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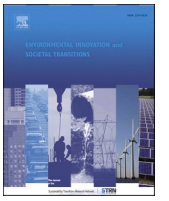

Research article

Driving the change: How do personal factors and socio-economic context influence electric vehicles adoption across Europe?

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ABSTRACT

This paper investigates the determinants influencing consumer adoption of battery electric vehicles (BEVs) across three European markets characterized by distinct socio-economic contexts and varying levels of EV market maturity. We develop a theoretical model based on Theory of Planned Behavior. A survey was conducted involving 737 consumers in Germany, Italy, and Norway. The data was analyzed using structural equation modeling, multigroup analysis, and Kruskal-Wallis's test. The findings indicate that hedonic motivations, ascription of responsibility, subjective norms, and direct experience significantly enhance consumers' willingness to purchase BEVs. Conversely, range anxiety and environmental concerns negatively affect purchase intentions. Significant differences in consumer perceptions of BEVs and the effect of behavioral determinants across the three countries are highlighted. This research contributes to the literature on sustainable mobility adoption and proposes several avenues for future investigation. The findings can inform the development of marketing strategies and policy interventions to foster EV adoption in Europe.

1. Introduction

Electric vehicles (EVs) have become a widely discussed and debated topic in recent years. Despite the negative aspects that they encompass, such as battery disposal (Xiong et al., 2023; Iturrondobeitia et al., 2022) and the extraction of raw materials like lithium, cobalt, and nickel (de Aquino Sales et al., 2024; Maisel et al., 2023), EVs represent a significant innovation in terms of emission reduction, technological advancement, comfort, and ease of maintenance (Chen et al., 2019; Sierzchula et al., 2014). EVs play a crucial role in mitigating climate change by reducing the transportation sector's environmental impact (Salari, 2022), which is a major contributor to environmental degradation and greenhouse gas emissions (Zamil et al., 2023). Indeed, the transport sector accounts for approximately one-quarter of total CO_2 emissions in Europe, with 71.7 % of these emissions originating from road transport (IEA, 2022), and automobiles are among the most significant contributors to pollution, accounting for 60.7 % of total CO_2 emissions. In response, the European Parliament has formulated and enacted the European Climate Law, aiming to reduce greenhouse gas emissions by 55 % by 2030, relative to 1990 levels. EVs are emerging as a promising solution to achieve this ambitious target (Salari, 2022; Su et al., 2021). The shift towards electrification of mobility, by replacing internal combustion vehicles with zero-emission EVs, presents a significant and effective strategy for mitigating the adverse environmental impacts of road mobility and constitutes a key component of

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the sustainability transition in the transport sector (Rajagopal, 2023; Srivastava et al., 2022). According to Statista (2023), the EV market has experienced a rapid growth, with global sales exceeding 10.2 million units in 2022, a 55 % increase compared to 2021. Tesla leads the market, with Model Y capturing an 8 % market share, followed by BYD and key manufacturers such as Volkswagen and BMW. China remains the dominant player (Gong and Hansen, 2023), accounting for nearly 58 % of global EV sales, driven by government subsidies, a wide range of affordable models, and an extensive charging infrastructure with over 1.76 million public charging points (Statista, 2023). The U.S. and Europe have also recorded notable increases in EV sales, spurred by new model releases, incentives, and stricter emission regulations.

Despite market growth, EV enrolments still lag behind traditional vehicles (EV volumes, 2022), and both scholars and practitioners call for further examination into the factors influencing consumer acceptance and adoption of this sustainable transportation method (Rajagopal, 2023). Understanding consumer acceptance is crucial for the diffusion of EVs to enable the sustainability transition in individual road mobility, where behavioral change plays a central role. This paper aims to achieve this objective by contributing to the literature on sustainable behavior (Davis et al., 2021; Milfont and Markowitz, 2016) in the field related to encouraging consumer behavior change toward sustainability (Jones et al., 2017; White et al., 2019), thus supporting policies and strategies that foster the societal transition toward sustainable mobility by addressing the consumers' adoption towards EVs.

EVs can be distinguished into two distinct groups based on their propulsion systems: battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs) (e.g., Un-Noor et al., 2017). This study focuses on BEVs. BEVs are characterized by an electric engine exclusively powered by electricity stored in the battery. Their functionality is primarily influenced by battery capacity and recharging speed.

In the literature, some studies have been conducted aimed at highlighting the factors able to affect the willingness to purchase BEVs (e.g., Asadi et al., 2021; Higueras-Castillo et al., 2023; Riverso et al., 2023) and specifically purchase intention (e.g., Huang and Ge, 2019; Degirmenci and Breitner, 2017). Several factors driving or hindering consumers' propensity to adopt EVs were detected (e.g., Haustein et al., 2021; Peters et al., 2018), along with the identification of various consumer segments (e.g., Chen et al., 2024; Jaiswal et al., 2022). These factors are associated with specific characteristics of EVs, such as their technological advancements, contribution to sustainable mobility, and status symbolism, all of which shape consumer perceptions (Wang et al., 2021). Additionally, personal factors, including attitudes, social pressure, environmental beliefs, and perceived behavioral control, significantly influence consumer decision-making (Huang and Ge, 2019). To more effectively explain and predict the adoption of EVs, the literature recommends developing new theoretical frameworks that extend the established Theory of Planned Behavior (TPB) to incorporate these variables (e.g., Shalender and Sharma, 2021; Hasan, 2021).

The sociocultural context significantly shapes consumer behavior (De Mooij, 2021). The literature underscores the relevance of political-economic factors, such as fiscal incentives (Lévay et al., 2017), cultural aspects (Novotny et al., 2022), and institutional pillars encompassing technological, business, and cognitive dimensions (Khatua et al., 2023) in EVs consumption. These factors differ across countries, exerting distinct impacts on consumer behavior and market development (Styczynski and Hughes, 2019). In this context, two main gaps in the literature can be underlined. First, most studies on EV adoption are limited to single-country analyses (Khatua et al., 2023), while cross-country comparisons remain rare, despite revealing significant differences (Higueras-Castillo et al., 2023; Song et al., 2022). Second, the existing studies primarily examine the Chinese and North American markets (e.g., Shao and Mišić, 2023; Boucher and Mérida, 2022), prompting scholars to call for expanded analyses in other cultural contexts, especially within European countries (Li et al., 2020; Plananska, 2020). Further, as the sociodemographic characteristics of consumers are relevant in influencing consumer behavior toward EVs (e.g., Buhmann and Criado, 2023; Huang and Ge, 2019), scholars emphasize the need to incorporate these factors into analyses of EV adoption to gain a more comprehensive understanding of consumer decision-making.

To address the gaps identified in the literature, this study is guided by the following research questions:

RQ1. *What are the determinants of consumer's intention to purchase BEVs among European consumers?*
RQ2. *Are there differences in the determinants of intention to purchase BEVs based on the consumers' country of origin?*

To address these questions, a comprehensive literature review was first conducted to examine the factors influencing consumers' willingness to purchase BEVs. A novel theoretical framework was developed, grounded in the TPB. This study employs an empirical approach, developing a survey conducted across three European markets: Germany, Italy, and Norway. These countries were selected for their distinct socio-economic contexts and differing levels of market maturity in EV adoption. The study aims to provide valuable insights into the diverse factors driving EV adoption, by comparing consumer behavior across these markets. This comparative analysis will help inform more effective policies and strategies for promoting sustainable transportation across Europe.

Several elements of novelty arise from this study. First, a novel theoretical framework was developed to investigate consumer behavior by extending the TPB model by including additional variables. This study further advances the literature on BEV's purchase intentions by elucidating the role of key behavioral determinants. Second, for the first time, consumer behavior toward BEVs is examined across three European markets, i.e., Germany, Italy, and Norway, highlighting relevant differences. Third, this paper provides empirical evidence and perspectives that can inform future research on BEV adoption. Finally, the findings offer important insights into the determinants of EV adoption, informing marketing strategies aimed at targeting diverse consumer segments and identifying critical factors for interventions to enhance the acceptance and widespread use of electric vehicles. These contributions provide behavioral evidence to guide systemic change toward decarbonized individual road mobility and support the development of effective transition pathways in the transport sector.

The paper is structured as follows: Section 2 provides the literature review and the development of hypotheses. Section 3 outlines the methodology. Section 4 presents the data analysis and results. Section 5 discusses the findings and their implications. Finally,

Section 6 offers the conclusion.

2. Theoretical background

2.1. Research framework

This section examines the factors influencing consumers' purchase intentions toward the adoption of BEVs. The study draws on the TPB, a widely applied framework in consumer behavior research (e.g., Aravindan et al., 2023; Rafiq et al., 2023). According to Ajzen (1991), the TPB model posits three key factors that shape an individual's intention to engage in a particular behavior. The first is the attitude toward the behavior, which refers to how positively or negatively an individual evaluates the behavior. The second is subjective norms, encompassing the perceived social pressure or expectations from others regarding whether the behavior should be performed. The third is perceived behavioral control, which reflects an individual's perception of the ease or difficulty of performing the behavior, influenced by past experiences and potential barriers. In other terms, if someone holds a positive attitude towards a behavior, experiences social pressure to engage in it, and perceives he/she has control over performing it, he/she is more likely to form an intention to perform that behavior. These factors work independently but collectively influence the strength of one's intention to engage in the behavior, ceteris paribus.

