j.techfore.2016.05.006.

Kamboj, S., & Joshi, R. (2021). Examining the factors influencing smartphone apps use at tourism destinations: A UTAUT model perspective. *International Journal of Tourism Cities*, *7*(1), 135–157. https://doi.org/10.1108/IJTC-05-2020-0094.

Kandemir, M. A., Franklin, T., Perkmen, S., & Yıldız, Y. (2022). Developing a Mobile Learning Acceptance Scale for Mathematics. *Canadian Journal of Science Mathematics and Technology Education*, *22*(2), 392–404. https://doi.org/10.1007/s42330-022-00216-3.

Kapser, S., & Abdelrahman, M. (2020). Acceptance of autonomous delivery vehicles for last-mile delivery in Germany – extending UTAUT2 with risk perceptions. *Transportation Research Part C: Emerging Technologies*, *111*, 210–225. https://doi.org/10.1016/j.trc.2019.12.016.

Lashari, Z. A., Ko, J., & Jang, J. (2021). Consumers' intention to Purchase Electric vehicles: Influences of user attitude and perception. *Sustainability*, *13*(12), 6778. https://doi.org/10.3390/su13126778.

Liu, R., Ding, Z., Wang, Y., Jiang, X., Jiang, X., Sun, W., Wang, D., Mou, Y., & Liu, M. (2021). The relationship between symbolic meanings and adoption intention of electric vehicles in China: The moderating effects of consumer self-identity and face consciousness. *Journal of Cleaner Production*, *288*, 125116. https://doi.org/10.1016/j.jclepro.2020.125116.

Lohana, S., Imran, M., Harouache, A., Sadia, A., & Ur Rehman, Z. (2023). Impact of environment, culture, and sports tourism on the economy: A mediation-moderation model. *Economic Research-Ekonomska Istraživanja*, *36*(3), https://doi.org/10.1080/1331677X.2023.2222306.

Madigan, R., Louw, T., Dziennus, M., Graindorge, T., Ortega, E., Graindorge, M., & Merat, N. (2016). Acceptance of Automated Road Transport systems (ARTS): An adaptation of the UTAUT Model. *Transportation Research Procedia*, *14*, 2217–2226. https://doi.org/10.1016/j.trpro.2016.05.237.

Mahdiraji, H. A., Yaftiyan, F., Abbasi-Kamardi, A., Jafari-Sadeghi, V., Sahut, J. M., & Dana, L. P. (2023). A synthesis of boundary conditions with adopting digital platforms in SMEs: An intuitionistic multi-layer decision-making framework. *The Journal of Technology Transfer*, *48*(5), 1723–1751. https://doi.org/10.1007/s10961-023-10028-8.

Manutworakit, P., & Choocharukul, K. (2022). Factors Influencing Battery Electric Vehicle Adoption in Thailand—Expanding the Unified Theory of Acceptance and Use of Technology's variables. *Sustainability*, *14*(14), 8482. https://doi.org/10.3390/su14148482.

Pagiaslis, A., & Krontalis, A. K. (2014). Green Consumption Behavior antecedents: Environmental concern, knowledge, and beliefs. *Psychology & Marketing*, *31*(5), 335–348. https://doi.org/10.1002/mar.20698.

Palau-Saumell, R., Forgas-Coll, S., Sánchez-García, J., & Robres, E. (2019). User Acceptance of Mobile apps for restaurants: An expanded and extended UTAUT-2. *Sustainability*, *11*(4), 1210. https://doi.org/10.3390/su11041210.

Palos-Sanchez, P., Saura, J. R., & Correia, M. B. (2021). Do tourism applications' quality and user experience influence its acceptance by tourists? *Review of Managerial Science*, *15*(5), 1205–1241. https://doi.org/10.1007/s11846-020-00396-y.

Patil, P., Tamilmani, K., Rana, N. P., & Raghavan, V. (2020). Understanding consumer adoption of mobile payment in India: Extending Meta-UTAUT model with personal innovativeness, anxiety, trust, and grievance redressal. *International Journal of Information Management*, *54*, 102144. https://doi.org/10.1016/j.ijinfomgt.2020.102144.

Rogers, E. M. (1962). *Bibliography on the diffusion of innovations*. Department of Agricultural Economics and Rural Sociology.

Salari, N. (2022). Electric vehicles adoption behaviour: Synthesising the technology readiness index with Environmentalism values and instrumental attributes. *Transportation Research Part A: Policy and Practice*, *164*, 60–81. https://doi.org/10.1016/j.tra.2022.07.009.

Sanaye, A., & Bahmani, E. (2012). Integrating TAM and TPB with perceived risk to measure customers' Acceptance of Internet Banking. *International Journal of Information Science and Management*, 25–37. https://api.core.ac.uk/oai/oai:ojs.localhost:article/153.

Saura, J. R., Ribeiro-Soriano, D., & Palacios-Marqués, D. (2021). Setting B2B digital marketing in artificial intelligence-based CRMs: A review and directions for future research. *Industrial Marketing Management*, *98*, 161–178. https://doi.org/10.1016/j.indmarman.2021.08.006.

Saura, J. R., Ribeiro-Soriano, D., & Palacios-Marqués, D. (2022). Assessing behavioral data science privacy issues in government artificial intelligence deployment. *Government Information Quarterly*, *39*(4), 101679. https://doi.org/10.1016/j.giq.2022.101679.

