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Perceived value and preferences of purchasing EVs

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Abstract. The article emphasizes the fact that the perceived values, behaviour and attitude of consumers are among the key elements in the implementation of the electrification policy of the automotive industry in Europe. Customers' perception differs on several European markets. In Poland, single studies on a small research sample have been carried out so far. The main aim of the paper is to discover the perceived value and intention of adopting EVs by consumers in Poland. The perceived values were divided into functional and non-technical values. The analysis also took into account the socio-demographic and behavioural characteristics of potential buyers and their intentions to adopt EVs. The main data for this study's analysis was obtained from 3,129 respondents. Both the PAPI (Paper and Pen Personal Interview) and CAWI (Computer Assisted Web Interview) research methods were used. The results show that internal factors influencing consumers' decisions to buy an EV (such as charging time, driving range, EV price) are more important than external factors (e.g., fuel prices, consumer characteristics, charging networks, social visibility, and social norms).

Keywords: consumer, preferences, adoption intention, electric vehicles, Poland

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1. INTRODUCTION

The countries of the European Union (the EU), EFTA, and the United Kingdom are in the process of energy transformation, the main goal of which is to achieve climate neutrality in 2050, i.e., net zero greenhouse gas emissions. In November 2018, the European Commission (EC) presented a long-term vision of a competitive and climate-neutral economy that is in line with the 2015 Paris Agreement goal of keeping the temperature rise well below 2°C and trying to bring it down to 1.5°C (Communication from the Commission to the European Parliament, 2018). In line with the climate and energy strategy outlined in this vision, the EU has committed to reducing emissions by at least 40% by 2030 compared to 1990.

In December 2019, Ursula von der Leyen, President of the European Commission, announced the introduction of the European Green Deal (EGD) for the EU. EGD is a new growth strategy that aims to transform the EU into a fair and prosperous society, living in a modern, resource-efficient and competitive economy that will achieve net zero greenhouse gas emissions by 2050, where economic growth is decoupled from the use of natural resources (European Commission, 2022).

In September 2020, the Commission presented a plan to increase, in a responsible manner, a reduction in carbon dioxide (CO2) emissions by at least 55% compared to the 1990 levels (European Commission, 2020). To this end, the transformation of transport, which is responsible for 21% of greenhouse gas emissions in Europe, is crucial. The EU electrification policy forces the automotive industry to make investments and deliver zero-emission technology that meets the emission requirements for new passenger vehicles. Regulations on the reduction of CO2 emissions by car manufacturers apply to all EU countries as well as Iceland, Lichtenstein, Norway, and the UK.

The EU is one of the three largest world markets (alongside China and the U.S.) in terms of passenger car production volume, with a share of over 15.7% in 2020 (European Automobile Manufacturers' Association, 2022). Therefore, the transformation of the automotive industry as a whole and, consequently, the creation of a new electric vehicle (EV) industry will have a significant impact on the functioning of this industry in the future. Consumers have increasingly turned their attention to EVs like battery electric vehicles (BEV) and plug-in hybrid (PHEV) models, which has allowed them to achieve the highest market share so far – 19.2% (2.26 million units) in 2021 compared to 11.4% (1.37 million units) in the previous year (Best selling cars, 2021). Electric vehicles (EVs) are considered environmentally friendly due to their low CO2 emissions, so implementing this technology is considered a pro-ecological behaviour (She et al., 2017; Cui et al., 2021). Most EU countries have implemented support programmes for consumers through a wide system of incentives and subsidies for the replacement and purchase of low-emission vehicles and the EVs to stimulate the demand.

Poland is an EU member state with a large population of over 37 million inhabitants. In 2021, Poland was the fifth largest market in the EU in terms of the number of passenger cars sold, amounting to 447 thousand units compared to 428 thousand units in the previous year. It accounted for the 4.6% market share in total EU sales. A total of 16,433 electric vehicles were sold in 2021, compared to 8,184 in the previous year, which represents a 50% increase (Best selling cars, 2021). At the end of 2021, there were 38,001 electric passenger cars on Polish roads. BEV accounted for 49% (18,795 units) of this part of the vehicle fleet, and the remaining volume (51%) were PHEVs – with 19,206 units (Polish Alternative Fuels Association, 2022).