Starting from this framework, we have extended it by categorizing the three factors as follows: (1) attitude, encompassing hedonic motivations, ascription of responsibility and environmental concern; (2) subjective norms; and (3) perceived behavioral control, encompassing perceived ease of use, range anxiety, and government incentives.

Regarding the attitudinal components, several factors can be traced back to the consumer's positive feelings associated with BEV adoption, thanks to the intrinsic characteristics of this product. Consumers' hedonic motivations are a relevant attitudinal factor, influenced by features such as smooth acceleration, low noise levels, and advanced technology, core attributes of BEVs (Singh et al., 2023; Zhou et al., 2021). Similarly, consumers' ascription of responsibility and environmental concern are important attitudinal elements, given the reduced environmental impact of BEVs and their attractiveness as a sustainable transportation solution (Shalender and Sharma, 2021; He and Zhan, 2018). Accordingly, following previous studies (e.g., Alzubaidi et al., 2021; Dangelico et al., 2021), these factors are operationalized as the attitudinal component within the TPB framework in this study.

The literature emphasizes that subjective norms play a pivotal role in shaping consumers' intentions to adopt EVs (e.g., Karami et al., 2024; Ausawanetmanee et al., 2024), as this behavior is often strongly influenced by social relationships and peer networks (Sharma et al., 2024). For these reasons, in this study, we operationalize subjective norms as the social component of the TPB in line with its original conceptualization.

Regarding the control components, several factors associated with the intrinsic attributes of BEVs can shape consumers' perceptions of the ease or difficulty of adopting these vehicles. Perceived ease of use is linked to the advanced features of BEVs, such as simplified driving, operation, charging, and maintenance, thanks to their superior technology level compared to internal combustion engine vehicles (Xu et al., 2020). Government incentives, including tax credits and investments in charging infrastructure, address economic barriers by making BEVs more affordable, thus enhancing their accessibility to consumers (Sierzchula et al., 2014). Conversely, range anxiety, i.e., the concern that the vehicle's battery may deplete before reaching a destination or charging station, reflects a potentially perceived difficulty in adopting and using BEVs. This anxiety can negatively influence purchasing decisions and impact daily driving habits, as it highlights potential challenges in the practical use of EVs (Yang and Wang, 2018; Bonges III et al., 2016). Thus, while perceived ease of use and government incentives may positively impact consumers' purchase intention, range anxiety may negatively influence the purchase intention of customers (Pevec et al., 2019). These factors are operationalized as perceived behavioral control components within the TPB framework in this study.

Further, the literature underscores consumers' previous direct experience with EVs shapes consumers' preferences and intentions (Tan et al., 2023; Zhao et al., 2022), thus we decided to include this factor in the model. Gender and age are incorporated in the model as control variables to account for their potential influence on consumer behavior.

2.2. Hypotheses development

2.2.1. Hedonic motivations

Hedonic motivation refers to consumer willingness to engage in behaviors that promote pleasant experiences and that mitigate negative experiences (Kaczmarek, 2017). Recent studies emphasize the growing importance of hedonic motivation in shaping consumer behavioral intentions. Shao (2024) underlines how virtual influencers significantly impact consumer preferences, underscoring the need to address hedonic desires in social media marketing. Likewise, Yavuz (2024) identifies hedonic motivation as a key factor influencing the acceptability of Urban Air Mobility among university students, highlighting the strong link between perceived enjoyment and the intention to adopt this new mode of transportation. In the context of EVs, hedonic motivations refer to the pleasure and enjoyment derived from using advanced technology, influencing product adoption based on perceived enjoyment (Gunawan et al., 2022). This includes the enjoyable experiential elements associated with driving an EV (Wang et al., 2023), such as reduced noise, vigorous acceleration, advanced technology, and the appeal of using an innovative transportation means (Singh et al., 2023; Zhou et al., 2021). Studies highlight the significant role of hedonic motivations in shaping consumer intentions to purchase EVs. Manutworakit and Choocharukul (2022) underscore the impact of hedonic motivation on BEV purchase intentions in Thailand, suggesting that highlighting enjoyment factors can help promote BEV adoption. Similarly, Curtale et al. (2022) identify hedonic motivation as a key factor in adopting Autonomous Electric Car-Sharing Services. Silberer et al. (2022) further emphasize its importance in rural areas,

noting that integrating hedonic elements into the design and promotion of electric car-sharing can increase acceptance and usage rates. Based on these considerations, we propose the following hypothesis:

H1. *Hedonic motivations positively affect purchase intention towards full electric vehicles.*

2.2.2. Ascription of responsibility

Ascription of responsibility refers to "feelings of responsibility for the negative consequences of not acting prosocially" (De Groot and Steg, 2009, p. 426). It is embedded in the belief that individuals are responsible for their actions and impact on others and the environment (Rezvani et al., 2017). This suggests that individuals who perceive themselves as responsible for the environmental impact of their actions are more likely to adjust their behavior by opting for sustainable solutions (Flores and Jansson, 2021). Scholars highlight the importance of ascription responsibility in encouraging pro-social and pro-environmental behaviors. In the food choice context, consumers with a higher degree of responsibility are more likely to shift their purchases toward lower carbon-emissions products when the product's climate-impact information is provided (Edenbrandt et al., 2021). Similarly, Song et al. (2023) find that consumers who feel responsible are more inclined to adopt reusable express packaging if they recognize its positive environmental impact. Additionally, a recent study on corporate social responsibility in sports shows that the ascription of responsibility positively influences sustainable behavior at sporting events and in daily life when fans perceive sports teams as acting sustainably (McCullough and Trail, 2023). In the EV context, this sense of responsibility is associated with choosing EVs to reduce the negative environmental impact of the automotive sector, leading the consumer towards a more friendly mode of transportation choice. Simsekoglu (2018) found that the ascription of responsibility is positively linked to EV adoption. Similarly, Higueras-Castillo et al. (2023) suggest that when consumers attribute environmental problems to the automotive sector, they feel a moral obligation to adopt EVs, which strengthens their intention to purchase. Lee et al. (2023) further explore this relationship, proposing that individuals who perceive themselves as responsible for environmental issues are more likely to develop a personal norm to act pro-environmentally, reinforcing the role of responsibility in shaping EV adoption intentions. Based on these considerations, we propose the following hypothesis:

H2. *Ascription of responsibility positively affects purchase intention towards full electric vehicles.*

2.2.3. Environmental concern

Environmental concern reflects strong positive attitudes toward environmental preservation (Crosby et al., 1981). In recent years, it has gained increased significance thanks to growing environmental awareness. Research suggests that a higher degree of environmental concern among consumers is linked to a greater likelihood of eco-friendly purchases (Yadav and Pathak, 2016). The positive impact of environmental concern on consumer behavior is well-documented across various contexts. Milford and Muiruri (2024) highlight its role in driving sustainable food consumption. Similarly, Shehawy et al. (2024) stress its influence on green purchasing behavior and the adoption of eco-friendly accommodation services. Hojnik et al. (2021) reaffirm its importance in consumers' willingness to pay for green energy and support for renewable energy technologies acceptance. Khazaei and Tareq (2021) highlight that BEVs are regarded as green technologies that reduce carbon dioxide emissions effectively, despite their reliance on electricity from primarily unsustainable sources. Environmental concern significantly affects attitudes toward BEVs and adoption intentions. Sang and Bekhet (2015) demonstrate that environmental concern positively impacts the intention to purchase an EV. Consumers are often willing to accept limitations such as reduced driving range and higher costs in exchange for the environmental benefits of EVs (Higueras-Castillo et al., 2023). Additionally, Hull et al. (2024) found that awareness and concern about environmental issues enhance the willingness to adopt EVs. Based on these considerations, we propose the following hypothesis:

H3. *Environmental concern positively affects purchase intention towards full electric vehicles.*

2.2.4. Subjective norms

Subjective norms refer to "the perceived social pressure to perform or not to perform the behavior" (Ajzen, 1991, p. 188). The relevance of this factor is highlighted across various contexts. Traberg et al. (2024) suggest that to understand how to eliminate misinformation, it is essential to analyze the role of this factor. Meanwhile, Shahzad et al. (2024) shed light on the role of subjective norms in encouraging the adoption of ICT in learning institutions in China. Additionally, Scheuch et al. (2024) discuss how the media affect people's perceptions towards social movements. Several studies have demonstrated that subjective norms significantly influence the intention to adopt EVs. Higueras-Castillo et al. (2023) identify subjective norms as a key driver for EV adoption, highlighting that many individuals seek the opinions of others before making a purchase. EVs are also often perceived as symbols of social status, becoming integral to users' identities. Mukherjee and Ryan (2020) emphasize the role of close friends and family as key influencers in encouraging EV purchases. Additionally, Deka et al. (2023) explore various forms of herd behavior in EV adoption, investigating the effects of personal norms and social relationships on purchase intentions. Understanding these socio-psychological factors is essential for promoting EV adoption and informing effective policy development. Based on these considerations, we propose the following hypothesis:

H4. *Subjective norms positively affect purchase intention towards full electric vehicles.*

