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Enhancing Sustainable Business Models for Green Transportation

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Abstract: Business models (BMs) are crucial for the successful market penetration and diffusion of sustainable innovations. Nonetheless, consumer preference knowledge about adopting electric vehicles (EVs) under innovative BMs is low. Drawing on existing conceptualizations of BMs, this investigation studied consumer preferences for three innovative BMs (EV-leasing; battery-leasing; B2C EV-sharing) and the traditional total purchase BM. This research aimed to analyze the growth of the EV market, as well as to understand consumer preferences regarding business models and how these can overcome the barriers to EV purchase. During this study, an empirical study was applied based on a quantitative method. Data were collected through Google Forms and disseminated via social media. Using survey data to conduct a quantitative analysis, the findings showed that most people have an interest in EVs but consider their high cost the main barrier. The environmental benefits are the main motivation for buying an EV, since people are very concerned about the environment. Regarding the innovative business models (IBMs), most people were not aware of their existence but believed that they were fundamental for EV acquisition.

Keywords: electric vehicles; business models; innovative business models; consumption behavior

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1. Introduction

For many years, there have been a lot of discussions concerning the environment. Significant research has been performed regarding technological progress, policy support, and market pull [1], so that sustainable innovations could be developed to ameliorate environmental problems, such as global warming and air pollution [2].

The transportation sector was reported to be responsible for 75% of greenhouse gas emissions, being one of the top contributors in the European Union. These emissions have been increasing since 2014 [3]. In Portugal, 76% of the total primary energy used is related to fossil fuel dependency, of which almost half is associated with the transportation sector [4]. Naturally, electric vehicles are changing customer perceptions, despite classic and hybrid vehicles having a lower price compared to EVs. This happens because of their disruptive technology. However, EVs themselves are not entirely carbon neutral, given the way most electricity is generated [5].

The impact of different business models on the EV commercialization is often ignored in the literature. As Bohnsack et al. [6] stated, "Commercialization takes place through business models, which describes how a company creates, delivers and captures value". As previously mentioned, an EV's price is higher than standard vehicles, but the conventional BM (in this case, total ownership) might have some limitations for achieving a wider adoption and diffusion of sustainable innovations [7]. To address the societal transition towards sustainability, the IBM is recognized as an important factor. Over the years, multiple business model innovations have emerged in the EV market.

One research challenge is the few studies that have examined the impact of different business models on EV commercialization in Portugal, allowing a more focused view on consumer preferences. Consumer attitudes towards EVs needs to change [8], so that it is possible to overcome all the problems associated with their purchase [9]. Since innovative

BMs address the concerns regarding the traditional BMs and also, seem to be more worried about achieving sustainability and addressing environmental concerns, it is important to understand how these IBMs can change people's perception regarding EVs.

Many academics have performed similar research about the impact of certain of these business models. Zarazua de Rubens et al. [8] investigated the challenges for EV mass adoption under the current business models, through conducting semi-structured interviews. To predict consumer preferences about increased EV use depending on the type of EV leasing, Liam et al. [10] applied an economic model. Liao et al. [11] examined and differentiated consumer preferences regarding EV's with two innovative business models (vehicle-leasing and battery-leasing).

The research most similar to this study was that performed by Huang et al. [12], where their aim was an empirical investigation under four different business models of the consumer preferences in the biggest EV market of the world, China.

To date, there have been no other similar investigations in Europe and, in particular, in Portugal. With Portugal being one of the most advanced Europe countries regarding use of electric vehicles and road electrification, there have been no recent investigations about consumer needs/preferences and the impact of BMs. As such, this research used an approach similar to the one above: focusing on empirically investigating consumer preferences under four different business models (traditional business model: total car purchase; and three innovative business models: car-leasing, battery-leasing, and B2C EV-sharing) but regarding the Portuguese context.

2. Theoretical Framework

The theme of electric vehicles is connected with the protection of the environment and represents a necessary change that needs to be made in the automotive industry, since it is one of the industry's most responsible for pollution globally; thus, this section will begin with the sustainable transition. Afterwards, an analysis of the EV market will be made. The barriers to and motivations for adopting an EV will also be considered, alongside government incentives. To conclude, the impact of the business models on the adoption of this disruptive technology is discussed.

2.1. EV Market and Sustainable Transition in the Vehicle Industry

Road transport, which is mainly powered by fossil fuels, contributes to a wide range of sustainability problems, such as global warming, environmental pollution, and oil dependency. Substituting cars powered by internal combustion engines with electric vehicles (EV) at a large scale is expected to form a potential solution to the above problems (Siegel, 2009).

The automobile industry has undergone and is undergoing significant transformations, driven by technological changes and external issues such as government policies and consumer concerns about protecting the environment [13]. In addition, Guffarth and Knappe [14] and Faisal et al. [15] stated that the use of petrol cars has created substantial environmental problems, such as air pollution and energy shortages. Electric vehicles are causing a shift in consumer expectations, despite their price compared with classic vehicles [16], where consumer satisfaction is intrinsically linked to technological performance [17,18]. Furthermore, innovative business models may be a prerequisite for sustainable technologies to become commercially viable and fulfil its potential in alleviating environmental problems [19].

In the initial years, electric cars were unattractive for most consumers due to their high purchase price and many uncertainties, such as the battery life, short driving range, limited number of charging stations, and long charging times [11].

In 2019 and 2020, global sales stayed below trend. In 2019, the demand and supply of popular offers in China and Europe were reduced because of the WLTP. In 2020, support was increased by policy makers, but the first wave of COVID-19 caused a slump in car sales [20]. According to Figure 1, there has been an exponential growth in EV sales since

the first years of their commercialization. We can see that in almost every year, sales had a growth of at least 45%. In 2021, it was estimated that 6.4 million electric vehicles would be sold, with 4.42 million BEVs and 2.18 million PHEVs.

When analyzing Figure 2, we can reach the conclusion that EV sales showed a large increase in growth rates during 2021 H1, achieving +157% in Europe, +197% in China, and +166% in USA, with 1.06 million, 1149 million, and 0.297 million sales, respectively. Our focus will now change to the EU. Regarding Figures 3 and 4, in the second quarter of 2021, the expansion electric cars continued in the EU. The BEV market share more than doubled to 7.5% in 2021. PHEVs showed an increase up to 8.4%. Regarding HEVs, their sales also had a large increase, accounting for 19.3% of EU registrations.

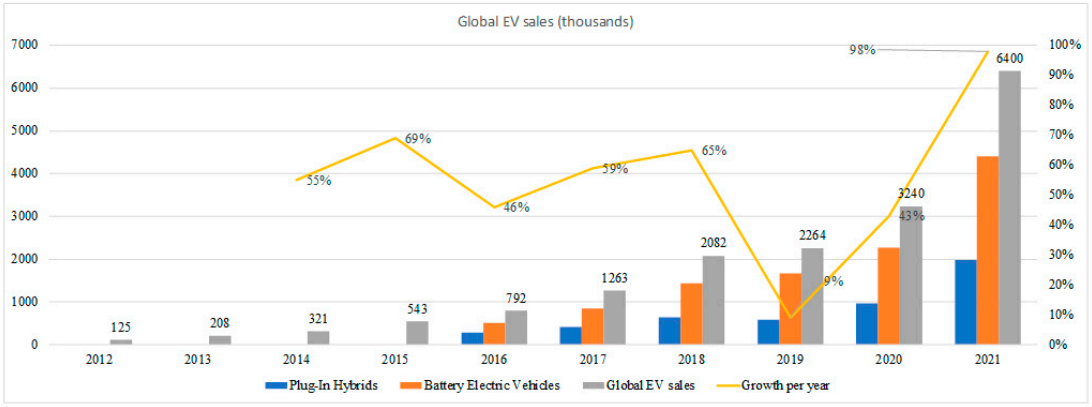

Figure 1. Expected global EV sales (from 2012 to 2021) [22].

