

Article

Social Perception of Environmental and Functional Aspects of Electric Vehicles

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Abstract

Climate change caused by CO₂ emissions, the depletion of oil resources, and their unequivocal association with road transport constitute the primary factors behind the development of the electromobility sector. Simultaneously, existing infrastructure limitations and specific aspects of the social perception of electric vehicles may pose significant barriers to this sector's growth in Poland, one of the fastest-growing economies in Europe. Therefore, this study aims to identify the level of diffusion of expert opinions regarding battery electric vehicles (BEVs) among vehicle users, in the context of user convenience (functionality) and their environmental impact, and to analyse the variability and determinants of these opinions. The obtained results are intended to serve as a basis for initiating actions to identify the limitations in the development of this automotive sector in Poland. Our study results indicate that the level of diffusion of expert opinions regarding BEVs among respondents is high. In contrast, opinions about these vehicles' usability are more consistently internalised than those concerning their environmental impact. Moreover, this study demonstrates that limited financial resources and low levels of education among potential car buyers constitute barriers to developing this segment of the automotive market in Poland.

Keywords: electromobility; green transport; electric vehicles; sustainability; consumer; expert opinions



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1. Introduction

According to data from the European Parliament, the transport sector is responsible for as much as 30% of total CO₂ emissions in the European Union, with the vast majority (72%) attributable to road transport [1]. Therefore, in order to reduce CO₂ concentration, the share of electric vehicles should be increased. At the same time, internal combustion engines, whose operational lifespan is limited due to the impending depletion of global oil reserves, should be gradually phased out [2]. Since electric vehicles do not emit CO₂ during operation, their widespread adoption can contribute to reducing emissions, positively impacting the environment and human health, especially for residents of large urban areas [3].

The establishment of priorities within the EU environmental policy results from multiple factors. Among the most significant priorities are increasing energy efficiency, reducing greenhouse gas emissions (mainly CO₂) in the industry and energy sectors, and developing renewable energy sources. In the context of these priorities, considerable

emphasis has been placed in recent years on promoting and developing low-emission and zero-emission transport [4].

The transition to electromobility, however, entails a range of challenges, including not only the necessity to establish appropriate legal regulations but also to ensure an adequate scale of electric vehicle production, the expansion of infrastructure—primarily the network of charging stations—and the preparation of a qualified workforce of specialists. The development of electromobility requires comprehensive technical and logistical support to adapt the market and infrastructure to new demands. It is also important to develop educational programs and training courses that will increase the number of specialists capable of servicing and operating modern technologies related to electric transport [5]. Moreover, it will be a significant challenge to engage vehicle users with this modern technological solution, which, under certain conditions, can provide environmental benefits compared to conventional vehicles [6–9]. From a systems-level perspective, circular-economy (CE) governance links corporate sustainability outcomes with CE innovations and stakeholder engagement mechanisms. Recent work in Business Strategy and the Environment [10] argues that involving stakeholders—particularly consumers—in the design and implementation of circular models (e.g., reuse, repair, second-life batteries, and service-based mobility) strengthens legitimacy, trust, and perceived usefulness of electromobility solutions. This systems view provides a theoretical channel connecting firm-level CE governance with consumer perceptions of BEVs, complementing the environmental rationale discussed above and helping to explain variation in attitudes and adoption intentions. Therefore, this study is dedicated to the social perception of electric vehicles in Poland, focusing on environmental and functional aspects. It has been assumed that this will be achieved by identifying the diffusion level of expert opinions on electric vehicles among Polish respondents.

1.1. Climate Change as a Global Issue of Strategic Importance to the World

One indicator of climate change is global warming, evidenced by a continuous increase in the average air temperature. This trend can also be observed in Poland [11]. Neither the rate nor the direction of contemporary climate change can be explained by known natural cycles [11–13]. The intensive development of the economy, including heavy industry and agriculture, as well as the burning of fossil fuels, particularly for transport, and unsustainable consumption, are responsible for current climate change.

The role of greenhouse gases in climate change, particularly global warming, is indisputable [13]. Even the biomass increase is insufficient to improve the situation significantly [14–16]. However, the gas most frequently identified in the literature as having a significant impact on climate change is CO₂. This is because a considerable amount of it is generated by human activities [17]. It is worth highlighting that at the same time, it is possible to influence the level of its emissions. A radical reduction of CO₂ emissions into the Earth's atmosphere can be achieved by using renewable energy sources and implementing and enhancing technologies to reduce energy consumption. However, to achieve improvements in these areas, educating the public is essential [14], as it emerges as one of the major social challenges of the 21st century [18]. These actions are crucial because, unfortunately, it is expected that CO₂ emissions resulting from the combustion of fossil fuels, including those used to power internal combustion engines in vehicles, will remain the dominant factor causing the increase in the concentration of this gas in the atmosphere. This is due to the fact that modern human life is associated with an increasing energy demand [19].

According to the latest data, the concentration of CO₂ in the atmosphere is approximately 420 ppm, whereas before the Industrial Revolution it was 280 ppm. In recent years, the average annual increase in CO₂ concentration has exceeded 2.5 ppm [20]. Moreover, it has also been confirmed that the combustion of fossil fuels is responsible for the increase

in CO₂ concentration. Therefore, it is necessary to reduce its emissions, especially in the energy and transport sectors [19,21]. For example, globally, volcanoes are responsible for the emission of 300 million tons of CO₂ annually, whereas Germany accounts for 684 million tons, Italy for 325 million tons, and Poland for 320 million tons [22]. Human activities release over 36 billion tons of CO₂ into the atmosphere annually, which is 120 times more than the volcanoes mentioned above [23].

As CO₂ concentration in the atmosphere increases, land and oceans will absorb a progressively smaller fraction of its emissions. This means that burning one litre of gasoline in 10 years will increase the concentration of CO₂ in the atmosphere to a greater extent than burning the same amount of petrol today. Over the years, the greenhouse effect caused by burning one litre of gasoline will progressively increase. The release of one unit of CO₂ into the atmosphere will have a greater warming potential in the future than it does currently [24,25].

Available data indicate limited potential for reducing atmospheric CO₂ levels by increasing green area coverage. Although this action undoubtedly benefits the overall CO₂ balance, it is insufficient to solve the problem. Reducing Poland's yearly CO₂ emissions through forest absorption alone would require 104 million hectares of forested land, which is over three times larger than the country's entire land area [26]. Therefore, climate protection requires comprehensive efforts encompassing global solutions and individual actions.

In summary, it should be concluded that advancing industrialisation across all its sectors has significantly contributed to the increase in CO₂ emissions, which is the primary cause of climate change, clearly manifested by the perceptible phenomenon of global warming. Therefore, environmental protection measures are becoming an increasingly important element of both policy and the daily lives of Europeans. The identification of effective strategies to achieve a substantial reduction in atmospheric CO₂ levels is imperative [19].

1.2. The Depletion of Fossil Fuels as a Growing Challenge for Human Civilisation

Human life and civilisation's development in every domain are determined by access to energy [27,28]. The only trustworthy source of energy on Earth is the Sun. Upon reaching the Earth, the energy of its radiation has been dispersed and stored over time in the form of coal, crude oil, and natural gas—classified as non-renewable energy sources [29]. Of course, classifying these energy sources as non-renewable is a certain simplification, stemming from the human perspective on the timescale required for their regeneration [30].

Humans' use of coal dates back to ancient times [31]. However, its widespread adoption as an energy resource occurred only many centuries later. It was only the population boom and demographic changes, the occurrence of the Little Ice Age (a natural climatic cooling from the 16th to the 19th century) [32], and technological development that contributed to a radical increase in interest in this resource [30]. Currently, it is difficult to predict when the coal era will end, but the situation in Asian markets will likely determine its future.

In turn, crude oil and its derivatives have played a decisive role in the transformation and development of transportation [33]. Crude oil has been known and used by humans since ancient times. Although new potential uses of oil were discovered over the subsequent centuries, its utilisation remained marginal. It was only in the 19th century that crude oil gained a significant role and began to replace coal, following the invention of the internal combustion engine. This led to the development of the automotive industry, followed by the aviation industry, and also to the modernisation of the British navy. In the 1970s, crude oil became a resource of geopolitical importance, increasingly associated with armed conflicts. The decade's oil crisis marked the beginning of ecological movements that highlighted the need to move away from fossil fuels. At the turn of the 1970s and 1980s, the foundations of

energy transition were developed, and directions for replacing fossil fuels with alternative energy sources were identified [30]. In the 21st century, the 2011 oil shock contributed to a technological leap resulting from the phenomenon known as the shale revolution, while Russia's aggression against Ukraine in 2022 led to an increase in fuel demand. At the same time, the crude oil market became decoupled from the fuel market, making production capacity a critical factor.