2.2.5. Perceived ease of use

Perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis,

1989, p. 320). Accordingly, the lower the degree of effort perceived by users, the higher their perceived ease of use will be, ceteris paribus. Perceived ease of use has been identified as a key factor influencing consumers' willingness to adopt various products and services, including smart energy technologies (Fleiss et al., 2024), food waste reduction apps (Fraccascia et al., 2023), and travel booking platforms (Revett et al., 2007). Additionally, Khatoon (2024) demonstrated that it positively influences consumers' intention to engage in online shopping. In the context of EVs, perceived ease of use refers to how effortless and straightforward it is to use the vehicle. This includes aspects such as the ease of charging, intuitive vehicle controls, user-friendly interfaces, and the overall simplicity of using an EV compared to traditional internal combustion engine vehicles. Previous studies have demonstrated that perceived ease of use positively influences the willingness to adopt or purchase EVs, with research spanning several countries including Malaysia, China, India, the USA, and Europe (Adu-Gyamfi et al., 2024). Vafaei-Zadeh et al. (2022) emphasized that when users perceive EVs as easy to operate, little effort is required to relearn the system. Additionally, Prabaharan and Selvalakshmi (2020) suggested that factors facilitating EV use, such as accessible charging infrastructure and urban convenience, play a crucial role in increasing consumer interest in purchasing EVs. Based on these considerations, we propose the following hypothesis:

H5. *Perceived ease of use positively affects purchase intention toward full electric vehicles.*

2.2.6. Range anxiety

Range anxiety is described as the concern that a vehicle may run out of battery power before reaching a charging station (Neubauer and Wood, 2014). Consequently, drivers may opt for alternative modes of transportation, even if their BEVs have sufficient range and performance. Range anxiety is an extensively studied factor in the literature and is widely recognized as a significant barrier to EV adoption (Lin and Sovacool, 2020; Yang and Wang, 2018; Bonges III et al., 2016). Khazaei and Tareq (2021) highlight that consumers are particularly concerned about the limited driving range of EVs. This concern about range limitations remains one of the primary obstacles preventing broader acceptance of EVs. Range anxiety extends beyond logistical concerns, representing a psychological barrier that hinders consumer confidence in BEVs. It poses a significant challenge to the adoption of sustainable transportation. Studies, such as Pevec et al. (2019), show that potential EV owners are worried about the availability and distribution of charging infrastructure, with participants expressing a preference for more closely distributed charging stations akin to traditional gas stations. Based on these considerations, we propose the following hypothesis:

H6. *Range anxiety negatively affects purchase intention towards full electric vehicles.*

2.2.7. Government incentives

The high cost of EVs is a significant barrier to their widespread adoption. Government incentives can help reduce this obstacle and boost EV market share (Sierzchula et al., 2014). Government incentives include policies or measures designed to encourage specific behaviors. For instance, like EVs, solar photovoltaic systems markets are hindered due to high installation costs and its diffusion relies heavily on governmental support policies. Government incentive programs positively influence consumers' intention to install PV systems (Sun et al., 2020). Likewise, Kolawole et al. (2024) highlighted the critical role of government incentives in promoting sustainable energy supply in West Africa, demonstrating how government funding has facilitated infrastructure development. Regarding sustainable consumption, Hazen et al. (2017) emphasize that government incentives significantly boost the intention to switch to remanufactured products. Similarly, Simantiris (2024) argues that additional incentives are required to promote the transition from disposable to reusable products, suggesting that economic measures, such as taxes or levies, can effectively drive this behavioral shift. In the context of sustainable mobility, government incentives play a critical role in shaping consumer perceptions and behaviors toward EV adoption. Gunawan et al. (2022) demonstrated that these incentives act as key drivers in the uptake of green vehicles, facilitating the transition to sustainable transport systems. Government actions in this area typically include subsidies (e.g., tax rebates) and infrastructural improvements (e.g., the expansion of charging stations). Gómez Vilchez et al. (2019) highlighted the critical role of government incentives in influencing consumer decisions to purchase EVs across European countries. Their survey findings reveal that most respondents consider government incentives a fundamental factor in their decision-making process, underscoring their importance in driving EV adoption. Based on these considerations, we propose the following hypothesis:

H7. *Government incentives positively affect purchase intention towards full electric vehicles.*

2.2.8. Direct experience

According to Schulte et al. (2004), experience with alternative fuel vehicles includes a combination of general life experiences, knowledge of relevant subjects, educational background, and hands-on interaction with the product. Previous research indicates that insufficient experience with EVs undermines consumers' perceptions of their attributes, hindering the development of informed preferences (Kurani et al., 1996). Preferences are shaped by direct experience and can evolve following exposure to EVs, underscoring the significance of firsthand interaction in shaping consumer attitudes (Zhao et al., 2022). The literature emphasizes that direct experience with EVs is a relevant factor influencing consumer decisions to adopt them and can enhance purchase intentions (Tan et al., 2023). Jensen et al. (2014) utilize a "long panel" survey to assess changes in consumer attitudes resulting from direct EV experiences, finding that increased exposure improves positive perceptions of driving performance and reduces charging concerns. Similarly, Burgess et al. (2013) found that direct experience with EVs significantly increases awareness and addresses misconceptions, playing a critical role in shifting public attitudes from skepticism to acceptance of EVs. Based on these considerations, we propose the following hypothesis:

H8. *Direct experience with EVs positively affects purchase intention towards full electric vehicles.*

2.2.9. The role of country

Consumer decision-making processes can vary significantly across national contexts, as cultural and socio-economic environments shape individual attitudes and behaviors (De Mooij, 2021). Prior research has shown that people in different countries may respond differently to the same stimuli (Davis et al., 2008), particularly in the domain of sustainable consumption. For instance, studies have identified both cross-national differences and shared patterns in consumer responses to sustainable food labels (Peschel et al., 2016), organic wine (Capitello and Sirieix, 2019), and sustainable fashion (Şener et al., 2019) among the others. In the context of EV adoption, socio-economic factors play a crucial role (Chandra, 2022), and disparities in political, geographic, and social conditions have contributed to heterogeneous uptake across world regions (Tan et al., 2023). Recent evidence underscores these patterns: Han et al. (2024) highlight the varying influence of perceived value and risk on EV purchase intentions across Asian markets. Balcioglu et al. (2024) demonstrate preference heterogeneity for electric and hybrid vehicles in Germany, Sweden, the Netherlands, and Turkey. Cross-cultural comparisons also reveal how national context and market maturity shape motivations and behaviors. For instance, studying EV users' motivations, Song et al. (2022) find differences in consumer priorities: U.S. consumers prioritize driving experience, innovation, and cost-efficiency, while Chinese consumers value social image and environmental benefits. Similarly, Higueras-Castillo et al. (2023) show that culture moderates the adoption of EVs in India and Spain, leading to different consumer responses. Taken together, these studies suggest that cross-country comparisons are essential to better understand how socio-cultural and economic contexts influence sustainable mobility choices. Based on these considerations, we propose the following hypothesis:

H9. *There are significant differences in the determinants of intention to purchase full electric vehicles based on the consumers' country of origin.*

Fig. 1 displays the theoretical model investigated in this study.

3. Methodology

3.1. Research context

The study is conducted on consumers belonging to three European countries: Germany, Italy, and Norway. These countries exhibit significant demographic, economic, and energy-related differences that might shape EV adoption trends.

On the one hand, from the sociodemographic perspective, Germany had the largest population at over 84 million, followed by Italy with approximately 59 million, and Norway with around 5.5 million inhabitants. When considering the youth population (aged 15–29), Norway had the highest proportion, accounting for 18.7 % of its total population, compared to 16.0 % in Germany and 15.0 % in Italy. Economic disparities are evident, with Norway's GDP per capita (€71,870) significantly exceeding that of Germany (€36,290) and Italy (€28,520). Additionally, the gender pay gap varies, with Germany showing the highest at 17.7 %, compared to 14.4 % in Norway and 4.3 % in Italy. On the other hand, from the energy perspective, Norway leads in renewable energy, with 75.8 % of its gross

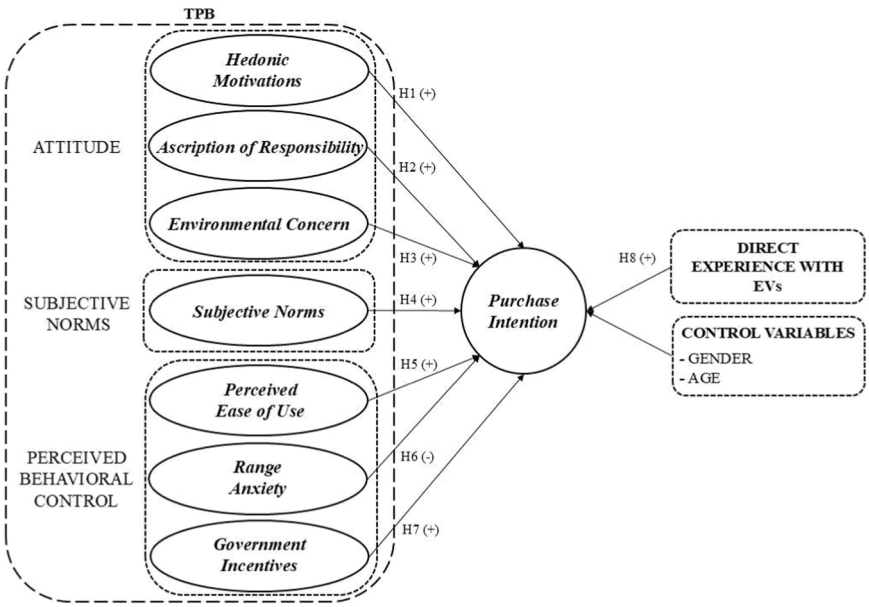

Fig. 1. Theoretical model.

final energy consumption coming from renewables, compared to 20.8 % in Germany and 19.1 % in Italy. The electricity price is much lower in Norway (€121.1 per MWh) compared to Germany (€416.2) and Italy (€361.9). Moreover, Norway is a major energy exporter with a negative energy import dependency rate of −700 %, in contrast to Germany's (68.6 %) and Italy's (79.2 %). These demographic, economic, and energy-related factors underscore the distinct contexts in which EV adoption unfolds in these three countries, shaping consumer behavior and policy interventions.