On the other hand, Poland has one of the oldest vehicle fleets in Europe, with an average vehicle age of 14 years in 2018 (compared to 11 years in the EU), partly due to the high number of imported used

vehicles. In 2018, 80% of the internal combustion cars were over 10 years old. This is one of the major factors influencing air pollution, especially in large cities. To meet the EU's CO2 emission targets, improve local air quality and stimulate the economy, the Polish government is committed to promoting the electrification of the vehicle fleet.

The expectations and perspective of customers are – along with the strategy of car manufacturers, technology development and national policies regarding infrastructure development and incentives – among the main factors influencing the pace of development and the adoption of battery electric vehicles of the EV market. Understanding customer needs becomes a key issue, especially on the markets where a new product is to be launched. Knowing customer perceived values and expectations is also important while introducing new products is taking place, mainly due to the market regulator, which in the case of the electric vehicle market is the EC and the governments of individual Member States. Finally, consumer behaviour and attitude is one of the key elements in the implementation of the electrification policy and the transformation of the automotive industry in Europe.

Customers' perception differs on several European markets. Taking into account the size of the population in Poland, the purchase potential of electric cars is large. Despite the gradual interest in electromobility issues in Poland, little research has been carried out on the preferences of consumers and potential customers of EVs. For this purpose, a study of consumer preferences in Poland was conducted. The research question is what factors are significantly important for the individual buyers choosing the EV in Poland?

The main aim of the paper is to discover the perceived value and adoption intention of customers of battery electric vehicles in Poland. The perceived values were divided into functional and non-technical values. The analysis also took into account the socio-demographic and behavioural characteristics of potential buyers and their intentions to adopt EVs.

As the research is exploratory in character, four hypotheses were formulated:

H1. Internal factors affecting consumers' decisions to purchase EVs (such as: driving range charging time, the EV price) are more important than external ones (such as: fuel prices, consumer characteristics, charging networks, public visibility and social norms).

H2. The driving range is the first priority in purchasing the EV in Poland.

H3. The awareness of new technological solutions has an influence on the purchase of EVs.

H4. The gender of consumers has an influence on the purchase of EVs.

In order to evaluate customer preferences and willingness to buy battery electric vehicles in Poland, both the PAPI (Paper and Pen Personal Interview) and CAWI (Computer Assisted Web Interview) research methods were used. The data collection process was carried out between 01.07-31.08.2020. Three thousand, one hundred and twenty-nine filled questionnaires were received. The survey questionnaire was divided into two groups: consumers' preferences and demographic data.

In the first section of the paper the theoretical background and literature review is presented, including the presentation of the concept of perceived value, the importance of functional and non-technical values as well as the description of the key characteristics of buyers and their intentions to adopt electric vehicles. The second section clarifies the research methodology, while the next section shows the empirical research results. Following this, the research method, main results and discussions are presented. The paper finishes with conclusions and the practical implications of the study.

2. LITERATURE REVIEW

2.1. Concept of perceived value

The concept of perceived value has been broadly studied by many researchers from the 1990s. In the literature, there is no one accepted definition, as authors concentrate on different key elements. However, one of the general definitions of those proposed is by Zeithaml (1988, p. 14) – consumer perceived value is "an overall assessment of the utility of a product based on perceptions of what is received and what is given". Błoński and Skikiewicz (2013, p. 34) argue that values, identity and needs influence consumers' goals. He and Hu (2021, p. 89) underline the validated conclusion that "perceived value is a powerful predictor of individuals' adoption intention toward technology innovations". Chen and Chang (2012, p. 513) added that it is an important determinant in green purchase intention. Concentrating attention on sustainable products, Zhang et al. (2018) argue that the perceived value is divided into perceived economic value and perceived environmental value (Li et al., 2021, p. 782). Based on an in-depth literature review by Han et al. (2017, pp. 186-187), it can be said that consumer value is a multidimensional concept. Thanks to this approach, there is a greater ability to predict purchase intentions than with the one-dimensional approach (Sheth et al., 1991; Leroi-Werelds et al., 2014).