Natural gas, whose main component is methane, was already known in ancient times. However, it did not become widespread until the 18th century, when it was employed for urban lighting. Global interest in natural gas as an energy source did not emerge until the late 20th century, when it became a significant energy commodity. A fundamental characteristic of natural gas is its lower carbon intensity, with CO₂ emissions approximately 50% lower than coal [34]. Therefore, natural gas was intended as a transition vector towards climate neutrality [35]. This transition was to be based on the development of renewable energy sources and nuclear power. However, using natural gas still involves infrastructural challenges, such as pipelines, other means of transport, and storage facilities. For this reason, entities controlling gas reserves and transmission networks can influence the economy and policies of consumer countries [36], which makes natural gas the most politically sensitive energy resource. In this context, natural gas has taken the place of oil. Global natural gas production increased by 60% over two decades, with the most significant volumes extracted in the USA, Russia, and Iran [37]. Consequently, the concept of energy liberalism, which assumed that market mechanisms alone can resolve issues related to meeting energy resource demand, has proven to be inadequate.

Currently, the combustion of fossil fuels (crude oil—32%, coal—28%, and natural gas—25%) accounts for as much as 85% of the total energy consumed by humanity. Only 9% of the world's primary energy consumption is associated with biomass combustion. In comparison, the remaining 6% is collectively supplied by nuclear, hydroelectric, wind, and solar sources. In this context, crude oil emerges as the dominant energy source, and due to its high calorific value and greater availability compared to coal and natural gas, it is also significantly more expensive than the other two. At the same time, the current rate of crude oil extraction is nearly four times greater than the rate at which new reserves are being discovered. Although it is premature to speak of exhausting crude oil resources, it is important to realise that the geological "battery" is depleting progressively as it continues to power modern civilisation. It is even acknowledged that oil reserves will never be entirely exhausted, as their extraction will become economically unviable long before that point is reached. This fuel will become irrelevant to the global energy supply [14].

Therefore, the depletion of fossil fuels is likely to limit the maximum extent of anthropogenic global warming, although holistically addressing this issue will remain a significant challenge. Simultaneously, changes in human energy-related behaviours may also lead to a wide range of impacts on natural ecosystems. Energy, economy, and ecology are rarely perceived as interconnected issues [17].

In this context, it is justified to conduct research on the possibilities of reducing dependence on crude oil through alternative fuels. Alternative fuels, as defined by the directive, encompass all fuels or energy sources that can serve as substitutes for crude oil and potentially contribute to the decarbonization of the transport sector. These primarily include electricity, hydrogen, biofuels, synthetic and paraffinic fuels, as well as natural gas, including its compressed (CNG) and liquefied (LPG) forms [38].

1.3. Electromobility as a Response to Climate Change and Fossil Fuel Depletion

Robert Davidson of Aberdeen built the first known electric car in 1837 in Scotland. In the early days of the automotive era, liquid fuel was not expected to become the standard.

Electricity demonstrated greater efficiency than other power sources (such as gas and coal), and the electric motor was the simplest and, consequently, the most reliable option. At the turn of the 19th and 20th centuries, steam engines constituted the largest share (40%), followed by electric engines (38%), while gasoline engines accounted for the smallest proportion (22%). The likely primary reasons for the lack of interest in gasoline engines at that time included the lack of infrastructure for internal combustion vehicles, the high costs associated with their development, and the characteristic use of automobiles during that period predominantly for short-distance trips. Even the first vehicles designed by Ferdinand Porsche were electrically powered, and their creator believed that “the air was terribly polluted by the large number of gasoline engines”. Nevertheless, the design of the world’s first hybrid car, the *Semper Vivus* (Latin for “always alive”), by Porsche in 1900, significantly contributed to extending its range. This innovative vehicle was powered by an internal combustion engine that drove a generator, which supplied electric power to the wheel hubs [39,40]. Since then, there has been a significant leap in civilisation, technology, and economics, resulting in a substantial increase in car users; however, the challenges remain unchanged, namely, the utility of automobiles and their environmental impact.

Electromobility encompasses all issues related to producing and operating vehicles with pure or hybrid electric drivetrains. Electromobility, therefore, includes the technical, technological, operational, environmental, social, economic, and legal aspects associated with producing and using vehicles with pure or hybrid electric propulsion systems. Electric cars constitute the core and essence of electromobility. However, they do not fully capture the concept’s meaning, which encompasses a complex system of actions aimed at sustainable development in response to the needs of the contemporary world [39,40].

HEVs (Hybrid Electric Vehicles) are vehicles equipped with both an internal combustion engine and an electric motor, which cannot recharge their batteries from external energy sources. They use conventional fuel and energy recovered during braking, deceleration, approaching intersections, and other manoeuvres. These vehicles are exceptionally efficient during heavy traffic and peak hours, as the electric motor activates at lower speeds, enabling fuel savings and reduced exhaust emissions [21].

PHEVs (Plug-in Hybrid Electric Vehicles) combine a conventional internal combustion engine with an electric drive system. They can be refuelled with conventional fuel at gas stations and recharged from external energy sources, similar to fully electric vehicles (BEVs). Plug-in hybrids (PHEVs) are gaining popularity due to their ability to utilise both propulsion types. During operation, the user can switch between the internal combustion engine, electric drive, or hybrid mode, significantly extending the vehicle’s range to 1000 km. However, when using only the electric drive, the range is shorter than that of fully electric cars due to the limited battery capacity resulting from their technical design. Although PHEVs can reduce traditional fuel consumption, in practice, the electric drive is most often used for short trips, with the combustion engine providing support for longer journeys. High production costs and the fact that these vehicles still generate some exhaust emissions mean that they do not entirely eliminate the air pollution problem [21].

REEVs (Range Extended Electric Vehicles) are electric vehicles with extended range that—similar to PHEVs—are equipped with an electric motor, the primary propulsion unit, and an internal combustion engine. The internal combustion engine in these vehicles activates only when it is necessary to generate energy to recharge the battery, enabling a significant extension of the driving range. REEVs are particularly practical for users who primarily travel short distances and only occasionally undertake longer trips. Despite hybrid technology, these vehicles still produce some harmful emissions, and their purchase price and maintenance costs are generally higher than those of cars equipped with only a single propulsion system [41,42].

BEVs (Battery Electric Vehicles) are fully electric vehicles powered exclusively by batteries that can be charged directly from an electrical outlet. They do not have an internal combustion engine, and their sole source of propulsion is the electric motor. As a result, BEVs significantly reduce the carbon footprint because they do not emit harmful substances into the atmosphere. The range of these vehicles depends on battery capacity, which makes them best suited for urban environments and shorter trips. Their operation is also relatively economical, as the vehicle can be charged at home, especially during nighttime when electricity prices tend to be lower. BEVs feature a simplified mechanical design—they contain fewer parts and consumable fluids than conventional drivetrain vehicles, resulting in lower maintenance and operating costs [21].

The process of establishing legal regulations to support the transformation of road transport has already been initiated in Polish legislation. The Act on Electromobility and Alternative Fuels of 11 January 2018 stipulates the following:

- The principles for the development and operation of infrastructure for the use of alternative fuels in transport, including the technical requirements that such infrastructure must meet;
- The obligations of public entities regarding the development of alternative fuels infrastructure;
- The information obligations related to alternative fuels;
- The conditions for the operation of clean transport zones;
- The national policy framework for the development of alternative fuels infrastructure and the manner of its implementation.

This Act serves as a foundation for the development of electromobility in Poland and contributes to promoting environmentally friendly solutions in transport [43].

2. Materials and Methods

2.1. Research Objectives and Hypotheses

This study aims to identify the extent to which expert opinions on battery electric vehicles (BEVs), concerning their functionality (in terms of user convenience) and environmental impact, have diffused among car users and analyse the variability and determinants of these perceptions. The significance of this issue is grounded in two indisputable facts. The first is the systematic depletion of crude oil reserves, which, over time, will lead initially to economic inaccessibility and eventually to the physical unavailability of this fuel source for internal combustion engine vehicles. The second is the accelerating pace of climate change resulting from releasing significant amounts of CO₂ into the atmosphere, a process to which the use of internal combustion engine vehicles contributes substantially. In light of these facts, it is essential to undertake efforts to identify the limitations to the development of this automotive industry sector that stem from its social perception in both environmental and functional terms.

This study is based on the following assumptions:

1. The extent to which expert opinions on electric vehicles have diffused among respondents is substantial;
2. The extent of diffusion of expert opinions regarding the functionality of electric vehicles is significantly higher than the diffusion of expert opinions concerning their environmental impact;
3. The material situation (respondents' economic status) is the strongest factor differentiating the distribution of respondents' FSI (Statement Significance Index) values regarding electric vehicles.