The adoption of EVs and the level of market maturity vary significantly across European countries. ICCT (2024) categorizes Italy as an "early adopter" market, Germany as an "early majority" market, and Norway as a "late majority" market stage. According to Eurostat (2021), in 2021, Germany, Italy, and Norway showed differing growth rates in EV adoption, with Italy experiencing the highest growth at 122.4 %, followed by Germany at 100 %, and Norway at 35 %. However, looking at the total number of EVs on the road, Germany led with 618,460 units, compared to Norway with 465,410, and Italy with just 110,000. Norway remains the leader in EV market penetration, with EVs representing 23.96 % of all passenger vehicles, compared to 2.87 % in Germany and only 0.54 % in Italy (Eurostat, 2023). In 2023, the total number of EVs in the EU surpassed 4.4 million, a significant increase compared to previous years. Germany recorded 524,219 new EV registrations, representing 18.43 % of its new passenger car sales, while Italy registered 65,800 EVs, accounting for 4.16 % of new registrations. Despite its smaller market size, Norway registered 106,309 new EVs, making up 81 % of all new car sales, reinforcing its global leadership in EV adoption (Eurostat, 2024a). Data provided by Eurostat (2024b) highlights significant regional differences in EV adoption, with a slower rate in southern Europe compared to northern regions. In Norway, the average share of EVs reached 15.7 % in 2022, with peaks of 26.5 % in the Oslo and Viken regions. In contrast, German regions showed much lower adoption rates, ranging between 1 % and 5 %, while Italy lagged with rates between 0.1 % and 1 %. These variations are influenced by socio-economic factors including government incentives, access to charging infrastructure, and the affordability of EV models. High upfront costs remain a primary obstacle to the widespread adoption of EVs (Liu et al., 2021), as battery electric vehicles (BEVs) are still generally more expensive to purchase than equivalent internal combustion engine vehicles (ICEVs), despite offering lower maintenance and operational costs over time (Khandakar et al., 2020). The global volume-weighted average EV price is projected to reach around USD 57,400 in 2025, and Europe remains among the most expensive markets due to the dominance of premium models as well as the relatively high cost of small-segment vehicles (Statista, 2025b). However, prices in the second-hand market are decreasing, with used EVs becoming more accessible. Moreover, social leasing programs could play a key role in enabling low- and middle-income households to adopt EVs (IEA, 2024).

The rollout of EV charging infrastructure plays a pivotal role in enabling the transition to sustainable mobility, yet it differs markedly across European countries (ACEA, 2025). Among the sampled countries, Germany leads in absolute numbers, with around 97,704 alternating current (AC) chargers and 22,921 direct current (DC) fast chargers, followed by Italy with 35,195 AC and 5919 DC chargers, and Norway with approximately 20,000 AC and 5700 DC chargers (Statista, 2025a). While AC chargers dominate and are commonly used for slower charging at home, workplaces, or public places like supermarkets, DC chargers provide rapid charging, typically located along highways to facilitate long-distance travel and reduce range anxiety. However, fast chargers (DC or AC above 22 kW) remain a minority, except for Norway; the expansion of charging infrastructure has not kept pace with the surge in BEV sales, highlighting a gap between EV sales growth and infrastructure readiness (ACEA, 2025).

Policy frameworks across European countries play a pivotal role in shaping EV adoption (ACEA, 2024a). In Italy, purchase incentives for BEVs can reach up to €13,750 depending on income level (ISEE) and vehicle scrappage conditions, along with a five-year exemption from ownership tax and subsidies for private charging infrastructure. Germany offered generous purchase incentives until the end of 2023, alongside a ten-year ownership tax exemption for BEVs registered before 2025, and reduced taxation for electric company cars. In contrast, Norway stands out with one of the most consistent and favorable frameworks: BEVs benefit from full VAT exemption (up to NOK 500,000), extensive investment in fast-charging infrastructure, and a longstanding tradition of EV-friendly policies. These national differences highlight the importance of contextualizing consumer behavior within specific institutional and economic environments.

Notice that the comparison across Germany, Italy, and Norway is conducted in this study with an exploratory intent. While contextual information is provided for each country, no a priori hypotheses were formulated regarding expected differences. The aim is rather to uncover potential variations in consumer behavior related to BEV adoption across diverse socio-economic and market contexts.

3.2. Data collection

To test the hypotheses outlined in Section 2, primary data was collected via a survey of German, Italian, and Norwegian consumers. The survey was structured into two sections, with the questions developed based on prior literature. The first section includes two questions assessing respondents' indirect and direct experience with EVs: we asked whether he/she had ever heard (indirect experience) and used (direct experience) an EV (0 = "no", 1 = "yes", adapted from Dangelico et al., 2022), respectively. The direct experience variable was conceptualized broadly to capture any previous interaction with EVs, whether through ownership, leasing, or temporary use, as all of these forms may meaningfully shape perceptions and intentions toward EV adoption (Saleh et al., 2025). Then, the following constructs were measured using multi-item scales: (1) hedonic motivations with three items (Khazaei and Tareq, 2021);

(2) ascription of responsibility with four items (Higueras-Castillo et al., 2023); (3) environmental concerns with four items (out of five items, from Polonsky et al. (2014)); (4) subjective norms with three items (adapted from Alzubaidi et al., 2021); (5) perceived ease of use with three items (out of four items, from Higueras-Castillo et al. (2023)); (6) range anxiety with four items (Khazaei and Tareq, 2021); (7) government incentives[1] with three items (out of six items, adapted from Gunawan et al., 2022); (8) purchase intention with four items (Gunawan et al., 2022; Zhou et al., 2021). Each construct was measured using a five-point Likert scale (from 1 = "strongly disagree" to 5 = "strongly agree"). The third section of the survey collected socio-demographic data, including gender (coded as 0 for male and 1 for female, following Dangelico et al., 2021) and age (from 1 = "18–24″ to 6 = "over 65," based on de Marchi et al., 2020). Before data collection, a pre-test was conducted with a sample of 50 consumers (20 German, 20 Italian, and 10 Norwegian) to ensure the clarity of the questions. Minor adjustments were made to improve question comprehension. The pre-test also confirmed that the questionnaire could be completed within five to ten minutes. A convenience sampling method, commonly used in consumer behavior research (e.g., Butt et al., 2017; D'Agostin et al., 2020; de Medeiros et al., 2021), was employed for this study.

The final survey was created using Qualtrics and distributed online via instant messaging and social networks between January and February 2024. No compensation or incentives were provided to participants for completing the survey. All questions were mandatory, requiring respondents to answer each one before proceeding. As a result, only fully completed responses were collected, with no missing data. All in all, 737 European consumers were involved in this study: the total number of responses was 200 from Germany, 224 from Italy, and 313 from Norway. The average completion time for the survey ranged from 10 to 15 min, indicating a consistent level of respondent engagement throughout the data collection process. The sample size was determined by resource constraints (Lakens, 2022), including time and budget limitations associated with cross-country data collection using professional panel providers. While we acknowledge that there is no universal threshold for sample adequacy in structural equation modeling (Wolf et al., 2013), our sample size exceeds the minimum thresholds generally recommended for structural equation modeling (Hair et al., 2006) and aligns with similar cross-country research (e.g., Higueras-Castillo et al., 2023; Song et al., 2022; Şener et al., 2019).

3.3. Data analysis

A two-step approach was employed. First, confirmatory factor analysis (CFA) was performed to assess and validate the measurement model. Next, structural equation modeling (SEM) was applied to test the hypotheses. Following previous research on consumer behavior in the context of EVs adoption (e.g., Gupta et al., 2024; Degirmenci and Breitner, 2017), gender and age were tested as control variables, given their potential influence on consumers' behavioral patterns. Given the large sample size and the sensitivity of the chi-square (χ^2) statistic to sample size, additional indices were used to assess overall model fit (Bagozzi, 2010): the comparative fit index (CFI), the Tucker–Lewis's index (TLI), the global fit index (GFI), the root-mean-square error of approximation (RMSEA), and the standardized root-mean-square residual (SMRS). The multigroup analysis was carried out to evaluate differences among German, Italian, and Norwegian consumers. Further, the non-parametric Kruskal-Wallis's test was employed in our analysis to assess disparities in responses among the three countries. A post hoc pairwise comparison using the Dunn procedure with Bonferroni adjustment was performed to identify which specific groups exhibited significant differences. A significance level of 0.05 was applied to all statistical tests conducted in the data analysis. Analyses were conducted using IBM SPSS Statistics 27 and AMOS 27.0. All statistical tests, including those performed using AMOS (i.e., SEM and multigroup comparisons) and those using SPSS (i.e., Kruskal-Wallis tests), were conducted using two-tailed significance testing.