Lieven et al. (2011) and Han et al. (2017, p. 186) state that the development of the availability and sale of EVs depends mainly on their level of acceptance by consumers. In order to indicate the preferences of the customers, economic research usually include: financial, technical, infrastructure, and policy variables (Ghasri, Ardeshiri, Rashidi 2019, p. 272). Han et al. (2017, p. 188) classified consumers' value perceptions of EVs into: functional values (monetary, performance and convenience values) and non-functional values (emotional, social and epistemic values). Based on the literature review, Wicki et al. (2022, p. 5) identified facilitators of BEV acceptance and grouped them into seven categories of determinants: technical, contextual, cost related, sociodemographic, attitudinal and behavioural, social, as well as BEV-specific experience. Coffman (2017, p. 80-88) discussed key factors affecting consumers' decisions to purchase EVs and divided them into three groups. The first one was called internal factors and it concerns such elements as: vehicle ownership costs, driving range and charging time. The second group was connected with external factors like: fuel prices, consumer characteristics, charging networks, public visibility and social norms. The last group is called policy mechanisms: financial and non-financial incentives, supporting charging infrastructure and raising awareness.

Concluding the literature review and following the point of view of Coffman (2017, p. 80-88), a first hypothesis can be formulated as such: H1. Internal factors affecting consumers' decisions to purchase EVs (such as: driving range charging time, the EV price) are more important than external ones (such as fuel prices, consumer characteristics, charging networks, public visibility and social norms). The authors have formulated the above hypothesis based on both the Coffman approach and empirical research conducted in Western European countries in the last ten years (f.e. Deloitte 2020).

2.2. Functional values and EVs adoption intention

Wicki et al. (2022, p. 6-7) carried out an in-depth review of the literature, taking into account the geographical scope of existing research. They found 94 scientific studies that covered 19 countries. Most of them focus on the USA, Germany, Canada, China, Norway, as well as the Netherlands, Denmark, and Sweden. Driving range was one of the most frequently studied determinants chosen by Wicki et al. (2022, p. 9). Other researchers considered as well: range anxiety, long charging time, and high purchase price as being the main consumers' concerns about EV (Hidrue et al., 2011, p. 704; Wicki et al., 2022, p. 13).

Research conducted in selected countries concerned similar factors. Lieven et al. (2011, p. 239) discovered that price and driving range are two top priorities for German potential buyers of EVs. The other criteria like: performance, durability, environment, and convenience, are given less priority. However, in contrast, after 10 years, factors unfavourable to EVs, such as purchase price and driving range, were depreciated by respondents in Germany (Berneiser et al, 2021, p. 1123). In the research based on Spain, Junquera et al. (2016, p. 7) included: purchase price, driving range, recharging time, and the age of consumers, assuming them to be the most important determinants of the adoption of EVs. To the list of predictors of Spanish consumers' purchase intention, Higueras-Castillo et al. (2021, p. 808) add: noise, acceleration, safety, reliability, perceived benefit, incentives and infrastructure availability. Fontaínhas et al. (2016, p. 12) stated that purchasing EVs in Portugal is not yet effective; moreover on the lower/middle market car segment, the cost argument is still not considerable. A study performed for the Swedish market shows the importance of the combination of social influence factors (personal norms and opinion leading) together with environmental attitudinal factors (cleaner or more sustainable products) in pro-environmental behaviour in general and the adoption of eco-innovations (Jansson et al., 2017, p. 184). In Norway, the level of price and a lack of access to loans are key barriers against the adoption of EVs. However, the readiness to use new technologies to reduce energy consumption increases the likelihood of owning an EV (Orlov and Kallbekken, 2019, p. 13-14).