Saura, J. R., Palacios-Marqués, D., & Ribeiro-Soriano, D. (2023a). Exploring the boundaries of open innovation: Evidence from social media mining. *Technovation*, *119*, 102447. https://doi.org/10.1016/j.technovation.2021.102447.

Saura, J. R., Palacios-Marqués, D., & Ribeiro-Soriano, D. (2023b). Leveraging SMEs technologies adoption in the Covid-19 pandemic: A case study on Twitter-based user-generated content. *The Journal of Technology Transfer*, *48*(5), 1696–1722. https://doi.org/10.1007/s10961-023-10023-z.

Saura, J. R., Ribeiro-Navarrete, S., Palacios-Marqués, D., & Mardani, A. (2023c). Impact of extreme weather in production economics: Extracting evidence from user-generated content. *International Journal of Production Economics*, *260*, 108861. https://doi.org/10.1016/j.ijpe.2023.108861.

Schuitema, G., Anable, J., Skippon, S., & Kinnear, N. (2013). The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. *Transportation Research Part A: Policy and Practice*, *48*, 39–49. https://doi.org/10.1016/j.tra.2012.10.004.

Sedigh, S., & Hurson, A. (2012). Introduction and Preface. In A. Hurson & A. Memon (Eds.), *Advances in Computers, Volume 87* (pp. 1–6). Elsevier. https://doi.org/10.1016/B978-0-12-396528-8.00001-8.

Shukla, P. R., Dhar, S., Pathak, M., & Bhaskar, K. (2014). *Promoting Low Carbon Transport in India: Electric vehicles scenarios and a roadmap for India*.

Sinnappan, P., & Rahman, A. A. (2011). Antecedents of Green Purchasing Behavior among Malaysian consumers. *International Business Management*, *5*(3), 129–139. https://doi.org/10.3923/ibm.2011.129.139.

Sovacool, B. K., Abrahamse, W., Zhang, L., & Ren, J. (2019). Pleasure or profit? Surveying the purchasing intentions of potential electric vehicle adopters in China. *Transportation Research Part A: Policy and Practice*, *124*, 69–81. https://doi.org/10.1016/j.tra.2019.03.002.

Taylor, S., & Todd, P. (1995). Decomposition and crossover effects in the theory of planned behavior: A study of consumer adoption intentions. *International Journal of Research in Marketing*, *12*(2), 137–155. https://doi.org/10.1016/0167-8116(94)00019-K.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal Computing: Toward a conceptual model of utilization. *MIS Quarterly*, *15*(1), 125. https://doi.org/10.2307/249443.

Venkatesh, M., Davis, & Davis (2003). User Acceptance of Information Technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425. https://doi.org/10.2307/30036540.

Venkatesh, T., & Xu (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157. https://doi.org/10.2307/41410412.

Venkatesh, V., Thong, J., & Xu, X. (2016). Unified theory of Acceptance and Use of Technology: A synthesis and the Road ahead. *Journal of the Association for Information Systems*, *17*(5), 328–376. https://doi.org/10.17705/1jais.00428.

Verma, M., Verma, A., & Khan, M. (2020). Factors influencing the Adoption of Electric Vehicles in Bengaluru. *Transportation in Developing Economies*, *6*(2), 17. https://doi.org/10.1007/s40890-020-0100-x.

Wanasinghe, T. R., Galagedarage Don, M., Arunthavanathan, R., & Gosine, R. G. (2022). Industry 4.0 based process data analytics platform. In F. Khan, H. Pasman, & M. Yang (Eds.), *Methods in Chemical Process Safety, Volume 6* (pp. 101–137). Elsevier. https://doi.org/10.1016/bs.mcps.2022.04.008.

Wang, S., Fan, J., Zhao, D., Yang, S., & Fu, Y. (2016). Predicting consumers' intention to adopt hybrid electric vehicles: Using an extended version of the theory of planned behavior model. *Transportation*, *43*(1), 123–143. https://doi.org/10.1007/s11116-014-9567-9.

Wang, S., Wang, J., Li, J., Wang, J., & Liang, L. (2018). Policy implications for promoting the adoption of electric vehicles: Do consumer's knowledge, perceived risk and financial incentive policy matter? *Transportation Research Part A: Policy and Practice*, *117*, 58–69. https://doi.org/10.1016/j.tra.2018.08.014.

Weldon, P., Morrissey, P., & O'Mahony, M. (2018). Long-term cost of ownership comparative analysis between electric vehicles and internal combustion engine vehicles. *Sustainable Cities and Society*, *39*, 578–591. https://doi.org/10.1016/j.scs.2018.02.024.

Yakubu, M. N., Dasuki, S. I., Abubakar, A. M., & Kah, M. M. O. (2020). Determinants of learning management systems adoption in Nigeria: A hybrid SEM and artificial neural network approach. *Education and Information Technologies*, *25*(5), 3515–3539. https://doi.org/10.1007/s10639-020-10110-w.

Authors and Affiliations

María García de Blanes Sebastián[1] · José Ramón Sarmiento Guede[1] · Alberto Azuara Grande[1] · David Juárez-Varón[2]

✉ Alberto Azuara Grande
alberto.azuara@urjc.es

María García de Blanes Sebastián
maria.garciadeblanes@urjc.es

José Ramón Sarmiento Guede
joseramon.sarmiento@urjc.es

David Juárez-Varón
djuarez@upv.es

[1] Rey Juan Carlos University, Paseo de los Artilleros s/n, Madrid 28032, Spain

[2] Universitat Politècnica de València, Camí de Vera, s/n, Valencia 46022, Spain