4. Results

This section is organized into four subsections. Section 4.1 provides a descriptive analysis, outlining the socio-demographic characteristics of the sample and consumer indirect and direct experience with EVs. Sections 4.2 and 4.3 address the first research question, presenting the CFA results and hypothesis testing using SEM respectively. Section 4.4 focuses on the second research question, detailing the results of the Kruskal-Wallis non-parametric tests and the multigroup analyses.

4.1. Descriptive analysis

Table 1 displays the socio-demographic characteristics of the aggregate, German, Italian, and Norwegian samples.

To critically assess the representativeness of our convenience sample, we compared the demographic characteristics of our respondents with official national statistics for Italy, Germany, and Norway (as of January 1, 2025) (Destatis, 2025; Istat, 2025; Statistisk sentralbyra, 2025). Regarding gender, the aggregate sample presents a fairly balanced distribution (53.5 % male, 46.5 % female), which is generally consistent with national population data: Italy (48.9 % male, 51.1 % female), Germany (49.3 % male, 50.7 % female), and Norway (50.4 % male, 49.6 % female). Small deviations, such as a slight overrepresentation of males in the Italian subsample (62.5 %), are noted. In terms of age, younger age groups are somewhat overrepresented across the sample compared to the general populations of the three countries. Individuals aged 18–25 represent 30.4 % of the total sample, while they account for 8.1 % in Italy, 8.3 % in Germany, and 9.65 % in Norway. Conversely, individuals over 65 - who comprise 23.4 % of the Italian population, 21.3

[1] It should be noted that the measure of government incentives reflects individual perceptions of the current policy landscape, which may be influenced by contextual awareness and not represent an objective measure of available national support. Future research could complement this with official country-level indicators or the perceived usefulness of hypothetical incentives.

Table 1
Socio-demographic characteristics of the samples[1].

	Aggregate sample		**Norway**			**Italy**			**Germany**		
			Our sample		*Population*	*Our sample*		*Population*	*Our sample*		*Population*
Gender	*Frequency*	*Percentage*	*Frequency*	*Percentage*	*Percentage*	*Frequency*	*Percentage*	*Percentage*	*Frequency*	*Percentage*	*Percentage*
Male	394	53.5 %	160	51.2 %	50.4 %	140	62.5 %	49.35 %	94	47 %	49.35 %
Female	343	46.5 %	153	48.8 %	49.6 %	84	37.5 %	50.65 %	106	53 %	50.65 %
Age											
18–25	224	30.4 %	117	37.4 %	9.6 %	63	28.12 %	8.3 %	44	22 %	8.3 %
26–35	122	16.6 %	36	11.5 %	13.8 %	43	19.2 %	12.4 %	43	21,5 %	12.4 %
36–45	71	9.6 %	19	6.0 %	13.4 %	27	12.05 %	13.1 %	25	12,5 %	13.1 %
46–55	135	18.3 %	77	24.6 %	13.2 %	30	13.4 %	12.5 %	28	14 %	12.5 %
56–65	136	18.5 %	46	14.7 %	12.2 %	46	20.55 %	15.5 %	44	22 %	15.5 %
Over 65	49	6.6 %	18	5.8 %	17.8 %	15	6.7 %	21.3 %	16	8 %	21.3 %

[1] Data sources for the national populations: Germany: https://www-genesis.destatis.de/datenbank/online; Italy: https://demo.istat.it/app/?i=POS&l=it; Norway: https://www.ssb.no/en/statbank/list/folkemengde/.

% of the German population, and 17.8 % of the Norwegian population - are underrepresented in our sample (6.6 % overall). Overall, our sample presents minor imbalances in gender distribution within country subsamples and tends to overrepresent younger individuals.

Across all three countries, consumers demonstrate nearly universal indirect experience with EVs, with 99 % or more of respondents in each country indicating that they had heard of or were familiar with EVs, suggesting a high level of general exposure to the technology. Conversely, the consumers' direct experience with EVs, i.e., personal use of an EV, varies notably among countries. In Norway, most consumers reported direct experience (86.26 %) compared to only around half of the respondents in Germany (46 %) and Italy (49.1 %). Although direct experience with EVs was reported by a substantial portion of respondents in each country, it can be noted that these figures exceed the current market penetration rates of privately owned EVs (Eurostat, 2023). This discrepancy likely stems from the operational definition of direct experience used in this study, which includes any form of personal use, regardless of ownership. In many urban contexts, such experience may result from non-ownership situations such as corporate fleets, test drives, or car-sharing programs, which often include EVs in their offerings - e.g., 27 % of Italy's and 20 % of Germany's car-sharing fleets consist of electric vehicles (Osservatorio Nazionale Sharing Mobility, 2023; Invers, 2025; ICCT, 2025).

Table 2
Scales with Cronbach's alpha, AVE, and CR for each construct and mean, standard deviation, and factor loading for each item. Full sample.

Construct	Cronbach's alpha	AVE	CR	Item	Mean	Standard Deviation	Factor Loadings
Hedonic Motivations	0.905	0.842	0.941	HM1. Driving an electric car would be fun.	3.80	1.036	0.915
				HM2. Because of smoothness and high acceleration, driving an electric car is very pleasurable for me.	3.72	1.060	0.903
				HM3. Driving an electric car would be very enjoyable.	3.85	1.011	0.934
Ascription of Responsibility	0.831	0.670	0.891	AR1. I have the responsibility to preserve resources and to ensure quality of life for future generations.	4.14	0.850	0.804
				AR2. I have the responsibility to influence the vehicle industry toward more environmentally friendly solutions.	3.74	1.039	0.819
				AR3. I feel personally responsible for the environmental problems resulting from the type of vehicle I own.	3.28	1.196	0.831
				AR4. I feel joint responsibility for the negative consequences of conventional vehicles.	3.33	1.130	0.821
Environmental Concerns	0.867	0.716	0.910	EC1. I am concerned about the state of the environment.	4.09	0.955	0.844
				EC2. The state of the environment worsens every year.	4.14	0.926	0.880
				EC3. I worry about the shortage of natural resources in the future.	4.05	0.966	0.831
				EC4. We all need to change our behavior to protect the natural environment.	4.30	0.859	0.828
Subjective Norms	0.924	0.869	0.952	SN1. People who are important to me think that I should use EVs.	2.90	1.081	0.926
				SN2. People who influence my behavior think that I should use EVs.	2.82	1.033	0.945
				SN3. People whose opinions that I value prefer that I use EVs.	2.93	1.062	0.925
Perceived Ease of Use	0.885	0.821	0.932	PEU1. My interaction with the EV would be clear and understandable.	4.13	0.991	0.875
				PEU2. Learning to use an EV would be easy for me.	4.42	0.823	0.924
				PEU3. It would be easy for me to become skilful at using EVs.	4.37	0.837	0.919
Range anxiety	0.812	0.640	0.876	RA1. I have concerns about using electric cars.	2.59	1.244	0.822
				RA2. The lack of enough infrastructure is somewhat frightening to me.	3.09	1.290	0.836
				RA3. I am afraid that I may not reach my destination using an electric car.	3.01	1.336	0.864
				RA4. I am afraid that I do not understand how to use the electric car.	1.68	0.889	0.663
Government Incentives	0.760	0.678	0.863	GI1. The government currently offers incentives effective for the purchase of EVs.	3.09	1.190	0.800
				GI2. The government currently provides public charging infrastructure effective for EVs.	2.86	1.102	0.837
				GI3. The government offers incentives to encourage home charging of EVs effectively.	2.82	1.066	0.833
Purchase Intention	0.933	0.834	0.953	PI1. I am considering purchasing an EV.	3.27	1.380	0.914
				PI2. I intend to buy an EV.	3.22	1.338	0.936
				PI3. I am considering using an EV.	3.57	1.321	0.921
				PI4. I plan to use EV in the future.	3.88	1.221	0.881

4.2. Model validation

CFA was employed to assess the convergent and discriminant validity of the multi-item scales used in this study. All standardized factor loadings exceeded 0.50, and each construct's average variance extracted (AVE) was above the 0.50 threshold. These results prove convergent validity (Hair et al., 2006). Furthermore, composite reliability (CR) for each measure exceeded 0.80, and Cronbach's alpha was above 0.70 for all scales, indicating high internal consistency and reliability of the measures (Nunnally and Bernstein, 1994) (see Table 2). Discriminant validity was assessed following the guidelines established by Fornell and Larcker (1981). Specifically, the average variance extracted (AVE) for each construct exceeded the squared correlations between that construct and the others, indicating discernible discriminant validity among the constructs (see Table A1 in the Appendix). The model fit indices for the measurement model are summarized as follows: $\chi^2 = 777.606$; [df = 290]; $\chi^2/df = 2.68$; $p < .001$; CFI = 0.964; TLI = 0.957; GFI = 0.927; RMSA = 0.048; SRMR = 0.0448. These results indicate a good fit of the model (Hair et al., 2006).

4.3. Hypothesis testing

To test the research hypotheses, the hypothesized paths were incorporated into the measurement model. The resulting structural model displayed a good fit ($\chi^2 = 945.631$ [df = 347]; $\chi^2/df = 2.73$; $p < .001$; CFI = 0.958; TLI = 0.947; GFI = 0.921; RMSA = 0.048; SRMR = 0.0434). The SEM results are presented in Table 3.