So far, only single studies on a small research sample have been carried out in Poland. Bienias et al. (2020, p. 272) conducted research on 52 respondents only in one big city – Wroclaw. Lewicki et al. (2021, p. 34-36) examined 1,000 owners of conventional fuel vehicles. EVs are still perceived as expensive, although their operating cost is much lower compared to conventional fuels cars. Respondents would use EVs only in city traffic because of the lack of the charging infrastructure. Moreover, they expect the car to be able to reach the range of more than 450 km on a single charge. Researchers discovered that Polish consumers have rather optimistic opinions about EVs having a positive impact on the environment, but their cost seems to be the most important obstacle. Conclusions from commercial research conducted in Poland (Raport EV Klub Polska, 2021; PSPA, 2022) are similar and indicate that the price of an EV is the most important factor for private buyers, although the range and operating costs are of secondary importance. In addition, respondents indicated the need to expand the charging infrastructure in Poland. Nevertheless, in general, Poles are enthusiastic about buying EVs.

According to the 2018 "Electromobility Barometer" of Bank BZ WBK (Presentation of the Electromobility Barometer, 2018), 17% of respondents considered purchasing an EV in the next three years, which was a five percent increase compared to 2017. Benefits such as the possibility of using bus lanes or free parking were also important.

Access to the infrastructure network, the price of an EV, charging time and one-time range are also indicated by respondents in a pilot study conducted in March 2019 in Wroclaw on the obtained sample of 52 respondents (Bienias, 2020). As a purchase barrier, 92% of them indicated access to infrastructure, 91% charging time, and 85% the EV's range. One of the barriers discouraging potential electric vehicle users from purchasing such a vehicle is the lack of a well-prepared charging infrastructure network. (related to relatively low battery capacity).

Conclusions from the literature review in the field of functional values, which are important for purchasers, influenced the formulation of the second hypothesis: H2. Driving range is the first priority in purchasing the EV in Poland.

2.3. Non-technical values and the intention of adopting EVs

In research on customer preferences and willingness to buy EVs, non-technical aspects were also taken into account. Psychological studies are based on the theory of planned behaviour (Ajzen 1991) and emotional reactions. They concentrate on attitudes, beliefs, emotions, perceptions and the usage intention of individual buyers that are affected by vehicle attributes (hedonic and symbolic values, social norms, impact of historical experiences and socioeconomic effects) (Ghasri et al., 2019, p. 272; Rezvani et al., 2015a, p. 175-176). Emotions play an important role in consumers' adoption behaviour. Chaudhuri (2006, p. 275) showed evidence that the dimensions of emotion are strongly related to risk perceptions in products. The emotions studied by He and Hu (2021, p.97), such as pride and guilt, have a significant impact on the intention to adopt an EV, and the influence of positive emotions is stronger than negative emotions. The feeling of pride motivates consumers to manifest pro-environmental behaviour, while guilt shows potential engagement in environmental protection too.

When purchasing EVs, researchers have observed that emotional factors such as self-image, self-identity, satisfaction and emotional pleasure related to contributing to a cleaner environment, are more important than rational (cognitive) arguments (Bennet and Vijaygopal, 2017, p. 502; Moons and De Pelsmacker, 2012, p. 201; Schuitema et al., 2013, p. 9-10; Rezvani et al., 2015b, p. 131). Li et al. (2021, p. 782) argued that "the perceived environmental value of a sustainable product helps consumers to establish a "green" self-image and form positive awareness of consequences". Graham-Rowe et al. (2012, p. 150) discovered the presence of feeling good due to having an environmentally friendly product such as an EV that could encourage a purchase. Hahnel et al. (2014, p. 326) noticed that the ecological themes positively influenced the perception of electric vehicles and the assessment of all product characteristics. Brase (2019, p. 216-217), Carley et al. (2013, p. 42), Rezvani et al. (2015b, p. 131) and Cui et al., (2021, p. 6) stated that people who prefer EVs have a stronger attitude to environmental protection and energy security and are attracted to the novelty and possibility of being among early adopters of the new technology. Moon (2021, p. 10) underline that consumers' environmental propensity has an even greater indirect effect on the intention to purchase EVs than the innovative propensity.