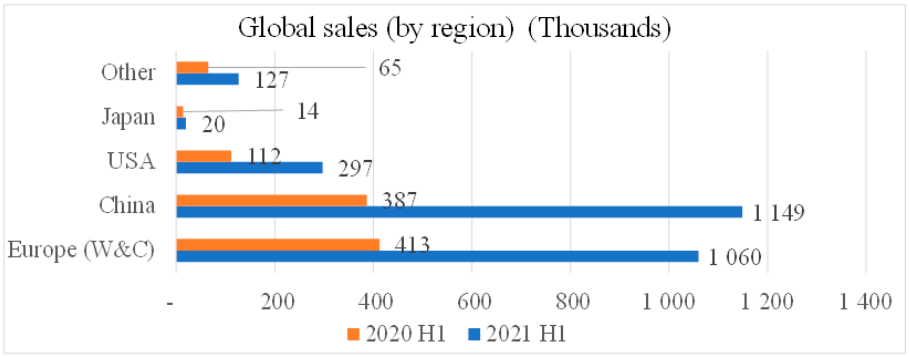

Figure 2. Global sales (by region) [22].

The market share of traditional fuel types (petrol and diesel) decreased, having a combined market share of 62.2%, as can be seen in Figure 5 [21]. During the second quarter of 2021, BEV registrations included 210,298 cars, an expansion of +231.6% comparatively to 2020. PHEV registrations reached 235,730 units sold, having a growth of +255.8%. HEVs, with 541,162 units sold, represented the EU's largest alternative-powered car category [21].

2.2. Barriers, Incentives, and Motivations for EV Adoption

Several authors have studied the barriers regarding EV adoption and how they influence consumer preferences. An analysis was carried out of sentiments towards the technology present in EVs and they were predominantly negative [23].

Lack of Knowledge. According to Diamond [24], the lack of knowledge of potential customers is a common barrier to the adoption of any innovative technology. In general, clients' choices are influenced by the media and social networks, being the largest information sources nowadays [25]. Besides some early adopters who have paved the way, most consumers are still learning or unaware about the advantages of EVs and misconceptions about electric vehicles are still common [26].

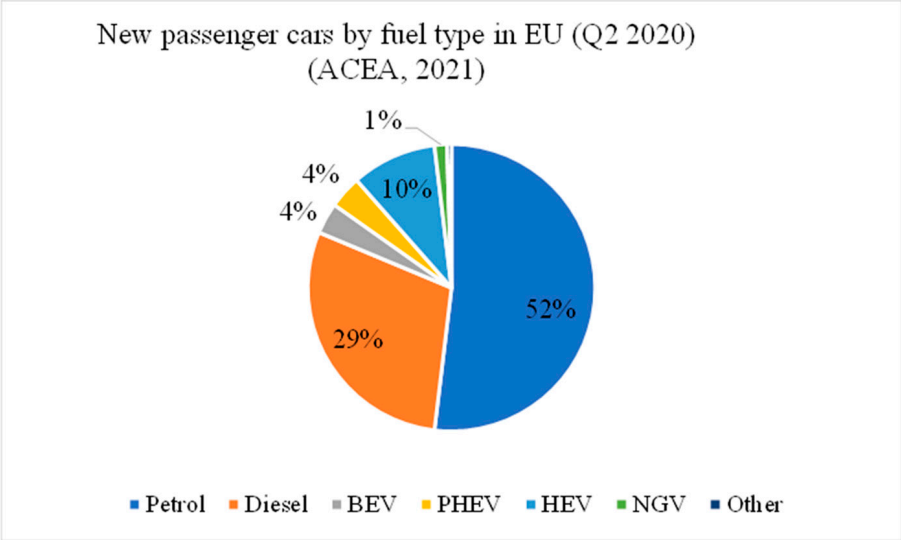

Figure 3. New passenger cars by fuel type in EU (Q2 2020) [21].

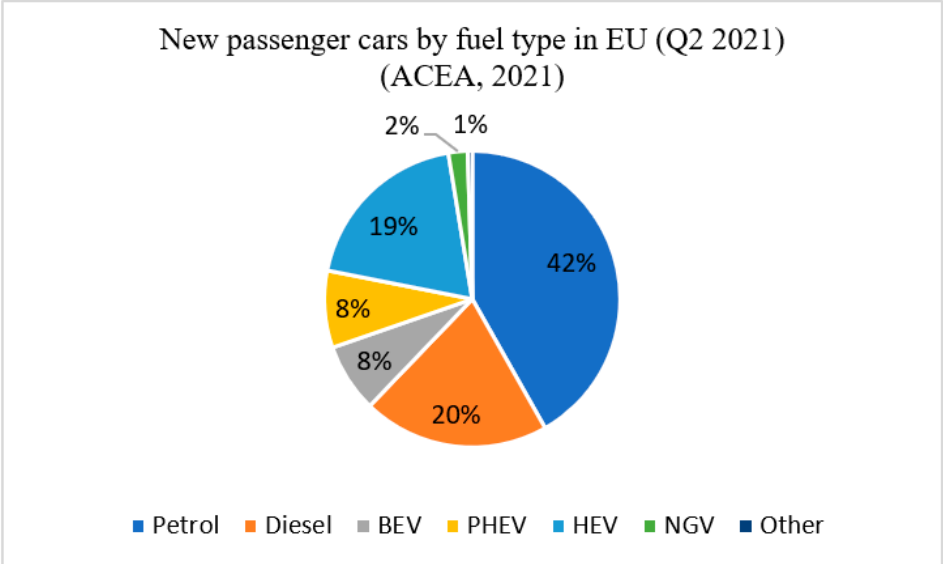

Figure 4. New passenger cars by fuel type in EU (Q2 2021) [21].