2.2. Characteristics of the Object and the Subject of This Study

The object of this research comprises the opinions of passenger car users who may potentially be interested in using battery electric vehicles or who are already using them. It is essential to clarify that within the context of this study, the term “opinion” refers to the respondent’s attitude towards the statements articulated by experts from the automotive sector, who represent the influential opinion-forming group. Only individuals with relevant knowledge, skills, and attitudes shaped by these competencies related to electromobility have the potential necessary to formulate a statement. Respondents evaluating these well-substantiated statements, developed according to the knowledge available during this study, may either agree or disagree, thereby exemplifying their autonomy in expressing their viewpoints. Therefore, in the subsequent part of this study, the term “respondents’ opinions” will be used to indicate that the object of this study is the respondents’ opinions.

The subjects of this study were 503 respondents recruited from across the entire territory of Poland. The characteristics of the studied respondent group are presented in Table 1.

Table 1. Characteristics of the respondents.

Population Parameter		Number of Individuals	Percentage of Individuals (%)
Total		503	100
Gender	W	343	68.2
	M	160	31.8
Age	18–25	246	48.9
	26–36	149	29.6
	37–78	108	21.5
Level of education	Primary/Vocational education	33	6.56
	Secondary education	186	36.97
	Higher education	284	56.46
Field of education	Technical	258	51.29
	Natural Sciences	97	19.28
	Humanities and Social Sciences	148	29.42
Economic Status	Below Average	49	9.74
	Average	338	67.19
	Above Average	116	23.06

The division of respondents into three age categories was made only after a sufficiently large group of participants had been collected. This approach aimed to establish an age group classification that reflects the specific societal tendencies in research participation and meets the requirements for applying statistical methods to interpret the findings.

This study was conducted nationwide between 5 March and 25 March 2025. Accordingly, it is assumed that the results of this study provide a reliable reflection of the opinions of residents throughout Poland. However, they cannot be considered representative of the entire country.

2.3. Characteristics of the Research Area

This study was conducted across the entire territory of Poland via the Internet, the coverage of which may have been one of the limiting factors affecting access to participation in the research, as illustrated in Figure 1.

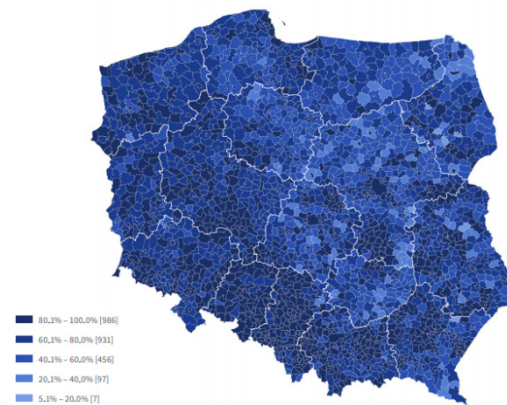


Figure 1. Map of Poland showing LTE internet coverage. Source: [44].

Another factor potentially influencing the interest in participation in this study could have been the popularity of electric vehicles in specific voivodeships of Poland, as illustrated in Figure 2.



Figure 2. Number of passenger electric vehicles in Poland by voivodeship. Source: [45].

2.4. Characteristics of the Research Instrument

The research instrument consisted of an original survey questionnaire. It comprised three main sections. The first section of the questionnaire was dedicated to statements related to the environmental impact of using electric vehicles. The second section of the survey focused on statements regarding electric vehicles' functionality (convenience of use). The statements forming the core of the first and second sections, supported by numerous sources, were formulated arbitrarily based on a critical review and analysis of opinion-forming literature concerning the ecological and functional aspects of electric vehicle usage. The third section encompassed sociodemographic data. All statements and opinions in the survey questionnaire were formulated as unambiguous and straightforward sentences. The validity and reliability of the statements and opinions included in the questionnaire were evaluated by three experts scientifically engaged in the development of BEV technology, all affiliated with the same university as the authors of this study. The statements are presented in Table 2.

Respondents indicated the extent to which they agreed with the presented statements using a 5-point Likert scale, where the numbers represented the following: 1—strongly disagree, 2—disagree, 3—neither agree nor disagree, 4—agree, 5—strongly agree. For each statement, respondents were allowed to select only one response.

The allotted time for completing the questionnaire was brief, approximately five minutes, which facilitated obtaining reliable responses.

Table 2. Statements on the environmental and functional aspects of battery electric vehicle (BEV) use.

No.	Statement on the Environmental Impact of BEVs	Source of Opinion
1.	BEVs do not emit air pollutants (gases).	[3,46–49]
2.	BEVs do not generate significant noise pollution.	[47,50–53]
3.	BEVs do not contaminate the environment with operational fluids.	[54–58]
4.	BEVs do not negatively affect the odour of the air.	[49,50,59–61]
5.	BEVs pose a safety risk due to their silent operation at low speeds.	[47,50–53]
6.	BEVs have an environmental impact when battery disposal becomes necessary.	[48,62–64]
No.	Statement on the Functional Aspects of BEVs	Source of Opinion
7.	BEVs have a relatively limited driving range.	[41,51,64–66]
8.	BEVs are allowed to park free of charge in urban areas.	[3,48,64,67]
9.	BEVs are permitted to use bus lanes.	[3,64,68,69]
10.	BEVs require extended charging time.	[51,55,62,70]
11.	The cost of repairing BEVs is high.	[3,51,58,71,72]
12.	BEVs experience accelerated battery depletion at low temperatures.	[41,51,62,73]

Data were collected using the CAWI method (Computer-Assisted Web Interview). The questionnaire was created using the Google Forms platform, and the link was subsequently shared on Facebook to facilitate snowball sampling. In this study, a snowball sampling method was applied as Computer-Assisted Web Interviewing (CAWI) using the Facebook platform. This approach was chosen to quickly reach a diverse group of respondents as part of a pilot study, as well as due to the organisational and budgetary constraints of the project. It should be emphasised that such a sampling method does not allow for full representativeness of the entire adult population of Poland, which has been noted in the Limitations section of the manuscript. Therefore, the obtained results should be interpreted as reflecting the attitudes of the surveyed group rather than as an exact representation of the opinion structure in the general population. It was preliminarily assumed that this study would continue until at least 500 wholly and correctly filled questionnaires were obtained. The process of primary data collection was concluded after obtaining 503 completed questionnaires. The threshold of 500 respondents was adopted for two reasons; (1) it was the recruitment target set for the pilot study stage, sufficient for the preliminary validation of the research tool and for conducting the planned statistical analyses, and (2) it allowed for meeting the minimum sample size requirements for the statistical tests used at the assumed significance level and statistical power. The main study plans to increase the sample size and strive for better representativeness through additional recruitment channels. The sample was selected using a convenience sampling approach, based on the availability and accessibility of respondents relevant to our study objectives.

An internal consistency analysis was conducted to assess the reliability of the applied scales. Cronbach's α coefficient was $\alpha = 0.9962$ for the environmental scale and $\alpha = 0.9960$ for the functional scale, indicating excellent internal consistency for both measurement tools.

2.5. Characteristics of Statistical Methods Used in Data Analysis

The input data obtained through the survey questionnaire were used to assess the significance of differences in the distribution of respondents' answers to individual statements, based on the selected variability criteria: gender, age, education level, field of education, and economic status of the examined group. For this purpose, the chi-square test (χ^2), Student's *t*-test, ANOVA, and Tukey's test were employed as statistical tools, with a significance level set at $p \leq 0.05$ [74].

These data were also used to estimate the Statement Significance Index (FSI) value, which served as an indicator of the extent to which each statement was disseminated

throughout the entire group of respondents. An FSI value greater than 1.0 indicates a predominance of positive responses (strongly agree and agree) over negative responses (disagree and strongly disagree) to a given statement. This suggests that the majority of the surveyed group agrees with the experts' opinions. Values oscillating around 1.0 indicate that the proportion of respondents who agree and those who disagree with expert opinions is similar within the surveyed group. Conversely, an FSI value less than 1.0 reflects a higher proportion of negative responses than positive ones regarding the examined statement, implying that most respondents in the study group disagree with the expert opinions [75]. As the value of the FSI increases, the importance of a given statement regarding the environmental and functional aspects of electric vehicle usage also rises. This assumption is based on Lamm et al. [76], who implemented the approach proposed by Gaworski et al. [75].

An important methodological consideration is that when analysing the level of diffusion of expert opinions regarding electric vehicles among respondents using the FSI, the respondents' level of knowledge is not identified. Nevertheless, this method enables evaluating the extent to which reliable information (expert opinions) has permeated the respondent group, thereby indicating the degree of their absorption by the respondents.

Furthermore, these data were used to estimate the value of the FSI as a source of information on the level of diffusion of individual statements within respondent subgroups homogeneous concerning specific criteria (gender, age, education level, field of education, and economic status). Thus, information was obtained regarding the variation in the diffusion of opinions for each examined statement, conditioned by sociodemographic factors. The estimation and comparison of the FSI values served as the basis for determining the level of diffusion of individual opinions among respondents and their variation between different respondent groups. It was assumed that consumer opinions regarding both the functional and environmental aspects related to the production and use of electric vehicles are characterised by varying levels of diffusion across the entire surveyed respondent group and by variation conditioned by the specific characteristics of subgroups homogeneous concerning certain criteria. Therefore, it became possible to identify information deficits, the dissemination of which may play a significant role in the development of campaigns promoting electromobility regarding BEVs within society. Furthermore, this information enabled the identification of respondent groups whose awareness of the advantages and disadvantages of electric vehicles is insufficient and may require targeted educational interventions.