Results show that the impact of *hedonic motivations, ascription of responsibility, subjective norms, perceived ease of use*, and *direct experience* on the purchase intention is positive and statistically significant. This result supports the hypotheses H1, H2, H4, H5, and H8. Conversely, *range anxiety* and *environmental concern* have a negative impact on purchase intention. Accordingly, H6 is supported, whereas H3 is not supported. *Government incentives* were found to be not significant. Thus, H7 is rejected. Among the significant relationships, *hedonic motivations* ($\beta = 0.497$) and *range anxiety* ($\beta = -0.321$) exhibit the strongest effects, respectively positive and negative, on purchase intention, indicating that pleasant experiences and psychological barriers play a central role in consumer decisions. *Ascription of responsibility* ($\beta = 0.226$), *environmental concern* ($\beta = -0.198$), *direct experience* ($\beta = 0.159$), and *subjective norms* ($\beta = 0.155$) show more moderate effects, while *perceived ease of use* ($\beta = 0.126$) has the smaller, though still meaningful, impact. This highlights that although several factors are significant, their practical impact on consumers' intentions varies in magnitude and should be interpreted accordingly. Concerning the control variables, both *gender* and *age* were found to be not significant in influencing consumers' purchase intentions.

4.4. The role of country

First, Kruskal-Wallis's test results are presented (Table 4). This test assesses differences in consumer responses across Germany, Italy, and Norway, focusing on consumers' perceptions of the determinants of EV adoption. Post hoc comparisons, using pairwise analysis, were also performed to highlight significant differences between specific country groups. Results highlight several important differences across Germany, Italy, and Norway.

In terms of attitudinal factors, Norwegians display significantly higher levels of hedonic motivation than both Italians ($p = 0.003$) and Germans ($p < 0.001$), with no significant differences between Italy and Germany. Italians demonstrate a stronger sense of responsibility for environmental issues related to EV adoption compared to both Germans ($p = 0.009$) and Norwegians ($p < 0.001$), with no notable difference between Germany and Norway. Additionally, Italians show the highest levels of environmental concern, followed by Germans and Norwegians, with significant differences across all three groups ($p \leq 0.050$).

Norwegians also report stronger subjective norms regarding EV adoption compared to Italians and Germans ($p < 0.001$), with no significant difference between the latter two.

Regarding behavioral control variables, Norwegians perceive EVs as easier to use than both Italians and Germans ($p < 0.001$), while

Table 3
SEM results.

Hypothesized relationship	Standardized coefficient	Result
H1. HM → PI	0.497***	*Supported*
H2. AR → PI	0.226*	*Supported*
H3. EC → PI	−0.198*	*Not Supported*
H4. SN → PI	0.155***	*Supported*
H5. PEU → PI	0.126*	*Supported*
H6. RA → PI	−0.321***	*Supported*
H7. GI → PI	0.055	*Not supported*
H8. EXP → PI	0.159*	*Supported*
Control Variables		
GENDER → PI	−0.009	
AGE → PI	0.013	

* $p < .05$; ** $p < .01$; *** $p < .001$.
Abbreviation: HM: Hedonic Motivations; AR: Ascription of Responsibility; EC: Environmental Concern; SN: Subjective Norms; PEU: Perceived Ease of Use; RA: Range Anxiety; GI: Government Incentives; EXP: Direct Experience; and PI: Purchase Intention.

Table 4
Results of Kruskal-Wallis, country differences.

Variable	Kruskal-Wallis (p-value)	Result	St. test statistic	Pairwise comparison (p-value)		
				Germany vs Italy	Germany vs Norway	Italy vs Norway
Hedonic Motivations	< 0.001	Significant	22.419	N.S.	< 0.001	0.003
Ascription of Responsibility	< 0.001	Significant	20.771	0.009	N.S.	< 0.001
Environmental Concern	< 0.001	Significant	27.828	0.050	0.036	< 0.001
Subjective Norms	< 0.001	Significant	48.170	N.S.	< 0.001	< 0.001
Perceived Ease of Use	< 0.001	Significant	34.872	N.S.	< 0.001	< 0.001
Range Anxiety	< 0.001	Significant	72.339	N.S.	< 0.001	< 0.001
Government Incentives	< 0.001	Significant	166.740	0.002	< 0.001	< 0.001
Purchase Intention	< 0.001	Significant	59.232	N.S.	< 0.001	< 0.001

no significant difference is found between Italy and Germany. Range anxiety is significantly lower among Norwegians compared to both Italians and Germans ($p < 0.001$), with no notable differences between the latter two. In terms of perceived government support for EV adoption, Norwegians report higher levels of support than both Italians and Germans ($p < 0.001$), while Germans perceive more support than Italians ($p = 0.002$).

Finally, Norwegians exhibit a significantly higher intention to purchase EVs than both Italians and Germans ($p < 0.001$), with no differences observed between Italy and Germany.

Figure A1 in the Appendix provides a clearer representation of the average responses from consumers in each country, offering a

Table 5
Multi-group analysis χ^2 significance.

Italy - Norway			
Unconstrained Model ($\chi^2 = 1841.182$; df = 1041; $p = 0$)			
Model comparison	**Δ df**	**Δ χ^2**	**P-value**
Constrained Model HM → PI	1	4.148	0.042
Constrained Model AR → PI	1	1.971	0.160
Constrained Model EC → PI	1	1.625	0.202
Constrained Model SN → PI	1	1.472	0.225
Constrained Model PEU →PI	1	1.024	0.312
Constrained Model RA →PI	1	0.579	0.447
Constrained Model GI →PI	1	0.093	0.760
Constrained Model EXP →PI	1	0.081	0.390
Constrained Model GEN →PI	1	3.160	0.075
Constrained Model AGE→PI	1	2.906	0.088
Germany - Norway			
Unconstrained Model ($\chi^2 = 1841.182$; df = 1041; $p = 0$)			
Model comparison	**Δ df**	**Δ χ^2**	**P-value**
Constrained Model HM → PI	1	0.782	0.382
Constrained Model AR → PI	1	0.269	0.604
Constrained Model EC → PI	1	0.794	0.373
Constrained Model SN → PI	1	0.313	0.576
Constrained Model PEU →PI	1	2.082	0.149
Constrained Model RA →PI	1	2.761	0.097
Constrained Model GI →PI	1	0.787	0.375
Constrained Model EXP →PI	1	0.178	0.674
Constrained Model GEN →PI	1	1.313	0.252
Constrained Model AGE→PI	1	7.066	0.008
Italy - Germany			
Unconstrained Model ($\chi^2 = 1841.182$; df = 1041; $p = 0$)			
Model comparison	**Δ df**	**Δ χ^2**	**P-value**
Constrained Model HM → PI	1	0.341	0.560
Constrained Model AR → PI	1	0.616	0.433
Constrained Model EC → PI	1	0.146	0.703
Constrained Model SN → PI	1	2.405	0.121
Constrained Model PEU →PI	1	0.129	0.719
Constrained Model RA →PI	1	0.328	0.567
Constrained Model GI →PI	1	0.234	0.629
Constrained Model EXP →PI	1	0.128	0.721
Constrained Model GEN →PI	1	0.209	0.648
Constrained Model AGE→PI	1	0.959	0.327

visual insight into the differences across the three countries. For each variable, the average of the items with which it was measured is reported. This visualization helps to highlight the disparities identified in the analysis.

A multi-group structural equation modelling analysis was conducted to assess the moderating effects of the country of origin, with respondents divided into three subgroups based on their country of origin. The analysis followed the procedure outlined by Awang (2012). Initially, we assessed the moderation effect across the overall model by comparing Chi-square (χ^2) values for both constrained and unconstrained models (as shown in Table 5). Specifically, structural weights were constrained to be equal between two countries at a time (Italy vs. Norway, Germany vs. Norway, and Italy vs. Germany), and the Chi-square differences between the constrained and unconstrained models were evaluated. Statistically significant differences in Chi-square values were only found for two relationships: the path from *hedonic motivations* to *purchase intention* between Italian and Norwegian consumers, and the path from *age* to *purchase intention* between German and Norwegian consumers.

Once the moderation effect is established, we assess in which groups relationships are more pronounced. The analysis of the path coefficient from *hedonic motivations* to *purchase intention* for Italian and Norwegian consumers shows significant and positive relationships in both groups, with a stronger effect observed among Italians compared to Norwegians. In contrast, the analysis of the path coefficient from *age* to *purchase intention* between German and Norwegian consumers shows that this relationship is positive and statistically significant for Norwegians, but non-significant for Germans. The multigroup path coefficients for these significant relationships are presented in Table 6.

5. Discussion

This study investigates the impact of seven key determinants of consumer purchasing intention toward BEVs, while also exploring the role of direct experience and consumers' gender and age (RQ1). Furthermore, the cross-comparison of three European countries (i.e., Germany, Italy, and Norway) highlights differences and similarities in consumer behavior toward EVs based on the consumer country of origin (RQ2).

5.1. RQ1: what are the determinants of consumer's intention to purchase BEVs among European consumers?

The positive influence of *hedonic motivations* on EV purchase intentions aligns with the results of several studies in the literature (Manutworakit and Choocharukul, 2022; Curtale et al., 2022; Silberer et al., 2022). Buying or using an EV can evoke feelings of pleasure and gratification, thus promoting its adoption (e.g., Singh et al., 2023; Zhou et al., 2021). Positive emotion expectancy and negative emotion avoidance play an important role in stimulating consumer adoption of EVs, supporting literature highlighting the positive role of hedonic motivations in driving consumer behavior towards pro-environment choices (Rezvani et al., 2018).