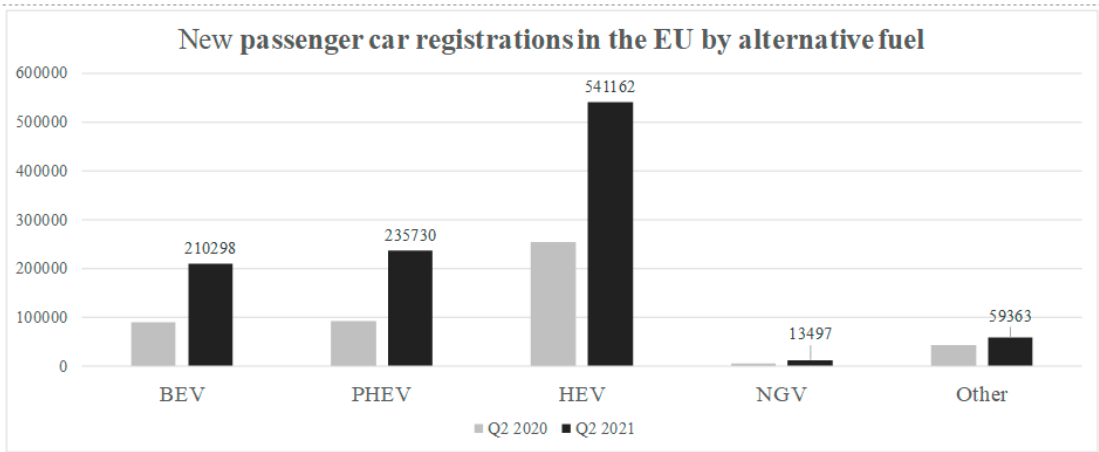

Figure 5. No of passenger car registrations in the EU by alternative fuel (Q2 2020 and Q2 2021) [21].

As Ge [27] stated, when people are buying a car, they probably just do not think about electric vehicles. Cars have been driven in the same way for 100 years, so the long-held norms and practices of society regarding vehicles has been challenged by EVs. Thus, most of the time, the purchase of this disruptive technology is not on people's radar because they have never ridden in an electric vehicle. In several studies, there is little information about people's opinions regarding costs, benefits, and driving experiences; and in those that have information, it was found that general knowledge is quite low [28].

High Costs. According to theory, price is a factor that does not play in "the same team" as the purchase of "green products". After all, this type of product is usually associated with high costs, creating a social dilemma during the act of buying [29]. As reported in several investigations, the second factor identified as a concern for customers is their perception of cost [30], and many people still consider this disruptive technology a luxury item [31,32].

In a study conducted in Portugal by Dias et al. [33], the monetary criteria were the ones which influenced people's buying decision the most. The development and production of EVs by car manufacturers uses different processes and techniques. In the past, another major cost associated with these products was the battery packs. The high cost of lithium-ion batteries, which increase battery capacity and driving range, is the origin of EV's high price [34,35].

There are some advantages regarding maintenance and fuel costs. The complexity of EV propulsion is significantly lower compared to combustion engines, making it less costly to maintain; however, when looking for an EV, customers do not incorporate fuel economy into their decision, leading to irrational behavior [32,36].

Battery Autonomy (Range anxiety). The conservatism about technology that still exists in consumers leads to the dimension of anxiety and concern emerging in relation to vehicle autonomy. This matter is emphasized when the topic is BEVs, without the possibility of using any other type of fuel, such as in hybrid vehicles. Thus, customers have some apprehension that the autonomy will not be sufficient, turning this into a barrier to the adoption of EVs [30]. Range anxiety is defined as the fear of an EV running out fuel in the middle of a ride [37]. Due to inexperience and the insecurity of some drivers about a trip's duration, it is hard for them to guess how long the battery will last. Most electric vehicles have reduced autonomy, which means that more than one charging will be necessary per long trip.

Although this apprehension is considered a barrier, an investigation affirmed that people evaluate, in a subjective way, autonomy as a factor they can successfully adapt to [38]. According to De Waard et al. [39], distance problems decrease when there is an increase in experience. At present, people are used to driving vehicles with an autonomy of 800 km. Instead, EVs need to be recharged almost every day. According to Van Barlingen et al. [40], the average range of EVs is 313 km (194 miles).

Charging Time. Considering the variety of EVs and the existent charging stations, it is probably no surprise that the charging time of these types of vehicles also varies [41]. Charging an electric vehicle can take from a few minutes to over 24 h and depends on two important factors: the type of charger, and the battery size [42]. According to several authors, such as Hidrue et al. [43] and Ebgue and Long [30], charging times are still very long. An investigation conducted by Yilmaz et al. [44] affirmed that charging time and battery life are connected to the characteristics of the charger. The authors defined three levels of charging. The less effective level can be used in any place, with a normal power plug. It can take up 6 to 8 h to charge the battery to 100%. The second level can be found in public places located in cities or by buying appropriate equipment to be used privately. This takes 1 h to charge 80% of the battery. The last level is usually found in gas stations and is the fastest. Despite taking 15 to 30 min to recharge a battery to 100%, the number of existent spots with this equipment is still limited and may not be sufficient to meet all users' needs.

Infrastructure. Similar to gas stations for combustion vehicles, charging infrastructure is a key factor in the transition and implementation of well-structured electric mobility, which is an obstacle to EV adoption [25,45]. In order to make EVs a viable option, harmonization of performance standards is important, as well as installation of fast charging stations and sustained R&D support [46]. In addition, it is possible to promote the purchase of EVs by developing dedicated infrastructure [11], which would allow driving more miles and ending the range anxiety demonstrated in some people [47,48]. The possibility of charging vehicles at home has been seen as an advantage in the investigations of some authors, not just for convenience, but also the security and safety afforded to the vehicle and charging cord [39]. The density of charging spots is an important factor concerning the utility of EVs. As Sierzchula et al. [49] mentioned, the charging infrastructure in a nation best predicts the EV market share.

Regarding incentives, it is true that there is positive growth in the European EV market; however, the uptake is still low. To make this innovative technology more attractive to customers, governments are offering incentives such as support policies and financial incentives [49]. The study of Lanbgroek et al. [50] concluded that the incentives offered by governments have a positive effect on EV adoption. These incentives reduce the purchase cost and the total cost of the ownership gap existing between EVs and the combustion vehicles, which is crucial for the consumers. The environmental fund created by the Portuguese Environment and Climatic Action Ministry supports the acquisition of electric vehicles with EUR 10 million. Portugal has developed its own support policies to reduce CO2 emissions and encourage EV adoption. There are several programs that promote the energy efficiency and electric transport, such as the MOBI.E program. This program is responsible for the installation of charging points [33], and the Environment Ministry has agreed a deal for the creation of a pilot grid. In addition, the Portuguese Government gives an incentive for the purchase of home chargers and has fully exempted EVs from ISV (Vehicle Tax) and IUS (Road Tax) (Law Proposal no. 257/XII).

Motivations include the following:

Performance. One motivation involves driving pleasure through good performance. A study conducted by Skippon and Garwood [51] affirmed that the experience of driving an EV improved in some measures for the drivers, including the initial acceleration, noise, smoothness, capacity of response, and driving pleasure. They also found that drivers divide car performance into two different/independent categories: the dynamic performance and travel. The first category covers factors such as the acceleration, the power, and starting response. The other consists in the smoothness and level of noise that the vehicle displays during high-velocity travel. EVs have the potential to offer better performance than combustion vehicles in these two dimensions, thereby this advantage may compensate the utility of long distances, charging times, and high costs. On the other hand, the participants of an investigation performed by Graham-Rowe et al. [52] felt that EVs were worse regarding power and performance than combustion vehicles. If these cars achieve a technical performance identical to conventional cars, customers tend to change their opinion [46].