This leads to the third hypothesis, namely: H3. The awareness of new technological solutions has an influence on the purchase of EVs.

2.4. Key characteristics of the respondents and their intention of adopting EVs

The characteristics of the respondents who might be potential buyers also had a significant impact on the purchase of EVs. Based on Hidrue et al. (2011, p. 704), the willingness of consumers to buy an EV is influenced by youth, education, eco-friendly lifestyle, and place of residence with access to charging. Awareness, knowledge and experience with EVs positively affect EV acceptance (Wicki et al., 2022, p. 17) and has a significant influence on the rate of adoption and buying behaviour (Shetty et al., 2020, p. 11; Rabindra, 2020, p. 607; Singer, 2020). This is consistent with the observations of Perera et al. (2022b, p. 2) that environmentally conscious consumers try to avoid the negative effects or have at least a minimal impact on the environment. This is conducive to buying green products that are considered as environmentally friendly because of being less harmful to humans and the environment (Perera et al., 2022a, p.4-5).

Berneiser et al. (2021, p. 1122) discovered that older people showed a lower willingness to buy than younger people. Taking into consideration cohorts X, Y and Z, Ghasri et al. (2019, p. 288) noted that for Gen Y respondents, EVs are better designed and have a lower environmental impact. For representatives of the Gen Z, cars are better in terms of safety. The gender of consumers has a significant impact on purchasing EVs as well (Ghasri, 2019, p. 283). Because of being more innovative, males are more willing to buy EVs than females (He et al., 2018; Kumar and Alok, 2020; Wang et al., 2021, p. 3). Carley et al. (2013,

p. 42) found that lower levels of education decrease interest in purchase. It seems that having a higher level of education make a person more likely to purchase an EV or be EV-oriented.

The researchers also took into account the number of cars at the family's disposal. Having more than one car in the family can decrease range concerns. In this area, EVs can be perceived as more likely to be economical and easier to adopt (Jakobsson, 2016, p. 12; Wicki et al., 2022, p. 16).

Taking into account the multitude of the analyzed elements and the fact that the specificity of the Polish consumer has not been well recognized, the fourth hypothesis was formulated: H4. The gender of consumers has an influence on the purchase of EVs.

3. METHODOLOGY

In order to evaluate customer preferences and willingness to buy battery electric vehicles in Poland, both the PAPI (Paper and Pen Personal Interview) and CAWI (Computer Assisted Web Interview) research methods were used. Respondents were interviewed at dealerships' points of sale in all regions in Poland. The data collection process was carried out between 01.07 – 31.08.2020 (all weekdays plus Saturdays), at different times of the day (morning, early afternoon, afternoon, evening). The non-probability sampling method was used (convenience sampling). At each chosen research point, one interviewer chose a person for a face-to-face interview. As a result, 3,129 filled questionnaires were received.

Preparation for the empirical study was carried out in some stages. First, the available scientific and industry literature was analyzed, with particular emphasis on consumer research carried out in the EU and Poland. This allowed for the preparation of a preliminary version of the questionnaire and the choice of the method used in the quantitative research. Then, a pilot study was carried out to check the logic, order and understanding of the questions contained in the questionnaire by the respondents. The pilot study was carried out on a sample of 47 respondents.