The results regarding the *ascription of responsibility* are consistent with several studies in the literature (Arkorful et al., 2024; Higueras-Castillo et al., 2023; Lee et al., 2023). Literature suggests that EV owners claim a higher level of responsibility compared to conventional car owners and see their decision to acquire an EV as a proactive step toward reducing environmental footprints (Simsekoglu, 2018). Consumers' feelings of responsibility regarding the use of conventional vehicles and their negative environmental impact promote the adoption of EVs, perceived as sustainable compared to traditional vehicles (e.g., Shalender and Sharma, 2021; He and Zhan, 2018). This result emphasized the importance of awareness and a sense of responsibility among people regarding the negative effects of their actions, supporting previous literature on sustainable consumption (Ashraf Javid et al., 2021).

Alternatively from the above-mentioned factors, the results regarding *environmental concern* differ from previous research (Traberg et al., 2024; Higueras-Castillo et al., 2023; Deka et al., 2023). For example, Zamil et al. (2023) suggest that individuals who identify as environmentally conscious or socially responsible are more likely to adopt HEVs. Similarly, Pailwar and Srinivasan (2022) demonstrate the positive influence of perceived social benefits, such as enhanced quality of life, on EV adoption intentions. In contrast, our study shows that environmental concern did not significantly motivate consumers to purchase EVs. Contrary to other sustainable product categories (e.g., food or clothing), it is possible that environmental concerns are not viewed as decisive in the EV context. Indeed, research argues that environmental concerns alone may not be sufficient to drive EV adoption (e.g., Lampo et al., 2023). Nonetheless, we advocate for additional exploration of this relationship in future studies.

The positive effect of *subjective norms* on purchase intention is consistent with previous research findings on EV adoption behaviors

Table 6
Multigroup path coefficient analysis.

	Hedonic Motivation					
	Italy - Norway					
	General		Italy		Norway	
Path	Std Coefficient	P value	Std Coefficient	P value	Std Coefficient	P value
HM → PI	0.497	***	0.599	***	0.347	***
	Age					
	Germany - Norway					
	General		Germany		Norway	
Path	Std Coefficient	P value	Std Coefficient	P value	Std Coefficient	P value
AGE → PI	0.013	N.S.	−0.061	N.S.	0.070	**

(e.g., Higueras-Castillo et al., 2023; Mukherjee and Ryan, 2020). This result supports the positive role of social force on sustainable product adoption extending it to EVs. The product's characteristics, such as the social status conferred by owning an EV, may explain this result. Positive peer perceptions and recommendations can influence and encourage the adoption of EVs (Asadi et al., 2022; Li et al., 2020). Further, the literature underscores that positive media coverage is associated with positive attitudes toward BEV (Scherrer, 2023), and social media may serve as a platform to share information on EV use and acquisition driving consumers to adoption (Meelen et al., 2019; TyreeHageman et al., 2014). Since social media influence through collaboration with influencers may positively influence adoption behavior (e.g., to advocate for environmental sustainability) (Cattapan et al., 2023), online influencers and celebrities should be included in future analyses.

Regarding *perceived ease of use*, our findings align with previous literature showing a positive influence of this factor on purchase intentions toward EVs (e.g., Adu-Gyamfi et al., 2024; Zhang et al., 2023). This result may be attributed to the fact that a significant portion of respondents had prior experience with EVs, leading to familiarity with their operational aspects, which fosters a sense of reliability and comfort (Xu et al., 2020). Additionally, technological advancements, such as improved user interfaces and simpler operation and maintenance compared to conventional vehicles, likely contribute to this perception by reducing barriers to adoption (Jaiswal et al., 2021; Wu et al., 2019). Nonetheless, further research should deeply explore this relationship, considering the limited evidence in existing literature on this topic.

Our findings reveal a negative impact of *range anxiety* on BEV adoption, aligning with previous studies that identify this factor as a significant barrier to EV adoption (e.g., Neubauer and Wood, 2014; Khazaei and Tareq, 2021). Research suggests that range anxiety stems from concerns over the battery depletion, limited availability of charging infrastructure, and lengthy charging times (Mukesh and Narwal, 2023; Chen et al., 2016). These logistical challenges increase uncertainty and reluctance among consumers, underscoring the need for advancing charging networks and technology to mitigate range anxiety and promote wider EV adoption (Yang and Wang, 2018).

Contrary to our hypothesis, *government incentives* were found to have no significant effect on consumers' intentions to purchase BEVs, in contrast with previous literature results (e.g., Gunawan et al., 2022; Gómez Vilchez et al., 2019). One possible explanation for this result is that consumers may not view government incentives as significant due to limited awareness or trust in governmental bodies, contributing to skepticism and reluctance (Alessandro et al., 2021; Gracia and Arino, 2015). Furthermore, the effectiveness of these incentives might depend on their size, which varies significantly across the three countries studied (ACEA, 2024a). Incentives that are too small relative to the purchase cost may be insufficient to influence most consumers' purchasing decisions. Although our findings differ from established literature, it is essential to note that the lack of significance does not undermine the relevance of government incentives entirely; their impact may vary across different cultural or regional contexts. Future research should investigate these relationships further, specifically by examining the nature of the incentives offered by government entities.

Our results show that *direct experience* positively affects consumers' purchase intention of EVs, in line with previous studies (e.g., Buhmann and Criado, 2023; Xu et al., 2020). This result confirms the relevant sole of experience with EVs in shaping consumer preferences, supporting previous research (Tan et al., 2023; Zhao et al., 2022).

Concerning control variables, both gender and age are found to be not significant in influencing consumers' EV purchase intention. Despite this result, previous research has highlighted the significant role of socio-demographic variables in influencing sustainable consumption choices (Chekima et al., 2016; Laroche et al., 2001), including within the context of EV adoption (Buhmann and Criado, 2023; Vassileva and Campillo, 2017; Plötz et al., 2014). Further research is needed to explore these relationships in more detail, offering valuable insights into the role of these variables.

5.2. RQ2: are there differences in the determinants of intention to purchase BEVs based on the consumers' country of origin?

Focusing on the role of country of origin, Kruskal-Wallis's test results reveal significant differences among German, Italian, and Norwegian consumers.

Norwegians' higher levels of subjective norms and perceived government support can be attributed to Norway's strong policies for EVs, including tax breaks and a well-developed charging infrastructure. These factors reduce practical barriers and shape social norms, making EV ownership more appealing and enjoyable (Higueras-Castillo et al., 2023; Gunawan et al., 2022; Prabaharan and Selvalakshmi, 2020). The higher hedonic motivation in Norway may stem from the cultural association of EVs with modernity and status, further enhancing their attractiveness (Noel et al., 2019). Indeed, governments can stimulate EV adoption through financial incentive policies, reducing the barriers of high EV prices and increasing market share (Aasness et al., 2015). EV buyers in both Germany and Italy benefit from tax exemptions. While Italy continues to provide purchase grants for BEVs and subsidies for home-charging infrastructure, Germany's purchase incentives were discontinued in 2023, retaining only reduced taxable amounts for certain vehicles (ACEA, 2024a). However, the varying economic conditions in these countries likely contribute to differences in how consumers perceive the impact of these support measures.

Italians show a higher sense of environmental responsibility and concern, likely linked to broader environmental movements. The 2023 Istat Report on Equitable and Sustainable Wellbeing in Italy highlights a strong level of environmental awareness, with climate change identified as the leading issue by most of the population aged 14 and over. Notably, concern for climate change saw a significant rise compared to previous years, reflecting a growing environmental concern (Istat, 2023). However, this does not translate into higher EV adoption intentions, suggesting that practical issues, such as economic conditions or infrastructure limitations, play a larger role in influencing behavior.

The lower levels of range anxiety and greater perceived ease of use reported by Norwegians, in contrast to Italians and Germans, can be attributed to Norway's mature EV market and widespread experience with EVs, as indicated in our results (see Table 2).

Norway's extensive exposure and use of EVs, coupled with an expanding network of roughly 23800 charging stations for 817500 electric and plug-in hybrid vehicles (Statista, 2024), contributes to reduced range anxiety and increased confidence in EV adoption, fostering a higher level of familiarity and comfort with the technology among consumers (Zhao et al., 2022; Burgess et al., 2013). In contrast, the less developed EV markets and infrastructure in Italy and Germany may explain the significantly higher levels of range anxiety and lower perceived ease of use reported by consumers in these countries.

Finally, the significantly higher purchase intention in Norway compared to Italy and Germany reflects the cumulative effect of these socio-economic and infrastructural factors. Norway's comprehensive support system for EV adoption creates a more favorable environment for consumers to transition to EVs (Skjølsvold and Ryghaug, 2020). Conversely, Italy and Germany still face infrastructural and economic challenges that hinder higher adoption rates. Purchasing power might also significantly influence this result. Norway's GDP per capita (€71870) is substantially higher than that of Germany (€36290) and Italy (€28520). This economic advantage correlates with EV market uptake; countries with a higher GDP per capita typically exhibit higher EV market shares (ACEA, 2019). Additionally, lower electricity prices in Norway (€121.10 per MWh) compared to Germany (€416.20) and Italy (€361.90) further diminish cost barriers for EV adoption linked to charging expenses (Eurostat, 2023). These results suggest that beyond individual characteristics, external factors such as national policy and economic conditions also play a crucial role in shaping consumer perceptions of EVs.