Fuel Price. Buying decisions of BEVs and HEVs are influenced, not only by the fact of being friendly-environmental solutions, but also by financial advantages. Studies based on the construction of scenarios and sales analysis of a determined temporal period affirmed that gasoline price increases have a positive influence on EV adoption [53].

A significant influence on fuel consumption may be connected to progressive increases in fuel prices, thus having a greater relevance for future buying decisions [33]. Nonetheless, the same authors concluded that fuel prices will need to increase by at least 70 cents to persuade customers to adopt an EV.

Environmental Incentives. The increase in CO_2 emissions in the atmosphere is a problem for all the population. The fact that electric vehicles produce no emissions is one of the reasons why people prefer them over conventional vehicles. Cao et al. [54] affirmed that environmental factors have an influence over customers intention to buy in

the acquisition of alternative-fuel vehicles. The principal reason for purchasing an EV is environmental concerns [55]. The investigation of Graham-Rowe et al. [52] affirmed that EV drivers experience a "well-being factor", due to environmental factor consciousness.

There is a wide range of negative externalities resulting from the burning of fossil fuels. Various studies have indicated that EVs are less harmful than combustion vehicles, including health and environmental impacts [56], while others pointed to some environmental concerns in the battery production phase [57]. Hidrue and Parsons [58] found that EVs have more advantages than conventional vehicles, since they reduce petrol dependency and provide benefits for climatic change, atmospheric pollutant, and local noises, especially in populous cities.

2.3. Consumer Behaviour

It is important to understand the underlying motives regarding the process of a consumers' search [59]. Assuming rational expectations implies that customers' beliefs are homogeneous, which can extenuate the retailers' need to discriminate the price based on heterogeneity beliefs [59]. Customers are stimulated by environmental factors (economic, technological, political, and cultural) and by marketing stimuli such as advertising, discounts, etc. [60]. In addition, cultural background was found to have a significant impact on consumer decision-making [61], suggesting that businesses need to take into account cultural differences when developing marketing strategies. Additionally, some articles explored the differences between consumer innovativeness and consumer creativity [62], suggesting that different consumers may approach new products or services in different ways.

Regarding the electric vehicle context, a variety of promotional activities are used by dealers to promote EVs, such as giving cash back, prize-giving sales, and old car replacement, to attract client attention. EV buyers are environmentally conscious individuals, highly educated, and younger [43] These vehicles are low-carbon innovative products, so to motivate customers to adopt EVs, it is necessary for them to experience the performance and characteristics [63]. Studies on consumer willingness discovered that people with an academic degree, higher income, and more concerned about global warming were more likely to pay a premium price for these vehicles [64]. Additionally, a study found that the number of cars and driver's license holders within a family and the household size had a critical direct impact on choosing a more fuel-efficient car [65]. Due to their highly innovative characteristics, EVs represent an innovative eco-friendly breakthrough. To encourage adoption by customers, some "rules" such as green special license plates, access to bus lanes, exemption from purchase taxes, and test drives are provided. It is important and necessary to give customers an opportunity reach out and increase their interest in EVs [60,63].

2.4. Business Models for EVs

Every successful organization needs a sound business model, whether it is a new venture by an established organization or a start-up [66]. Business models define how firms create and capture value with their product or service offerings, with particular attention to how they configure their activities with partners and suppliers and deliver value to a customer segment [67].

It has been argued, therefore, that firms need different business models to transform the specific characteristics of sustainable technologies into new ways to create economic value [67] and overcome the barriers that hinder market penetration [68]. The mass adoption of sustainable innovations is usually constrained by uncertainty associated with the technology [11,60].

The outcomes from different business models selling the same technology can vary greatly, depending on factors such as market demand, pricing strategies, distribution channels, and customer experience [69]. In particular, conventional business models are

typically based on ownership-based consumption but have limitations in achieving the wider adoption and diffusion of sustainable innovations [7].

Disruptive technologies have the potential to reinvent a product by introducing new attributes that could become a key source of competitive advantage [70]. BMI is increasingly recognized as a vital component of the societal transition towards sustainability [71]. Through business model innovation, sustainable technologies can create new sources of value for customers, in addition to their positive impacts on the environment [6]. BMI has attracted attention in recent years as a source of competitive advantage in early-stage technological industries. Indeed, research has shown that business model innovation can often make the difference between innovations that are successfully commercialized and those that stay on the shelf [67].

The emergence of innovative business models in the automotive industry is expected to lead to the growth of electric vehicles [68]. New strategies for value creation and value capture are being implemented, such as the integration of EVs in mobility service business models or through valuing them as resources in electricity markets. To correspond to the major barriers presented to EV market penetration, this sector is creating a diversity of innovative business models, with a view to changing consumer attitudes toward EVs [9]. Moreover, manufacturers have tried to overcome these difficulties by adopting a direct-sales model, improving services, and educating consumers on the benefits of using electric cars [6]. However, sustainable development of the industry will greatly depend on whether the key stakeholders fulfil their commitments, involvements, and efforts [68].

As Liao et al. [11] stated, "If Business models are found to be useful in increasing the market share of EVs, car manufacturers should pay more attention to providing innovative business models apart from focusing on improving EV technology. Knowledge regarding consumer preferences in BM is significant for the decision making of both car manufacturer marketing strategies and government EV promotion policies." There have been many literature reviews based on the conventional business model, EV total purchase [72], despite the positive effects that innovative business models have on EV adoption [8]. The social, economic, and environmental benefits can be transformed or enhanced, with additional value for the customer and firm [67]. These BMIs have led to a fall in the cost of adoption/usage and offer great value from the customer's perspective. Regarding the organizational view, this will have an impact on firm performance because it will attract new customers by creating and dominating new markets [73].

People with a positive view of EVs are more likely to adopt EV innovation models and consider them, not only a status symbol, but also a highly valuable symbol of modern living derived from EV usage [74]. It is important to know that consumers do not always share the same preferences and choices about a product, so communication is valuable for minimizing the perceived barriers [75]. The success of electric vehicles in the marketplace depends on effectively communicating the unique benefits of EVs to customers, which requires a deep understanding of customer needs and values, transparent and honest communication, and a focus on building trust and credibility [76]. To achieve this, it must be clearly proven that customers' needs and values are well understood, clearly highlighting the benefits and attributes that electric vehicles offer [77]. There has been little research that has empirically examined consumer preference for EVs when offered under different business models; some similar research includes Zarazua de Rubens et al. [8] and Liao et al. [11]. Our investigation is based on the last study and focused on the Portuguese context, to study customer preferences regarding four different business models.

According to the investigation of Liao et al. [11], the different BMs include the following types: EV-buying (traditional method): In this model, the EV's full ownership is purchased from the dealer by the customer. Limited warranty is provided for clients, while there is no warranty included for the battery. Due to high battery costs, the EV-buying model has considerably higher initial capital costs for the customer than the other three business models.

Battery-leasing: This model allows consumers to purchase only the car body, which means an initial capital lower than the full purchase and leasing the battery with annual payments. Without the necessity of recharging the battery, consumers that adopt this business model can opt to replace the used battery with a fully charged one at a swapping service station. Notably, the swapping time will be shorter than charging a depleted battery in a fast-charging station. The battery leasing business model reduces the negative environmental impacts resulting from battery disposal and provides a more professional lifetime management for the battery.