The estimation of the FSI was based on calculating the percentage of responses indicating disagreement or complete disagreement (ratings 1 and 2, respectively) and the rate of responses indicating agreement or complete agreement (ratings 4 and 5, respectively) for each statement concerning the environmental impact and functional aspects of electric vehicles. The FSI was estimated based on the following equation:

$$FSI = \frac{ps_{4,5}}{ps_{1,2}} \quad (1)$$

where $ps_{1,2}$ —percentage of responses indicating complete disagreement (1) and disagreement (2) [%]; $ps_{4,5}$ —percentage of responses indicating agreement (4) and complete agreement (5) [%] [75,76].

The FSI provides information on the level and variability of the diffusion of expert-formulated statements among the respondents. As a result of this study, it was possible to develop a ranking of statements describing the functionality of electric vehicles and their environmental impact as perceived by the respondents. Thus, the survey of respondents' opinions was conducted using a standardised tool, consisting of expert opinions and a

Likert scale. This approach, on the one hand, helped avoid issues related to the low level of respondent engagement with the subject matter (since the opinions were pre-formulated). On the other hand, it helped to prevent careless completion of the survey form in situations involving excessive complexity or the need for respondents to invest their own time and intellectual effort (marking their level of agreement with a statement on the scale with a cross).

3. Discussion and Analysis of the Study Results

This study focused on identifying and analysing the factors that differentiate users' opinions regarding electric vehicles. The article explores the underlying conditions shaping the development of purely electric cars, particularly the key drivers of their recent resurgence—namely, the depletion of fossil fuels and climate change associated with greenhouse gas emissions [4]. It was assumed that these facts significantly influence car users' perceptions regarding the functionality and the environmental impact of using electric vehicles. These opinions should also be regarded as one of the key factors determining the dynamics and direction of the development of this concept. In turn, they constitute a crucial element in managing electromobility.

3.1. Variation in the Distribution of Opinions According to the Sociodemographic Characteristics of Respondents

The problem of minimal interest in electric vehicles in Poland—though not only there—is well known, and various attempts have been made to diagnose this situation [4]. One essential aspect of this issue is its social dimension, which is related to people's attitudes toward electric vehicles and is reflected in the diffusion and subsequent adoption of expert opinions among potential buyers.

The first stage of this study on respondents' opinions regarding the environmental and functional characteristics of BEVs involved examining the variability of these opinions and their determinants related to factors differentiating the surveyed group. For this purpose, the chi-square test (χ^2) was applied to analyse the primary data, which consisted of mean point values estimated for individual statements. A grey background highlighted p -values ≤ 0.05 , indicating statistically significant differences between groups (Table 3).

The results indicate that the degree of differentiation in respondents' attitudes toward the examined statements was relatively high (33 out of 60). A greater level of opinion differentiation, influenced by specific respondent-diversifying factors, was observed in the functional domain of BEVs (19 out of 30) compared to the environmental domain (14 out of 30). Accordingly, it can be concluded that there is potential to identify those specific features of BEVs that warrant particular attention in educational and advertising campaigns, as they represent a key component of the strategic management of BEV market development. Moreover, there is an opportunity to identify specific groups of potential private vehicle users who should be targeted by educational and promotional campaigns to improve their access to reliable information about BEVs. This, in turn, may support more informed and rational decision-making regarding vehicle selection, considering the multiple factors associated with such a choice.

Respondents' gender was the factor that most broadly differentiated their attitudes toward most statements concerning environmental aspects (4 out of 6) and all statements related to the functional aspects (6 out of 6) of BEVs. Women expressed higher agreement with opinions regarding the environmental conditions of BEV usage. In contrast, men showed greater agreement with opinions about the functionality of BEVs (Figure 3). These results may suggest that women possess greater awareness of environmental—and consequently social—aspects related to the development of the BEV sector. Conversely,

men demonstrated a higher level of familiarity with the challenges associated with the everyday operation of BEVs. Similar results were obtained in a study conducted among respondents in Australia by Loengbudnark et al. [77]. Awareness of specific aspects, in turn, may indicate the significance of these issues in the decision-making process.

Table 3. Results of the χ^2 test (chi-square test).

Opinion	Factors Differentiating the Examined Group of Respondents				
	Gender	Age	Education Level	Field of Education	Economic Status
1.	$\chi_{\text{obs}} = 28.0494$ $\chi_{\text{crit}} = 9.4877$ $p = 1.2 \times 10^{-5}$	$\chi_{\text{obs}} = 27.0109$ $\chi_{\text{crit}} = 15.5073$ $p = 0.001$	$\chi_{\text{obs}} = 15.2999$ $\chi_{\text{crit}} = 15.5073$ $p = 0.054$	$\chi_{\text{obs}} = 12.0819$ $\chi_{\text{crit}} = 15.5073$ $p = 0.148$	$\chi_{\text{obs}} = 21.0396$ $\chi_{\text{crit}} = 15.5073$ $p = 0.007$
2.	$\chi_{\text{obs}} = 8.8229$ $\chi_{\text{crit}} = 9.4877$ $p = 0.066$	$\chi_{\text{obs}} = 3.8436$ $\chi_{\text{crit}} = 15.5073$ $p = 0.871$	$\chi_{\text{obs}} = 34.3773$ $\chi_{\text{crit}} = 15.5073$ $p = 3.5 \times 10^{-5}$	$\chi_{\text{obs}} = 10.2522$ $\chi_{\text{crit}} = 15.5073$ $p = 0.248$	$\chi_{\text{obs}} = 22.0176$ $\chi_{\text{crit}} = 15.5073$ $p = 0.005$
3.	$\chi_{\text{obs}} = 11.1505$ $\chi_{\text{crit}} = 9.4877$ $p = 0.025$	$\chi_{\text{obs}} = 7.9582$ $\chi_{\text{crit}} = 15.5073$ $p = 0.438$	$\chi_{\text{obs}} = 5.2226$ $\chi_{\text{crit}} = 15.5073$ $p = 0.734$	$\chi_{\text{obs}} = 11.5978$ $\chi_{\text{crit}} = 15.5073$ $p = 0.170$	$\chi_{\text{obs}} = 13.4018$ $\chi_{\text{crit}} = 15.5073$ $p = 0.099$
4.	$\chi_{\text{obs}} = 13.8984$ $\chi_{\text{crit}} = 9.4877$ $p = 0.008$	$\chi_{\text{obs}} = 12.3917$ $\chi_{\text{crit}} = 15.5073$ $p = 0.135$	$\chi_{\text{obs}} = 16.1153$ $\chi_{\text{crit}} = 15.5073$ $p = 0.041$	$\chi_{\text{obs}} = 15.9817$ $\chi_{\text{crit}} = 15.5073$ $p = 0.043$	$\chi_{\text{obs}} = 17.3842$ $\chi_{\text{crit}} = 15.5073$ $p = 0.026$
5.	$\chi_{\text{obs}} = 9.9312$ $\chi_{\text{crit}} = 9.4877$ $p = 0.042$	$\chi_{\text{obs}} = 6.8940$ $\chi_{\text{crit}} = 15.5073$ $p = 0.548$	$\chi_{\text{obs}} = 8.2631$ $\chi_{\text{crit}} = 15.5073$ $p = 0.408$	$\chi_{\text{obs}} = 14.4685$ $\chi_{\text{crit}} = 15.5073$ $p = 0.070$	$\chi_{\text{obs}} = 14.1569$ $\chi_{\text{crit}} = 15.5073$ $p = 0.078$
6.	$\chi_{\text{obs}} = 7.2671$ $\chi_{\text{crit}} = 9.4877$ $p = 0.122$	$\chi_{\text{obs}} = 12.4277$ $\chi_{\text{crit}} = 15.5073$ $p = 0.133$	$\chi_{\text{obs}} = 32.5437$ $\chi_{\text{crit}} = 15.5073$ $p = 7.4 \times 10^{-5}$	$\chi_{\text{obs}} = 20.0948$ $\chi_{\text{crit}} = 15.5073$ $p = 0.010$	$\chi_{\text{obs}} = 18.0014$ $\chi_{\text{crit}} = 15.5073$ $p = 0.021$
7.	$\chi_{\text{obs}} = 33.7520$ $\chi_{\text{crit}} = 9.4877$ $p = 8.4 \times 10^{-7}$	$\chi_{\text{obs}} = 15.5977$ $\chi_{\text{crit}} = 15.5073$ $p = 0.048$	$\chi_{\text{obs}} = 33.1066$ $\chi_{\text{crit}} = 15.5073$ $p = 5.9 \times 10^{-5}$	$\chi_{\text{obs}} = 20.7053$ $\chi_{\text{crit}} = 15.5073$ $p = 0.008$	$\chi_{\text{obs}} = 10.6087$ $\chi_{\text{crit}} = 15.5073$ $p = 0.225$
8.	$\chi_{\text{obs}} = 11.5889$ $\chi_{\text{crit}} = 9.4877$ $p = 0.021$	$\chi_{\text{obs}} = 12.7449$ $\chi_{\text{crit}} = 15.5073$ $p = 0.121$	$\chi_{\text{obs}} = 11.8523$ $\chi_{\text{crit}} = 15.5073$ $p = 0.158$	$\chi_{\text{obs}} = 13.0650$ $\chi_{\text{crit}} = 15.5073$ $p = 0.110$	$\chi_{\text{obs}} = 19.1523$ $\chi_{\text{crit}} = 15.5073$ $p = 0.014$
9.	$\chi_{\text{obs}} = 12.4648$ $\chi_{\text{crit}} = 9.4877$ $p = 0.014$	$\chi_{\text{obs}} = 7.5069$ $\chi_{\text{crit}} = 15.5073$ $p = 0.483$	$\chi_{\text{obs}} = 18.8492$ $\chi_{\text{crit}} = 15.5073$ $p = 0.016$	$\chi_{\text{obs}} = 20.0579$ $\chi_{\text{crit}} = 15.5073$ $p = 0.010$	$\chi_{\text{obs}} = 14.3944$ $\chi_{\text{crit}} = 15.5073$ $p = 0.072$
10.	$\chi_{\text{obs}} = 11.5236$ $\chi_{\text{crit}} = 9.4877$ $p = 0.021$	$\chi_{\text{obs}} = 16.3176$ $\chi_{\text{crit}} = 15.5073$ $p = 0.038$	$\chi_{\text{obs}} = 15.0825$ $\chi_{\text{crit}} = 15.5073$ $p = 0.058$	$\chi_{\text{obs}} = 9.0097$ $\chi_{\text{crit}} = 15.5073$ $p = 0.342$	$\chi_{\text{obs}} = 7.0324$ $\chi_{\text{crit}} = 15.5073$ $p = 0.533$
11.	$\chi_{\text{obs}} = 13.9169$ $\chi_{\text{crit}} = 9.4877$ $p = 0.008$	$\chi_{\text{obs}} = 12.3906$ $\chi_{\text{crit}} = 15.5073$ $p = 0.135$	$\chi_{\text{obs}} = 37.4939$ $\chi_{\text{crit}} = 15.5073$ $p = 9.3 \times 10^{-6}$	$\chi_{\text{obs}} = 21.7357$ $\chi_{\text{crit}} = 15.5073$ $p = 0.005$	$\chi_{\text{obs}} = 23.9604$ $\chi_{\text{crit}} = 15.5073$ $p = 0.002$
12.	$\chi_{\text{obs}} = 34.6038$ $\chi_{\text{crit}} = 9.4877$ $p = 5.6 \times 10^{-7}$	$\chi_{\text{obs}} = 11.9872$ $\chi_{\text{crit}} = 15.5073$ $p = 0.152$	$\chi_{\text{obs}} = 50.5473$ $\chi_{\text{crit}} = 15.5073$ $p = 3.2 \times 10^{-8}$	$\chi_{\text{obs}} = 18.4488$ $\chi_{\text{crit}} = 15.5073$ $p = 0.018$	$\chi_{\text{obs}} = 39.8169$ $\chi_{\text{crit}} = 15.5073$ $p = 3.5 \times 10^{-6}$