Despite the observed differences in perceptions, these are not such as to motivate the intention to purchase differently. The multigroup analysis reveals only two paths that are significantly different among the consumer groups: (1) hedonic motivation leads to a greater purchase intention for Italians compared to Norwegians, and (2) age has a significant effect on purchase intention for Norwegians – i.e., the older the consumer the higher the purchase intention, in line with previous research (Jansson et al., 2017; Plötz et al., 2014; Johansson-Stenman and Martinsson, 2006) - but is not significant for Germans. These results underscore the intricate and multifaceted nature of consumer behavior in the context of EVs, emphasizing the importance of further investigations into the determinants of behaviors across distinct consumer groups.

6. Conclusions

This paper explores the key determinants influencing consumer adoption of BEVs in three European markets with distinct socio-economic contexts and differing levels of EV market maturity. The results of the SEM revealed that hedonic motivations, ascription of responsibility, subjective norms, and direct experience significantly enhance consumers' willingness to purchase a BEV. In contrast, range anxiety and environmental concerns negatively impact purchase intentions. The Kruskal-Wallis's test and Multigroup analysis highlight significant differences in consumer perceptions of BEVs and the effect of behavioral determinants across countries. These findings contribute not only to the literature on consumer behavior and electric mobility but also help to better understand how to support the transition toward a more sustainable transport system.

6.1. Implications

Several academic and practical implications arise from this study. From a theoretical perspective, this study offers several contributions to the existing literature on EV adoption. First, drawing on a comprehensive literature review, we identified critical factors to develop a novel theoretical framework grounded in the TPB. Second, this study is the first to investigate consumer behavior toward BEVs across Germany, Italy, and Norway, countries characterized by distinct socio-economic contexts and varying levels of EV market maturity. Findings provide insights into significant cross-national differences in consumer perceptions and adoption patterns. Third, empirical evidence and perspectives stem from our results open avenues for future research in the field. The unexpected results, such as the counterintuitive effect of environmental concern and the non-significant influence of government incentives, gender, and age, need further investigation. Future research should investigate whether distinct consumer clusters, defined by sociodemographic characteristics, exhibit varying willingness to adopt EVs degrees. Regarding government incentives, future research should explore the distinct components of this factor to understand their specific impact on adoption behaviors and assess their relative effectiveness. The positive influence of subjective norms warrants further investigation, particularly by examining the role of digital platforms, including social media, influencers, and celebrity endorsements, which have become increasingly significant in shaping consumer behavior. Our study highlights the potentially significant role of direct experience in influencing EV adoption behavior, corroborating existing literature that emphasizes its importance. Prior research underscores direct experience with EVs enhances perceptions of ease of use and reduces range anxiety (Tan et al., 2023; Zhao et al., 2022). Additionally, individuals with positive experiences frequently influence others' perceptions, encouraging them to consider EV purchases (Li et al., 2017; Zhuge and Shao, 2019). While we have incorporated this factor as a direct determinant in our model, future research could explore its role as a potential moderator, examining how it interacts with other variables to shape adoption behaviors. Regarding cross-country comparisons, our findings emphasize that socio-economic contexts significantly shape consumer perceptions of EVs. Future research should replicate this study across a broader range of countries to further explore how regional differences influence the adoption process and consumer attitudes in diverse markets. Moreover, longitudinal studies are necessary to assess how evolving infrastructure and policy changes impact consumer perceptions and behaviors over time, providing deeper insights into the dynamic nature of EV adoption.

From a managerial perspective, this study offers some preliminary insights that could inform marketing strategies aimed at supporting EV adoption. It highlights factors that may influence consumers' willingness to purchase EVs and points to possible differences in consumer perceptions across countries. Accordingly, stakeholders and policymakers might consider general approaches such as increasing awareness of the environmental benefits of EVs and addressing concerns related to charging infrastructure. For example,

educational campaigns could emphasize ecological advantages, and efforts to improve the accessibility and reliability of charging stations may help reduce range anxiety. Additionally, promoting positive user experiences through test drives or user testimonials might contribute to shaping consumer attitudes, although the effectiveness of such strategies requires further validation.

Finally, any marketing efforts should be adapted to local contexts, recognizing that consumer motivations and barriers may vary by country. However, given the exploratory nature of the results, these recommendations remain tentative and should be complemented by further research before being widely implemented. Integrating marketing initiatives with supportive policies could potentially facilitate EV adoption, but more robust evidence is needed to guide specific interventions.

6.2. Limitations

Some limitations must be acknowledged. First, data come from a convenience sample. Although the use of convenience sampling is common in consumer behavior studies (e.g., Butt et al., 2017; D'Agostin et al., 2020; de Medeiros et al., 2021), such a sampling technique might not ensure the sample is fully representative of the overall population. While the large sample size increases the precision of the estimates by reducing random error, it does not eliminate systematic bias potentially introduced by the non-probability sampling method (Atkinson and Flint, 2001). Specifically, the possibility that the sample may overrepresent individuals with higher exposure or openness to EVs cannot be ruled out, and this may influence the generalizability of the findings. Indeed, as participation was voluntary and distributed through online platforms, the sample may be subject to self-selection bias (Bethlehem, 2010), which could lead to an overrepresentation of EV-interested individuals. Future research could benefit from distinguishing more precisely between types of direct experience (e.g., ownership vs. incidental use) to further validate the robustness of observed behavioral patterns. Thus, caution should be considered when generalizing the results. We acknowledge that our sample does not fully reflect the overall populations of Germany, Italy, and Norway; thus, future research should aim to expand the sample size and adopt probabilistic sampling methods to enhance representativeness. Moreover, the cross-country comparison is exploratory and limited to three European countries with specific socio-economic characteristics and levels of BEV market maturity. Therefore, the findings might not be generalized beyond these contexts without further validation. Second, the model includes only age and gender as control variables. Other relevant socio-demographic factors, such as income, education, and occupational status, were not considered due to comparability issues across countries. Future research should include broader and representative socio-demographic indicators to enhance contextual interpretation and generalizability. Third, in this study, we focused exclusively on the socio-economic context, without accounting for the cultural dimensions of the three countries, such as those identified by Hofstede (2001). Future studies should be conducted in this direction, enriching our understanding of the diverse motivations driving consumer behavior across distinct European contexts. Fourth, this study is focused exclusively on a specific category of EVs. Future research should consider comparing various types of EVs to provide a comprehensive understanding of consumer preferences and adoption behaviors. Finally, the identified relationships should be interpreted with caution. While we included a measure of prior EV use (i.e., direct experience), this does not distinguish between ownership and other forms, such as leasing or sharing, which could influence consumer perceptions differently. Future research could explore these distinctions more explicitly, especially considering ACEA's (2025) recent recommendations to implement social leasing schemes to improve EV access.

In conclusion, this paper enriches the literature on EV adoption by offering empirical evidence and perspectives on personal and socioeconomic determinants behind consumer decisions. We hope our contribution promotes the academic debate and inspires practical interventions, advancing sustainable mobility transition.

CRediT authorship contribution statement

Valerio Schiaroli: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization, Funding acquisition. **Luca Fraccascia:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A1
Correlation matrix (square root of the AVE of constructs in bold, as elements of the diagonal). Full sample.

Constructs	Hedonic Motivations	Ascription of Responsibility	Environmental Concern	Subjective Norms	Perceived Ease of Use	Range Anxiety	Government Incentives	Purchase Intention
Hedonic Motivations	**0.918**							
Ascription of Responsibility	0.341	**0.819**						
Environmental Concern	0.245	0.645	**0.846**					
Subjective Norms	0.369	0.392	0.290	**0.932**				
Perceived Ease of Use	0.573	0.252	0.174	0.235	**0.906**			
Range Anxiety	−0.564	−0.208	−0.080	−0.232	−0.566	**0.800**		
Government Incentives	0.205	0.124	0.077	0.280	0.218	−0.272	**0.823**	
Purchase Intention	0.696	0.344	0.165	0.403	0.544	−0.627	0.277	**0.913**

Table A2

Table A2
Mean values, standard deviation, and standard error of the mean of the variables' responses in each country. Abbreviation: HM: Hedonic Motivations; AR: Ascription of Responsibility; EC: Environmental Concern; SN: Subjective Norms; PEU: Perceived Ease of Use; RA: Range Anxiety; GI: Government Incentives; and PI: Purchase Intention.

Country		HM	AR	EC	SN	PEU	RA	GI	PI
Italy	Mean	3.722	3.827	4.342	2.710	4.192	3.089	2.433	3.272
	Std. deviation	0.957	0.920	0.686	0.914	0.861	1.130	0.806	1.282
	Std.error of the mean	0.064	0.061	0.046	0.061	0.058	0.076	0.054	0.086
Germany	Mean	3.597	3.601	4.167	2.655	4.143	3.282	2.678	3.120
	Std. deviation	0.937	0.881	0.766	0.989	0.819	1.113	0.849	1.220
	Std.error of the mean	0.066	0.062	0.054	0.070	0.058	0.079	0.060	0.086
Norway	Mean	3.962	3.489	3.984	3.152	4.494	2.505	3.431	3.874
	Std. deviation	0.925	0.787	0.827	0.974	0.699	0.975	0.779	1.004
	Std.error of the mean	0.052	0.044	0.0468	0.055	0.039	0.055	0.044	0.057

Data availability

Data will be made available on request.

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