EV-Leasing: Under a contract, the customer pays a leasing fee (annual or monthly) to have exclusive access to the car for a period (at least three months). After this, they can opt to renew the contract or lease a different EV. Additionally, consumers are exempt from the licensing process and registration of the vehicle. People who adopt this model have less financial pressure and the risk of market value depreciation is transferred to the service providers. B2C EV sharing economy: By providing clients who need instant mobility with a more flexible and on-demand access to EVs, this model has gained worldwide momentum. To gain access, the customers only need to make a request in a mobile app and can pick up the vehicle at an EV rental service location. If the remaining driving range is too low, people can switch to another EV. This service is charged by the hour/minute or driving distance (Tables 1 and 2).

Table 1. Component analysis of the four business models for EV adoption.

Models	Value Propositions	Value Network	Revenue Model
EV-Buying	Product-oriented (Limited warranty + Full ownership)	Car makers and dealers (Tesla is the only exception, since its sales are online)	Sell the whole vehicle
Battery-leasing	Product-oriented (Limited warranty + Battery swapping service + Car-body ownership)	Car makers, dealers, and battery swapping stations	Sell the car body and lease battery with annual charge
EV-leasing	Use-oriented (Free warranty + Exclusive access)	Car makers, dealers, or internet stores and service providers	Lease the vehicle, charging by month
B2C EV-sharing	Result-oriented (Free warranty + Exclusive access + On-demand car rental and return)	Car makers, mobile internet apps, and rental sites	On-demand rental of the vehicle, charging by usage (time and driving distance)

Table 2. Main issues in the EV literature.

Author	Title	Main Issues
Liao et al. [11]	Consumer preferences for electric vehicles: a literature review	EV's unattractiveness
Xu et al. [63]	Moving towards sustainable purchase behavior: examining the determinants of consumer intentions to adopt electric vehicles	Motivation and personal experience
Xu et al. [60,63]	Moving towards sustainable purchase behavior: examining the determinants of consumer intentions to adopt electric vehicles	Government Incentives
	Extending the theory of planned behavior to understand consumer intentions to visit green hotels in the Chinese context	Stimulation factors regarding the purchase time
Kleine [62]	Consumer innovativeness vs. consumer creativity: Conceptual distinctions and empirical illustration	Differences among customers

Table 2. *Cont.*

Author	Title	Main Issues
Schreiber & Eichberger [76]	Communicating the value proposition of electric vehicles: An analysis of OEM strategies	Highlight EV's benefits and attributes
Noor & Salim [69]	The impact of business model innovation on firm performance: A systematic literature review. *Journal of Business Research*	Outcomes of different business models selling the same technology

During the literature review, a market analysis was performed to evaluate the growth of this disruptive technology, globally, in Europe, and in Portugal (which is the focus of this investigation). Afterwards, research about the consumer behavior was carried out, with the objective of understanding preferences regarding EVs. The introduction of EVs has led the automobile industry to create new/innovative business models, to face new challenges regarding the perception of customers.

Taking into consideration the research gap mentioned in the above section, the present study seeks to answer the following investigation questions:

Question 1: What are the factors that condition EV commercialization in Portugal? Despite what Liao et al. [11] said about the unattractiveness of EVs due to the high purchase price and other uncertainties (battery life, short driving range, etc.), in Portugal, the process is moving fast. In the first 9 months of 2021, Portuguese consumers had already bought more 100%-electric cars than in the previous 7 years combined. This was 7839 registered cars, which represents a market proportion of 7% [78]. Although this is a good sign, it would be possible to further improve those numbers. Consumers need to be motivated to change to an electric perspective, either by personal experience of the performance and characteristics of the cars as Xu et al. stated, or by incentives from the government, as Wang et al. and Xu et al. explained in the literature. However, the importance of following commercial ethics is also important [79].

Question 2: What is the customer's perspective about the adoption of the new business models? In the literature, Wang et al. has stated that customers are led by various factors that decide when it the time for buying something. Moreover, Liao explained that knowledge regarding the BM consumer preferences is important for the decision-making and marketing strategies implemented by car manufacturers. At this level, artificial intelligence may play a very important role in commercial activity [80]. However, a global study by Kantar, to identify the consumption trends that drive electric vehicle commercialization, showed that people need more information about the technology associated with this subject, since 42% of people are not conscious of the benefits involved with the acquisition of this type of vehicle [81].

Question 3: Will companies benefit from the introduction of the innovative business models for EV commercialization? Padgett and Mulvey argued that it is important for companies to understand that consumers are all different and do not share the same preferences, so firms need to highlight the benefits and attributes that electric cars have for them. Companies need to recognize that business models are very important, because two BMs selling the same product/technology can yield different outcomes [67]. Furthermore, firms must be able to innovate or, at least, adapt their business model to the specificities of the product [82]. Since electric vehicles are a disruptive technology, the introduction of new/innovative BMs will be fundamental for their commercialization. For the development of the next section, these three questions will be fundamental, since they show what influences people when making their choices. To achieve more accurate results, an online survey will be further addressed in the Methodology section.

3. Materials and Methods

3.1. Research Design

According to Homburg and Kromher [83], data presentation is the basis of robust market research. During this study, an empirical study was applied based on a quantitative method. This method has the objective of quantifying a problem and understanding its dimensions. Moreover, this type of method is used to infer evidence about a theory through the evaluation of variables, which produces numerical results. This type of research provides numerical information about consumer behavior. Quantitative research generates precise metrics based on a determined sample.

Having in mind that the main objective of this study was to understand the expansion of EV in Portugal, investigating the impact of innovative business models on EV commercialization, an online survey was conducted in the context of the Portuguese EV market.

To support the main objective, through trying to give more detailed information about this topic, this study had some specific objectives that will give some insights about the aim of this study and will contribute to the concretization of the general objective, such as: (i) to analyze the growth of the EV market; (ii) understand consumer preferences regarding the business models; (iii) understand how the business models can overcome the barriers to EV purchase (Table 3).

Table 3. Linking the main issues to the research questions and objectives.