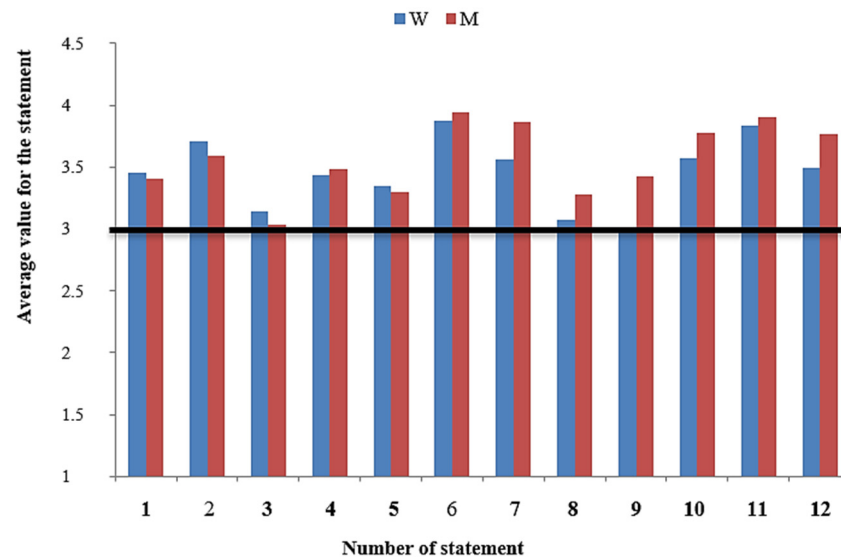


Figure 3. Differences in mean levels of agreement with the examined statements according to respondents' gender.

The Theory of Planned Behaviour, developed by Ajzen in the 1980s, explains the relationship between attitudes and behaviours. According to this theory, the factors influencing behaviour include intentions, attitudes toward the behaviour, subjective norms, and the individual's perceived control over the behaviour. The concept of intention serves as an indicator of how willing individuals are to engage in a particular behaviour, as it encompasses all motivational components underlying human actions. Attitudes, in turn, shape intentions, as they arise from an individual's beliefs about the expected outcomes of a specific behaviour. Subjective norms are formed based on personal beliefs regarding whether a particular behaviour will receive social approval or disapproval and are associated with social pressure. Meanwhile, perceived behavioural control is conditioned by the resources and opportunities available to the individual in performing the behaviour. At the core of these factors lie individual beliefs, which are derivatives of numerous variables considered by Ajzen as internal factors. Among these, particular attention is often given to socioeconomic status, personality traits, prior experiences, and the individual's knowledge [78]. Therefore, in promoting the development of electromobility—particularly in the BEV sector—and seeking to elicit specific behaviours from potential car consumers, it is necessary to undertake rational measures to shape their attitudes in a desirable direction. One rational measure may involve targeting advertising or educational campaigns at clearly defined audience segments. Indeed, evidence suggests that such campaigns' effectiveness depends on how well the communication methods are matched to their intended audience [79,80].

Education level and economic status were factors that to a lesser extent, differentiated respondents' attitudes toward environmental and functional aspects (7 out of 12). In the case of education level, a greater variation in opinions was observed in the functional domain (4 out of 6) compared to the environmental domain (3 out of 6). In contrast, this pattern was reversed in terms of economic status (Table 3). Based on this, a hypothesis was formulated that differences in education level more strongly influence respondents' attitudes toward statements concerning the functionality of BEVs, and thus the practical aspect of their ownership. Respondents with higher education levels expressed greater agreement with statements concerning the functionality of BEVs, whereas respondents with primary or vocational education tended to disagree with these statements (Figure 4).

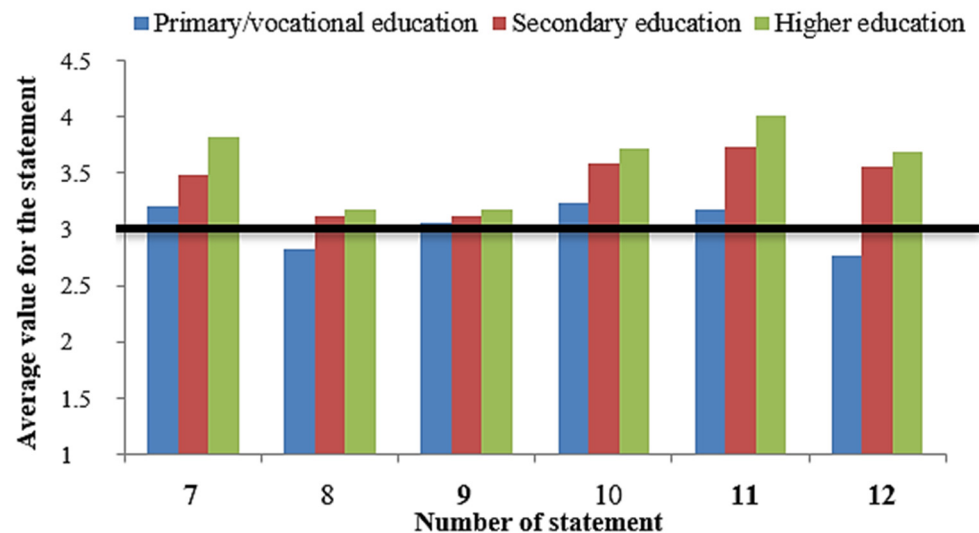


Figure 4. Differences in mean levels of agreement with the examined statements according to respondents' education level.

Similar conclusions are supported by the findings of a study conducted by Westin et al. in Sweden in 2018. The authors established that education level positively correlates with BEV ownership [81].

In contrast, economic status is a factor that more strongly differentiates respondents' attitudes toward statements concerning the environmental impacts of BEV usage, and thus the social dimension of this issue. Respondents reporting below-average economic status tended to disagree with statements regarding the pro-environmental effects of BEV use. In contrast, those declaring higher economic status agreed with these statements (see Figure 5).

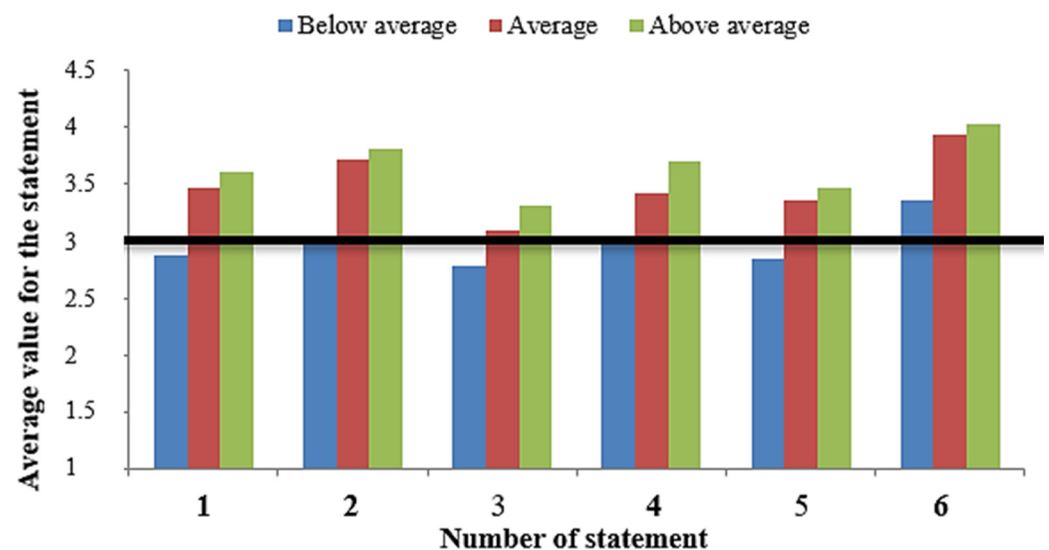


Figure 5. Differences in mean levels of agreement with the examined statements according to respondents' economic status.

This aspect of opinion formation is not addressed in the existing scientific literature. Nevertheless, it should be noted that a low economic status, which may constitute a rational justification for reluctance to purchase BEVs due to their price, should not serve as a basis for denying their pro-environmental impact. Therefore, it can be hypothesised that the

perception of BEVs in Poland is predominantly conditioned by a low level of knowledge regarding the nature, importance, and future of electromobility.

A factor that differentiated respondents' attitudes toward environmental and functional conditions to an even narrower extent was their field of education (6 out of 12). This factor had a minor influence (2 out of 6) on differentiating respondents' attitudes toward statements concerning environmental conditions, while it significantly more strongly differentiated (4 out of 6) their attitudes toward statements regarding the functionality of BEVs. It can be unequivocally stated that respondents declaring education in the humanities or social sciences showed significantly lower agreement with statements relating to the functionality of BEVs. Notably, respondents with a background in natural sciences showed higher agreement with these statements than those with technical education (see Figure 6). It can be assumed that this surprising difference may be influenced by a broader context shaping the attitudes of respondents with a technical education toward the analysed statements and opinions. Although each of these statements/opinions reflects reality, corresponds to the current state, and is supported by numerous sources, respondents possessing extensive technical knowledge may have referred to them not only based on the present situation but also taking into account trends and tendencies influenced by technological progress [82].

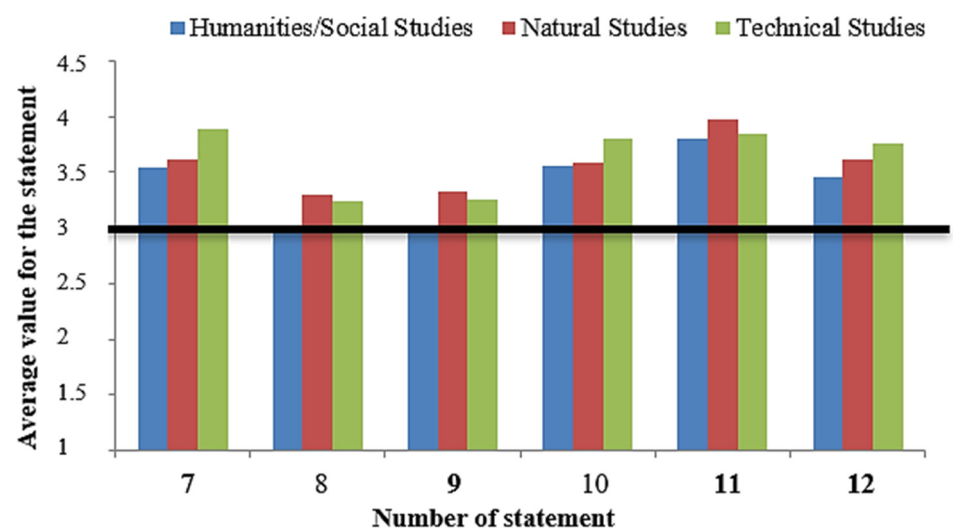


Figure 6. Differences in mean levels of agreement with the examined statements according to respondents' field of education.

In contrast, a surprising finding was that respondents' age had a negligible effect on differentiating their attitudes, both concerning statements on environmental conditions (1 out of 6) and on the functionality of BEVs (2 out of 6). It can therefore be assumed that the issue of transitioning to electromobility remains a topic of interest to potential consumers regardless of their age. The results may indicate that evolutionary changes are occurring in the perception of electromobility in Poland. In contrast, the findings of Sobiech–Grabka et al. [82], conducted on a smaller population, showed that age differentiated attitudes toward BEVs, as reflected in the declared willingness to purchase.

In summary, it should be noted that their education level and economic status strongly influence Polish respondents' attitudes toward BEVs. More specifically, differences in education level tend to polarise opinions regarding the functionality of BEVs more strongly. In contrast, differences in economic status more significantly polarise opinions related to environmental aspects.

3.2. Differentiation of the FSI According to the Sociodemographic Characteristics of Respondents

The next stage of this study involved estimating the diffusion level of expert statements concerning the ecological and functional aspects of using BEVs. The results obtained are presented in Table 4. Results of statistical analyses are presented in Table 5.

Table 4. Mean values of the FSI for individual statements concerning the environmental and functional aspects of BEVs.

Number of Statements		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
FSI	Total	2.07	3.54	1.24	2.44	1.81	4.75	3.51	1.25	1.27	3.94	5.03	3.96
	W	2.35	4.27	1.38	2.62	1.93	5.02	3.14	1.14	0.99	3.74	5.56	3.81
	M	1.65	2.53	0.98	2.13	1.60	4.30	4.44	1.49	2.24	4.36	4.16	4.20
	18–25	2.28	3.68	1.3	2.67	1.58	4.88	2.98	1.09	1.12	3.37	4.53	3.19
	26–36	1.66	3.23	1.13	1.85	2.17	4.57	3.03	1.12	1.28	4.09	4.8	5.19
	37–78	2.31	3.7	1.24	3.05	1.97	4.76	6.75	1.9	1.69	5.27	7.3	4.57
	P/VE	0.69	0.69	0.77	0.77	0.71	1.08	1.18	0.79	1.1	1.75	1	0.67
	SE	2.23	2.92	1.17	2.14	1.82	3.74	2.13	1.29	1.34	2.92	3.26	3.03
	HE	2.28	5.28	1.35	3.12	2.01	7.48	6.39	1.3	1.24	5.61	10.84	7.9
	H/SS	1.74	3.37	1.08	2.23	1.46	4.47	2.75	0.97	0.96	3.36	4.49	3.08
	NS	2.15	2.75	1.54	2.62	2.08	4.19	3.5	1.84	2.04	3.6	7.44	4.33
	TS	2.79	4.54	1.33	2.81	2.43	5.79	5.63	1.5	1.5	5.67	4.95	5.81
	↓BA	0.67	1.18	0.52	1	0.73	1.77	1.47	0.57	1.07	2.45	1.47	0.8
	↑A	2.15	3.67	1.22	2.38	1.86	5	3.71	1.21	1.09	3.77	5.63	4.45
	↑AA	3.0	5.67	1.83	3.89	2.58	6.85	4.65	1.82	2.14	5.71	7.73	10.14

W—women; M—men; 18–25—youngest respondent group; 26–36—middle-aged respondent group; 37–78—oldest respondent group; P/VE—respondents with primary or vocational education; SE—respondents with secondary education; HE—respondents with higher education; H/SS—respondents with humanities or social sciences education; NS—respondents with natural sciences education; TS—respondents with technical education; ↓BA—respondents with below-average economic status; ↑A—respondents with average economic status; ↑AA—respondents with above-average economic status.