Main Issues	Research Questions	Research Objectives
EV unattractiveness (Liao et al. [11])	Which are the factors that condition EV commercialization in Portugal?	Analyze the growth of the EV market
Motivation and personal experience (Xu et al. [63])	Which are the factors that condition EV commercialization in Portugal?	Analyze the growth of the EV market
Government Incentives (Xu et al. [63]; Wang et al. [60])	Which are the factors that condition EV commercialization in Portugal?	Analyze the growth of the EV market
Stimulation factors regarding the purchasing time (Wang et al. [60])	What is the customer's perspective about the adoption of the new business models?	Understand consumer preferences regarding the business models
Consumers' preference knowledge regarding Business Models (Liao et al. [11])	What is the customer's perspective about the adoption of the new business models?	Understand consumer preferences regarding the business models
Differences among the customers (Kleine [62])	What is the customer's perspective about the adoption of the new business models?	Understand consumer preferences regarding the business models
Highlight EV's benefits and attributes (Schreiber & Eichberger [76])	Will the companies benefit from the introduction of the innovative business models for EV commercialization?	Understand how the business models can overcome the barriers to EV purchase
Outcomes of different Business Models selling the same technology (Noor & Salim [69])	Will the companies benefit from the introduction of the innovative business models for EV commercialization?	Understand how the business models can overcome the barriers to EV purchase

3.2. Measures

The scales for this investigation were adapted from various studies presented in the literature regarding electric vehicles. First, in the question about age, a scale presented in the Hang and Qian [12] study was used, with 5 levels, "18–29", "30–39", "40–49", "50–59", and "more than 60". Regarding educational level, a complete scale was adapted from Hang and Qian [12], with 6 levels, "basic education", "high school", "bachelor's degree", "master's degree", "post-graduation", and "Phd". For evaluating driving time per day, the scale of 67.84. Vladimirova Ivanova [84] was adopted, divided into 6 levels, "less than 30 min", "30 min < 1 h", "1 h < 2 h", "2 h < 3 h", "3 h < 4 h", and "more than 4 h".

For the gross income per year question, the scale of values presented in Costa and Farinha [85], "Inquérito à situação financeira das famílias: metodologia e principais resul-

tados", and elaborated by "Banco de Portugal" was adapted, divided into 6 levels, "less than EUR 20,000", "EUR 20,000 to 40,000", "EUR 40,000 to 60,000", "EUR 60,000 to 80,000", "more than EUR 80,000", and "prefer not to say".

For the ownership of EVs, a scale was adapted from Liao et al., [11]. It is divided into two questions. First, to know if the respondent has any EVs, with "Yes" and "No" answers, and the second question is only answered if the "Yes" question was chosen, divided into 3 levels, "1", "2", and "more than 2".

To evaluate the level of interest regarding EVs, a Likert scale of 5 degrees was adopted, where 1 means "no interest at all" and 5 means "very interested". For familiarity with the innovative business models, a Likert scale of 5 degrees was also used, where 1 means "unfamiliar" and 5 means "very familiar".

3.3. Procedures and Sampling

Concerning the main procedures, after concluding the literature review and identification of the gaps, the study was designed, and its objectives and the investigation questions were formulated. After this, we proceeded to the questionnaire construction, which involved the selection of several questions to evaluate the different variables in the study. This questionnaire was disseminated via social media, to reach as many people as possible. It had a specific target, with only people at least 18 years old being allowed to answer. The data collection period was between 2 May and 29 June 2022. The questionnaire was intended for people who live in Portugal.

In order to discover any flaws in the survey, it was sent to a restricted number of people to test and verify if everything was correct. After this feedback, changes were made to the survey, to be as accurate as possible. Some alterations were made, such as the correction of semantic errors and the addition of a question directly linked with the literature. After this process, it was time to release the survey.

Our sample (N) was 163. In this case, and based on the analyzed sample average, it is pertinent to affirm that the standard error values were low, meaning that they were well distributed over the population average. To conclude, it was a representative population. A total of 167 participants answered the questionnaire; however, it was necessary to exclude four people who did not pass the control question. This control question had the objective of identify people who had the necessary knowledge of the subject, so that the survey could be as accurate as possible. Regarding the people that succeeded in the control question, of 163 people, 72 (44.2%) were female and 91 (55.8%) were male. Regarding age, this question was categorized into 5 different age groups. Most of the participants were "18–29", being 71.8% (117) of the total sample, followed by the "40–49" group with 12.3% (20). With 11.7% (19) were people "50–60", and then the "30–39" and "more than 60" groups, with 2.5% (4) and 1.8% (3), respectively. Regarding the gross income per year, it was possible to observe that 56.4% of the participants had an income of "less than EUR 20,000 ", followed by "EUR 20,000 a 40,000" income, with 23.9%. The next option was "rather not to say", with 12.3%, and then "EUR 40,000 a 60,000" and "EUR more than 80,000", with 3.7% and 1.2%, respectively.

4. Results

4.1. Descriptives

When asked to classify the factors they considered to be the biggest barriers to EV adoption, as the first choice, the respondents stated "high costs" with 48 votes, while "charging time" was the least voted, with 14 answers. For the second option of the biggest barriers to EV adoption, "battery autonomy" had the most responses, with 51, while only 13 people voted for "lack of knowledge". Regarding the third choice of the respondents, 55 people chose "charging time", being the most voted for, while "lack of knowledge" was, once again, the least voted option, with 12 answers. For the fourth choice, most respondents voted for "charging time", with 47 answers, followed by "infrastructure" with 45. The least voted was "lack of knowledge", with 19 answers. For the fifth choice of barriers, the

most answered option was "lack of knowledge", with 77 people choosing this. Meanwhile, "charging time" was the least answered option, with 11 answers.

For most of the respondents, 96 (58.9%), government incentives for EV adoption were "important: it can accelerate the introduction of EVs in the market;", 35 (21.5%) considered this "useful: it can be a good help for its purchase;" and 24 (14.7%) claimed that they are "fundamental: only through government incentives it is possible to buy an EV". For the final answer, five (3.1%) people believed that they are "bad for the market: in the sense that the market will be dependent on the Government", and only three (1.8%) argued that they are "unnecessary: the technical characteristics of an EV are more important".

When people were asked about their motivations for buying an EV, for first choice, they chose "environmental benefits", with 59 answers, while 15 people chose "performance" as their first motivation. For the second choice of motivation to adopt an EV, "fuel prices" was the most voted answer, with 61 nominations, while only 28 people chose "governmental incentives". Regarding the third choice, 61 people chose "performance", while 28 chose "fuel prices". To complete the motivation analysis, the respondents, as their fourth choice, voted the most for "governmental incentives", with 58 answers, while "fuel prices only had 21 votes.

For the question "how familiar are you with the innovative business models (EV-leasing; battery-leasing; EV-sharing economy)?", on a scale where 1 means "unfamiliar" and 5 means "very familiar", 55 respondents were not familiar at all, level 1; 47 people were at level 3; 37 at level 2; 16 people at level 4, and only eight respondents were very familiar, level 5. Regarding question 6, "after this brief explanation regarding the innovative business models, do you believe that their introduction could make the difference for customers in the moment of EV adoption?", 116 (71.2%) answered "Yes", 29 (17.8%) answered "I don't know", and 18 (11%) people said "No".

Concerning the question "If, at this moment, you were to adopt an EV, which business model would you opt for?", 64 people (39.3%) preferred "EV-leasing", 57 answered "full purchase (traditional method)", 29 (17.8%) opted for "battery-leasing, and finally 13 (8%) choose "EV-sharing economy". For the final question, "do you believe the BMs adopted are more important than barriers, government incentives, and motivations related to EVs?", 86 (52.8%) respondents believed that the adopted business models were more important than barriers, governmental incentives, and motivations related to EVs, while 77 (47.2%) did not believe so.