Table 5. Results of statistical analyses.

	Gender	Age	Educational Level	Field of Education	Economic Status
Environmental scale	$t_{\text{obs}} = 0.9792$ $t_{\text{crit}(0.05, 10)} = 2.2281$ $p = 0.3506$	$F_{\text{obs}(0.05, 2, 15)} = 0.1568$ $F_{\text{crit}(0.05, 2, 15)} = 3.6823$ $p = 0.8563$	$F_{\text{obs}(0.05, 2, 15)} = 5.6216$ $F_{\text{crit}(0.05, 2, 15)} = 3.6823$ $p = 0.0151$	$F_{\text{obs}(0.05, 2, 15)} = 0.7977$ $F_{\text{crit}(0.05, 2, 15)} = 3.6823$ $p = 0.7977$	$F_{\text{obs}(0.05, 2, 15)} = 6.9531$ $F_{\text{crit}(0.05, 2, 15)} = 3.6823$ $p = 0.0073$
Functional scale	$t_{\text{obs}} = 0.4733$ $t_{\text{crit}(0.05, 10)} = 2.2281$ $p = 0.6461$	$F_{\text{obs}(0.05, 2, 15)} = 1.5777$ $F_{\text{crit}(0.05, 2, 15)} = 3.6823$ $p = 0.2388$	$F_{\text{obs}(0.05, 2, 15)} = 6.3378$ $F_{\text{crit}(0.05, 2, 15)} = 3.6823$ $p = 0.0101$	$F_{\text{obs}(0.05, 2, 15)} = 1.1198$ $F_{\text{crit}(0.05, 2, 15)} = 3.6823$ $p = 0.3522$	$F_{\text{obs}(0.05, 2, 15)} = 5.2536$ $F_{\text{crit}(0.05, 2, 15)} = 3.6823$ $p = 0.0187$
All questionnaire	$t_{\text{obs}} = 0.2666$ $t_{\text{crit}(0.05, 22)} = 2.0739$ $p = 0.7923$	$F_{\text{obs}(0.05, 2, 33)} = 1.2911$ $F_{\text{crit}(0.05, 2, 33)} = 3.2849$ $p = 0.2885$	$F_{\text{obs}(0.05, 2, 33)} = 11.2037$ $F_{\text{crit}(0.05, 2, 33)} = 3.2849$ $p = 0.0002$	$F_{\text{obs}(0.05, 2, 33)} = 1.7779$ $F_{\text{crit}(0.05, 2, 33)} = 3.2849$ $p = 0.1848$	$F_{\text{obs}(0.05, 2, 33)} = 11.5124$ $F_{\text{crit}(0.05, 2, 33)} = 3.2849$ $p = 0.0002$

t_{obs} —t observed; t_{crit} —critical t.

Understanding public opinion on issues crucial to the functioning of a given country, region, or even the world enables the achievement of various objectives—not only cognitive and scientific but above all educational and marketing-oriented. These objectives, in turn, can serve as essential tools for the effective management of, for example, the development of electromobility and the promotion of new technological solutions. This approach is critical, especially when the growing interest in and adoption of new technological solutions align with efforts to achieve sustainable development [83]. This, in turn, is determined by

two premises whose significance is indisputable: fossil fuels are a non-renewable resource, and CO₂ emissions cause climate change that threatens human existence on Earth [1,2,4]. Therefore, the sooner actions are undertaken to achieve independence from the combustion of fossil fuels, the better. At the same time, it should be emphasised that one of the key arguments stimulating the dynamic development of new technologies is the interest in their use. Consequently, research on consumer opinions regarding BEVs can constitute an essential aspect of managing the development of electromobility.

Therefore, it is vital to identify the diffusion level of expert opinions among respondents based on the FSI index values. It can be assumed that initiatives aimed at promoting electromobility will be implemented due to a natural tendency toward progress. However, users' interest in its most cutting-edge solution, Battery Electric Vehicles (BEVs), is a strong catalyst for this progress. Thus, it is important to identify the level of diffusion of statements and opinions in two key areas related to the social (environmental) and individual (functional) aspects associated with using BEVs. It is imperative to identify those statements and opinions characterised by low FSI index values (below 1.0) [75]. These will require appropriate educational and marketing efforts to stimulate interest in BEVs by raising potential car buyers' awareness of the specific features of this solution.

Equally important is identifying the degree of variation in opinion distributions conditioned by the variability of respondents' sociodemographic characteristics. Identifying groups of respondents characterised by a low level of diffusion of statements and opinions, and exhibiting a conservative attitude toward BEVs, is essential as it is likely associated with a deficit in their knowledge on the subject.

The first step in the study of the level of opinion diffusion among respondents, using the FSI, was to estimate its value based on data describing the entire respondent group (Table 4). The FSI value represents the ratio of positive to negative opinions, as indicated by Gaworski et al. [75], followed by Lamm et al. [76] and Kłopotek and Ociecek [84]. A predominance of positive over negative opinions regarding a specific statement, regardless of the statement's tone, indicates a high diffusion level. Any value above 1.0 is considered high, with higher values indicating greater diffusion [75,76]. Conversely, an FSI value below 1.0 indicates a predominance of negative over positive opinions regarding the statement, and consequently, a minimal level of its diffusion.

Considering that this study was conducted with respondents who participated randomly and without any prior preparation, there was no basis to expect very high FSI values [75]. Nevertheless, the highest FSI value (5.03), estimated for the entire respondent group, should be considered high [84]. It referred to the statement concerning the high repair costs of BEVs, which relates to their usability. Therefore, the economic burden associated with using BEVs may be one of the factors limiting interest in these vehicles [85]. It was also demonstrated that for none of the examined statements, a predominance of negative over positive opinions was identified, which indicates a high level of opinion diffusion among respondents (Table 4). The lowest FSI value (1.24) within this group of results referred to the statement that BEVs do not contaminate the environment with operational fluids. The average FSI value estimated for opinions concerning environmental aspects was lower than the average FSI value estimated for opinions regarding functional elements, which indicates greater interest in the latter. This, on the one hand, reflects the practical approach of potential BEV users, and on the other hand, suggests the profile of the dominant participant in this study. Considering that most respondents (77%) assessed their economic status as average or below average (Table 1), it may be reasonably assumed that their stronger focus on the functionality of BEVs, rather than their environmental benefits, is a natural consequence. Accordingly, the hypothesis assuming a high level of diffusion of expert opinions on electric vehicles among respondents was confirmed.

Moreover, there were indications that the two remaining hypotheses would be positively verified. Nevertheless, they were subjected to a more in-depth analysis based on FSI index results estimated from data describing respondent subgroups.

Therefore, the study's next step involved determining and comparing the FSI values estimated separately for female and male respondent groups (Table 4). The analysis of these results indicated that the average diffusion level of the examined statements is higher among women than among men. Women showed a predominance of negative over positive attitudes only regarding the statement that BEVs are allowed to use bus lanes in Poland. This indicates a lack of knowledge of the applicable regulations in this respondent group. In contrast, men exhibited a predominance of negative over positive attitudes regarding the statement that BEVs do not contaminate the environment with operational fluids. This, in turn, indicates deficits in this respondent group's technical knowledge level. Furthermore, it was demonstrated that the average diffusion level of the examined statements in both respondent groups was higher for statements concerning the functionality of BEVs compared to those related to environmental conditions. It should be emphasised that the results obtained also suggest that men are better informed about the functionality of BEVs than women. In contrast, women demonstrate significantly greater awareness of environmental issues. Similar observations were identified by Kawgan-Kagan [86]. These findings constitute a preliminary basis for positively verifying the second hypothesis.

Subsequently, an analysis was conducted on the distribution of FSI values estimated from results obtained in respondent groups differentiated by age (Table 4). The analysis of the results led to the conclusion that the average diffusion level of the examined statements among the oldest respondents was considerably higher than that of the other groups. Furthermore, it was established that only the youngest respondents identified somewhat more strongly with statements concerning environmental aspects than those related to BEVs' functional aspects. The opposite pattern was observed in the different age groups, and the difference was significant. It is also worth noting that respondents from all age groups did not exhibit a predominance of negative over positive attitudes toward any of the examined statements. These findings constitute a second partial basis for positively verifying the second hypothesis.