4.2. Inferencial Analysis

The KMO test is a measure test to evaluate how suitable data are to the factorial analysis (Table 4). The final analysis, with a result of 0.518, allowed a factorial analysis, since the minimum value was 0.5. Bartlett's test is another indication of the strength between the relation of variables. It tests the null hypothesis that the correlation matrix is an identity matrix. An identity matrix is a matrix in which all the diagonal elements are 1 and all the elements outside of the diagonal are 0. Therefore, the null hypothesis is rejected. By analyzing the table, it is possible to observe that the sphericity of Bartlett's test is significant, meaning the probability of association is less than 0.5; with a significance of 0.002. This means that the level of significance was sufficiently small to reject the null hypothesis, meaning that the correlation matrix was not an identity matrix (Table 5).

Table 4. KMO test and Bartlett's test.

Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.518
Bartlett's Test of Sphericity	Approx. Chi-Square	28,205
	df	10
	Sig.	0.002

Table 5. Communalities.

	Initial	Extraction
How do you classify (. . .)	1000	0.608
In your opinion, the government incentives (. . .)	1000	0.807
How familiar are (. . .)	1000	0.667
After this brief explanation (. . .)	1000	0.648
Do you believe the business models (. . .)	1000	0.836

The communalities table demonstrates how much variance of the variables was accounted for by the extracted factors. For example, 83.6% of the variation of the question "Do you believe the Business Models (. . .)" is accounted for, while only 60.8% of the variation of the question "How do you classify (. . .)" was for accounted.

The next table shows all the extractable factors from the analysis, together with the eigenvalues, the percentage of the variance assigned to each factor, and the cumulative variance of the factor and previous factors. Notably, the first factor was answered by 28,441% of the variance, the second by 22,427%, and the third by 20,453%. All other factors were not significant (Table 6).

Table 6. Total variance explained.

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	1422	28.441	28.441	1422	28.441	28.441	1278	25.552	25.552
2	1121	22.427	50.868	1121	22.427	50.868	1183	23.666	49.219
3	1023	20.453	71.321	1023	20.453	71.321	1105	22.102	71.321
4	0.732	14.639	85.96						
5	0.702	14.040	100						

Note: Extraction Method—Principal Components Analysis.

The component matrix table shows the charge of the five variables on the three extracted factors. The higher the charge absolute value, the more the factor contributes to the variable. The visible gaps in the table are charger's inferior to 0.25, which were suppressed (Table 7).

Table 7. Component Matrix.

	Component		
	1	**2**	**3**
How do you classify (. . .)	0.682	−0.264	0.27
In your opinion, the government incentives (. . .)	−0.467		0.748
How familiar are (. . .)	0.548	−0.534	0.285
After this brief explanation (. . .)	0.65	0.466	
Do you believe the business models (. . .)		0.721	0.549

The objective of the rotated component matrix was to reduce the number of factors for which the variables in the analysis possessed high charges. For example, and according with the analyzed table, it was possible to verify that the questions "how do you classify (. . .)" and "how familiar are (. . .)" had a substantial charge for factor 1, while the variables "after this brief explanation (. . .)" and "do you believe the business models (. . .)" had a substantial load for factor 3. The remaining variables had a substantial charge for factor 2 (Table 8).

Table 8. Rotated component matrix.

	Component		
	1	**2**	**3**
How do you classify (. . .)	0.76		
In your opinion, the government incentives (. . .)		0.878	
How familiar are (. . .)	0.806		
After this brief explanation (. . .)		−0.622	0.465
Do you believe the business models (. . .)			0.909

For the regression analysis, the "R" value was the simple correlation coefficient in Table 9. It was used to measure the quality of the dependent variable predictions. It had a value of 0.298.

Table 9. R testing.

					Change Statistics				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of Estimative**	**R Square Change**	**F Change**	**df1**	**df2**	**Sig. F Change**
1	0.298	0.089	0.066	1072	0.089	3846	4	158	0.005

The R^2 value was the determination coefficient. It was the proportion of the variance of the dependent variable explained by the independent variables. The $R^2 = 0.089$ demonstrated that the independent variables explained approximately 8.9% of the dependent variable variance.

Based on the ANOVA in Table 10, it is pertinent to affirm that in this case there were differences between the groups, since the presented level was 0.005. Thus, the null hypothesis was rejected.

Table 10. ANOVA Test.

ANOVA						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	17.67	4	4417	3846	0.005
	Residual	181,496	158	1149		
	Total	199,166	162			

ANOVA null and alternative hypotheses:

H0: *The group averages are the same* ($p > 0.05$)

H1: *Differences exist between the group averages* ($p < 0.05$)

5. Discussion

We should point out that the inference did not allow drawing consistent conclusions, so most of the following discussion is based on descriptive statistics. This is a limitation and represents a future line of investigation of this study.

5.1. Determinant Factors

According to Liao et al. [11] and Jean-Pierre [23], during the introduction of EVs, there was a negative feeling/unattractiveness about them, but as stated in graphic 1, sales are rapidly in each year that passes. It was estimated that 6.4 million EVs were sold in 2021. Portugal is one of the countries in Europe with the best conditions for electric vehicle disruption, having the fourth most charging points [21]. Only during the second quarter of

2021, 13.967 EVs were sold here, an increase of 337% regarding the same period in 2020 (Graphic 6). If there was a negative feeling, it is gone for sure. In addition, according to this investigation, 114 people out of 163 were interested (level 4) or very interested (level 5) regarding this subject, which shows that people's perspective has changed during the past few years. However, as is known, there are more "variables" than the interest that influences consumers. Barriers, motivations, and external incentives are some of these variables. Several investigations, conducted by Carley et al. [32], Egbue and Long [30], and Buhler et al. [39], amongst others, referred to the five barriers mentioned above as the ones which influence consumers the most.

The impact these barriers have varies from country to country, depending on the conditions. A study conducted in Portugal by Dias et al. [33] reported monetary criteria as the most influential. Regarding the data analysis, it is possible to agree with their affirmation, since "high costs" was the most voted option, closely followed by "lack of knowledge" and "battery autonomy". Owing to these high costs, the association between a high income and the purchase of these types of cars was positively confirmed, reporting that people with a higher income were more likely to pay premium prices for these vehicles, and this was confirmed by this study [64]. Of the 163 respondents, 11 possessed EVs and six of these had an income of at least EUR 60.000.

In order to make EVs more affordable and attractive for consumers, governments provide incentives, mainly financial, to increase their adoption [86], and this is having a positive effect [87]. Portugal, thanks to tax breaks and subsidies, has one of the highest EV market shares in Europe. An environmental fund was also created to support the acquisition of these vehicles. Full exemption of vehicle tax and road tax were implemented in the Law Proposal no. 257/XII. As was mentioned previously, Portugal has a good market share and the adoption of EVs is increasingly rapidly, so these governmental incentives are working well; and this agrees with our analysis, in the sense that 158 people believed that incentives were useful, important, or fundamental for EV adoption. Thus, it is plausible to conclude that governmental incentives and EV commercialization are positively related. Finally, we consider the motivations inherent to this disruptive innovation. All technologies have good and bad aspects. Regarding this technology, the bad aspects have already been mentioned (barriers), as have some of the good ones (government incentives).

EVs are directly linked to the substitution of fossil fuel vehicles, towards solving sustainability problems. During the literature review, it was possible to identify different views regarding these motivations. Graham-Rowe et al. [52] stated that EV performance is worse than combustion vehicles, while Eggers and Eggers [46] added that, with time, this opinion will change. Another motivation is fuel prices. In recent times, fuel prices have reached prices never seen before. As Dias et al. [33] stated, this will contribute to future decisions when buying an EV. Whatever was said previously, Andersen [55] affirmed that the principal reason for purchasing an EV is environmental concerns. From the data analysis in this investigation, it is possible to agree with the latter author and corroborate that "environmental benefits" motivated most people to buy an EV, with 58 answers. Therefore, there is a positive relation between the environmental benefits and EV commercialization.

5.2. Business Models for EVs and Customer Perception

Believing that all customers are the same and share the same preferences is a mistake. To succeed, it is important to understand people (Padgett and Mulvey, 2007) and realize they are stimulated by the environmental factors around them (Wang et al., 2018). Regarding EVs and the context of this investigation, business model innovation leads to the creation of new sources of value for customers. The significance of knowing the preferences of consumers regarding BMs is huge. In the literature, Chesbrough and Rosebloom [67] stated that innovative business models can make a difference in product sales. However, do people know that the automobile industry has created innovative business models for this disruptive technology? According to this investigation, only 24 out of 163 people said they

were familiar (level 4) or very familiar (level 5) with them. Thus, this question was the one with the highest correlation value regarding the dependent variables, which means that, the familiarized people become with innovative business models, the more interest they will have in EVs. During the data analysis, a brief explanation regarding the IBMs was made to introduce to people these new IBMs and how they could be "applied". Afterwards, people needed to choose one of them, and the conventional option of adopting an EV and "EV-Leasing" were the most answered options.

5.3. Innovation in Business Models for EVs

Regarding the context of this investigation, Hidrue et al. [43] stated that dealers use promotional activities to promote EVs. To achieve success, firms need to highlight the characteristics of electric vehicles (Van Dijk, et al. [77]) and also to advertise the introduction of innovative business models. These IBMs are directly connected to the increase in environmental concerns and changes in customer views. As a matter of fact, the data analysis proved that this helps to change their perspective, since 116 people believed that the innovative business models could make a difference during EV adoption. Business models are how firms create and capture value from their products. Furthermore, Johnson and Suskewics [88] argued that it is possible to overcome the barriers to market penetration by adopting a direct sales model, improving services, and educating consumers on the benefits of EVs (Bohnsack et al., [6]). In the data analyzed, 86 people believed that innovative business models are the most important "variable" during EV commercialization. Additionally, this question was the one with the highest value of variation in the analysis.

6. Conclusions

The present investigation had as its main goal the investigation of the impact of business models on consumer preferences and how they can facilitate electric vehicle commercialization in Portugal. EVs sales have grown exponentially in Portugal. The market share had more than doubled in Q2 2021 compared to Q2 2020. However, the market still has a lot of potential to grow, since the barriers mentioned are still very present in the minds of customers. Each year that passes, people gain more knowledge about EVs. However, the cost of these types of cars is still very high, with this being the principal barrier to commercialization, in accordance with the literature. The studies of Dias et al., (2015) and Axsen et al. [31] agreed with this study, in the sense that they also highlighted the importance high costs have for customers. That is why Portugal's Government incentivized EVs, by helping people buy an EV with monetary subsidies and tax breaks, which are important for adoption of EVs. Since their introduction, EVs have been directly linked with the environment and sustainable practices, and this is still the main motivation for buying one. Despite the good infrastructure system present in Portugal, there is a lack of performance and battery autonomy, and consumers are not yet confident about these issues. These conclusions were corroborated by several authors in the literature; for example, in the studies by Lanbgroek et al. [50] about the positive effects of government incentives, Cao et al. [54] about the correlation of customer intention to buy an EV and environmental factors, and Liao et al. [11] regarding the development of dedicated infrastructure.

In the literature, the importance of business models is referred to many times, because they highlight the benefits of products. Since EVs are a disruptive technology, innovative business models have been created to facilitate their adoption and to demonstrate their best attributes. It was possible to conclude that, in Portugal, most people were not familiar with these IBMs, but after a quick explanation they realized their importance for the commercialization of EVs. In general, people believe that innovative business models are important for the proliferation of EVs. However, it was not possible to conclude if IBMs have a greater "weight" than barriers, government incentives, and motivations. The number of "Yes" and "No" answers was very similar and did not allow a confident finding. The investigations of Kley et al. [68] and Liao et al. [11] help to understand the emergence of IBMs in this industry and why they are valuable.

This study has made both professional and academical contributions. On the academic side, this study filled a gap existent in the literature and contributed to informing investigators about the impact that EVs are having globally and, of course, in Portugal. On the managerial side, this study helps companies to understand which BMs people believe to be the best fit and how they can help them to buy an EV, as well as helping companies to be more aware of people requirements and to be able to fulfill their wishes.

Some limitations can be identified. The first limitation, which probably affected the present study the most, was the small number of respondents. The sample should have been bigger than it was. The minimum for an investigation of this subject is 300 people. Moreover, most respondents were from the age group "18–29" and from the "Alentejo" and "Lisbon" regions. There was a small variety of respondents. Second was the lack of scales directly appropriate and properly tested for the study in question. On reflection, the elaborated questionnaire could have been better explored and devised, in order to give more depth to the research questions. The number of questions was also very limited. Another limitation was the fact the investigation was of a quantitative character only. It would have been an asset if interviews had been conducted for people to express their real feelings and opinions regarding the subject; to gather their perceptions from a different perspective. This limitation, similarly, to the sample size, was not possible to mitigate due to the time and resources available. The last limitation was the lack of information about the innovative business models and the context of electric vehicles in Portugal. Since this is a relatively subject, with a long "path to travel", this made it hard to find appropriate, relevant, and precise information about the impacts and outcomes.

For future research, the first recommendation consists of the possibility of expanding the size of the sample and gathering information over a longer period. Besides the online survey that was conducted through Google Forms, it could be interesting to explore and try to use other methods to collect data. Hand delivered questionnaires and interviews are some available options. Moreover, it could also be valuable to mix quantitative with qualitative research, where people could express their own opinions and feelings. Second, this investigation could be to extend to the less represented age groups and regions. Extending the number of questions in the questionnaire could be significant, to have a greater variety and deeper perspectives, in order to understand better what consumers are looking for in an electric vehicle. Futures researchers of this subject could also consider exploring the preferences of consumers regarding other potential IBMs in the future EV market, as well as investigating if they would be valued by customers, particularly when advanced technologies are integrated, such as autonomous driving and artificial intelligence. Platform business models (sharing mobility) are becoming increasingly prominent. Understanding if this is something with the potential for adoption in Portugal would be a good idea, because most people do not user their cars every day.

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Institutional Review Board Statement: Ethical review and approval were waived for this study, since written informed consent was obtained for the in-depth interviews before each session. In the survey, a link to the online survey platform was sent by social media and partners' social media, and at no times was contact established between researchers and participants. Moreover, the interview script and the personal questionnaire did not include any personal information or the participants' histories. As such, all data accessible to the researchers were stripped of the respondents' names, addresses, and birth dates and cannot be linked back to them.

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