The next stage of this study involved analysing the distribution of FSI values estimated using the results obtained from respondent groups differentiated by educational level (Table 4). It was found that the average level of diffusion of the examined opinions varied substantially among the different respondent groups. The highest level was identified in the respondents with higher education group, whereas a considerably lower level was observed in the group with secondary education. It should be emphasised, however, that the average FSI level in both groups exceeded 1.0, indicating a predominance of positive over negative attitudes toward each of the examined statements. In contrast, in the respondents with primary or vocational education group, the average FSI value was below 1.0, indicating a predominance of negative over positive attitudes toward each of the examined statements. Conversely, no FSI values below 1.0 were observed for any of the examined statements in the remaining respondent groups. Analysing the differences in the distribution of FSI values estimated separately for statements concerning the environmental and functional aspects of BEVs, it was established that the distribution of results for statements referring to ecological aspects of BEVs was analogous to that observed in the analysis conducted on all statements. However, regarding statements related to functional aspects, although the trend is similar, the average FSI value in the respondents with the lowest education level exceeds 1.0. Overall, FSI values were higher for statements concerning functional aspects. These

aspects were also identified by Westin et al. [81]. Therefore, it can be concluded that a third partial basis for the positive verification of the second hypothesis has been demonstrated.

Subsequently, the distribution of FSI values estimated based on results describing respondent groups differentiated by field of education was analysed (Table 4). Once again, the average diffusion level of the examined statements varied among the respective respondent groups. The highest level was identified in the respondents with a technical educational background, while the lowest was observed among those with a humanities or social sciences background. Moreover, only respondents from the latter group exhibited a predominance of negative over positive attitudes toward two statements, both falling within the category of statements concerning the functional aspects of BEVs, indicating a lack of awareness regarding the regulations applicable to BEV users in Poland. It is also worth emphasising that the average FSI value in the category of statements concerning the functional aspects of BEVs was not only higher than 1.0 but also exceeded the value estimated for the category related to the environmental aspects of BEVs. Similarly, significantly higher levels of diffusion were identified among the remaining respondents for statements pertaining to the functional aspects of BEVs. This finding provides a fourth partial support for positively verifying the second hypothesis.

The distribution of FSI values, estimated based on data from respondent groups differentiated by their subjectively perceived economic status, indicates that the average level of diffusion of the examined statements and opinions varied significantly across the groups (Table 4). The highest value was identified in the respondents who assessed their economic status as above average. At the same time, the lowest was observed in the group who perceived their financial status as below average. These findings are consistent with the results reported by Westin et al. [81] and Ling et al. [87]. This was also the only group in which five statements or opinions elicited a predominantly unfavourable rather than favourable response from the respondents. A review of these statements and opinions indicates significant deficiencies in awareness regarding BEVs' ecological and functional aspects. Notably, the level of awareness concerning functional aspects is considerably higher than that of ecological aspects. The fifth partial finding also provides grounds for positively verifying the second hypothesis. Consequently, the second hypothesis has been unequivocally confirmed.

The last hypothesis, positing that economic status (financial situation) is the most significant factor influencing the distribution of FSI values regarding electric vehicles, was confirmed. This conclusion was supported by the results of statistical tests (Table 6), which indicated that respondents' economic status and level of education were factors differentiating the distribution of FSI values. However, it was established that respondents' economic status had a more substantial influence on the differentiation of FSI value distribution than their level of education. A statistically significant increase in the mean FSI value was observed alongside improvements in economic status. Nevertheless, statistically significantly higher FSI values were observed exclusively in the group of respondents with higher education.

The results indicate a higher degree of internalisation of expert opinions regarding the functionality of BEVs than their environmental impact, and they fit into the broader context of decarbonization trajectories described in the literature. In the study by Saglam et al. [88] for France, partial validity of the Environmental Kuznets Curve (EKC) hypothesis in a time-varying approach was confirmed, where in the initial stages of economic development, CO₂ emissions increase, and subsequently—under favourable policy conditions and technological innovations—decrease. A similar mechanism can be applied to the transport sector in Poland: the mass transition to zero-emission vehicles requires creating situations in which users will perceive environmental benefits alongside improved functionality.

The results of this study show that messaging about the environmental advantages of BEVs should be more strongly personalised and targeted at groups with lower awareness levels (e.g., individuals with lower economic status or education levels). In line with the EKC approach, differentiated communication—combining information on actual operational cost savings, available financial support measures, and the impact on air quality—can accelerate the moment of “peak” emissions in road transport being surpassed. Thus, BEVs can become essential in decoupling economic growth from greenhouse gas emissions in Poland.

Table 6. Mean values ($\pm$ SD) of the FSI for environmental and functional aspects of BEVs.

Sociodemographic Variable		Total	Environmental	Functional
Gender *	W	2.996 $\pm$ 1.517 ^a	2.928 $\pm$ 1.414 ^a	3.063 $\pm$ 1.747 ^a
	M	2.840 $\pm$ 1.341 ^a	2.198 $\pm$ 1.155 ^a	3.482 $\pm$ 1.279 ^a
Age **	18–25	2.723 $\pm$ 1.290 ^a	2.732 $\pm$ 1.349 ^a	2.713 $\pm$ 1.357 ^a
	26–36	2.843 $\pm$ 1.515 ^a	2.435 $\pm$ 1.257 ^a	3.252 $\pm$ 1.751 ^a
	37–78	3.709 $\pm$ 2.029 ^a	2.838 $\pm$ 1.270 ^a	4.580 $\pm$ 2.371 ^a
Educational Level **	P/VE	0.933 $\pm$ 0.315 ^a	0.785 $\pm$ 0.149 ^a	1.082 $\pm$ 0.379 ^a
	SE	2.333 $\pm$ 0.842 ^a	2.337 $\pm$ 0.893 ^a	2.328 $\pm$ 0.872 ^a
	HE	4.567 $\pm$ 3.160 ^b	3.587 $\pm$ 2.343 ^b	5.547 $\pm$ 3.764 ^b
Field of Education **	H/SS	2.497 $\pm$ 1.286 ^a	2.392 $\pm$ 1.290 ^a	2.602 $\pm$ 1.396 ^a
	NS	3.136 $\pm$ 1.630 ^a	2.555 $\pm$ 0.909 ^a	3.717 $\pm$ 2.051 ^a
	TS	3.729 $\pm$ 1.839 ^a	3.282 $\pm$ 1.605 ^a	4.177 $\pm$ 2.095 ^a
Economic Status **	↓BA	1.142 $\pm$ 0.570 ^a	0.978 $\pm$ 0.455 ^a	1.305 $\pm$ 0.666 ^a
	↕ A	3.012 $\pm$ 1.566 ^b	2.713 $\pm$ 1.381 ^{ab}	3.310 $\pm$ 1.811 ^{ab}
	↑AA	4.668 $\pm$ 2.637 ^b	3.970 $\pm$ 1.931 ^b	5.365 $\pm$ 3.225 ^b

* Mean values in columns marked with the same lowercase letter do not differ significantly statistically. ** Mean values in columns marked with the same lowercase letter do not differ significantly according to Tukey’s test at $p \leq 0.05$.

4. Summary

The results of these studies made it possible to determine that the factors most strongly differentiating respondents’ opinions about BEVs in Poland are gender, education level, and financial situation. A higher level of opinion differentiation was observed regarding the functional aspects of BEVs compared to the environmental ones. Therefore, to effectively manage the development of the BEV sector, emphasis should be placed on its functional aspects, targeting women, individuals with lower education levels, and those in weaker financial situations.

The level of diffusion of expert statements regarding the environmental and functional aspects of BEV usage among respondents in Poland is high. In each of the respondent subgroups studied, this level was higher regarding the functionality of BEVs compared to their environmental impact. Moreover, it has been demonstrated that the economic status of respondents in Poland is the factor most strongly influencing the distribution of FSI. Therefore, there is a basis to assert that with the increase in the wealth level of people in Poland, the degree of integration of expert statements on BEVs rises. The results also indicated that a high level of education among respondents promotes the integration of statements on BEVs. Therefore, respondents in Poland with better economic status and higher levels of education are characterised by rationalism based on the integration of expert knowledge.

Thus, actions aimed at managing the development of the BEV sector in Poland, by increasing awareness of the global challenge, should be primarily directed towards individuals with lower levels of education. These actions should focus on highlighting the financial support provided by the Polish government to individuals interested in purchasing BEVs. Furthermore, campaigns promoting BEVs should emphasise essential knowledge deficits and must be adapted according to the target audience.

5. Conclusions

The findings of this study allow for several public policy recommendations. First, promotional activities for electric vehicles should be diversified and tailored to specific audience segments—particularly individuals with lower economic status and lower education levels, among whom the degree of internalisation of expert opinions on the environmental benefits of BEVs is relatively low. Effective information campaigns should combine economic aspects (operating costs, available financial support schemes) with messaging on improving air quality and reducing greenhouse gas emissions. Second, the development of charging infrastructure, regulatory facilitation, and support for technological innovation remain key factors in accelerating BEV adoption.

It is essential to acknowledge our study's limitations—the cross-sectional design prevents capturing the dynamics of changes in respondents' attitudes over time, and the Poland-specific context may limit the generalizability of results to other countries. Therefore, future research should adopt longitudinal approaches and employ mixed methods to better understand the evolution of opinions and barriers to BEV adoption over time.

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