Table 1

Characteristics of the research sample (n=3,129)

Variable	Research sample
Gender	Female 21%; male 79%
Age	18-25: 4%; 26-30: 9%; 31-40: 30%; 41-50: 30%; 51-60: 15%; more than 60: 12%
Education	primary school 1%; vocational 5%; secondary 29%; higher 66%;
Occupation	employees 55%; own business 34%; studying 2%; pensioner 7%; does not work 2%
Place of living	village 17%; city up to 20k 9%; city 20k-50k 10%, city 50k-100k 10%; city 100k-200k 10%, city over 200k 45%
Attitude to new products and new technologies	he/she is one of the first to buy new products / technologies 9%; he/she quickly accepts new products appearing on the market 27%; he/she accepts new products after some time, when others have already tested them 37%; he/she accepts new products only when they become popular on the market and most other people use them 20%; he/she is one of the last accepting new products 5%; he/she does not accept new technologies, products at all, remaining with proven, but often outdated solutions 4%

Source: Authors' results.

The research attempted to find an answer to the following questions: what is the respondents' attitude to electric vehicles, will potential customers choose an EV while buying another car, and what factors will influence their decision? If they do not intend to buy, what fears influence their decision? The survey questionnaire consisted of twenty-six questions, of which eighteen were related to consumers' preferences

and eight related to demographic data. The questions related to preferences consisted of single and multiple-choice questions, questions on a 1-5 Likert scale, and open-ended questions.

Analyzing the data from the empirical study, factor analysis and a one-way Anova were used. Factor analysis reduced the number of factors influencing the purchase of an EV. The one-factor anova checked how demographic characteristics influence the preferences to buy an EV.

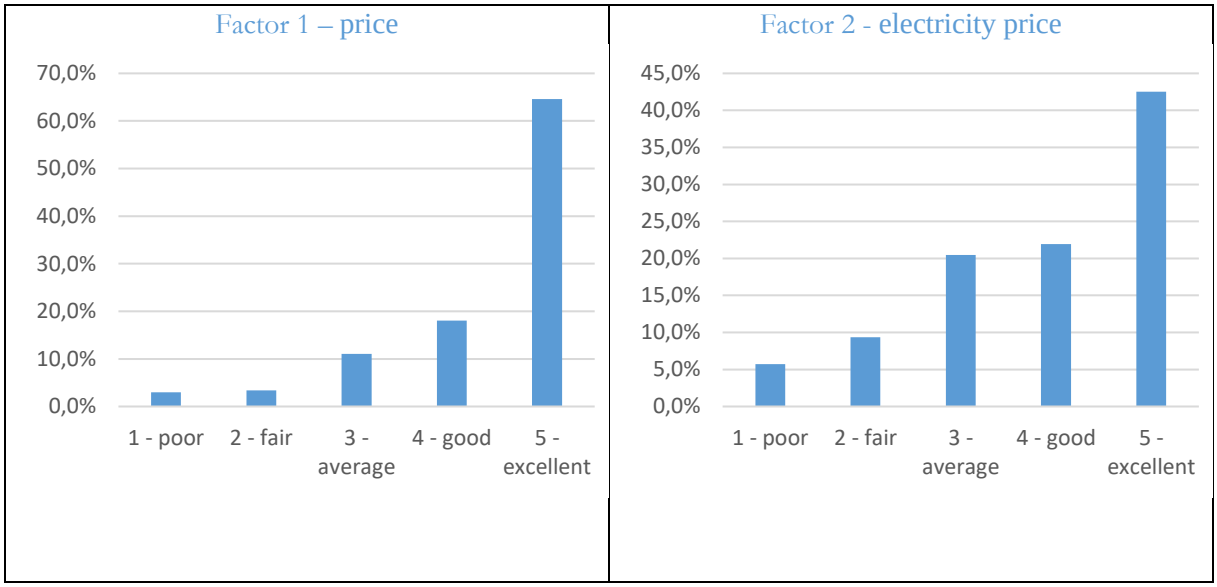
The Statistica and SPSS package were used to analyze our own research data. The main socioeconomic characteristics of the research sample are presented in Table 1.

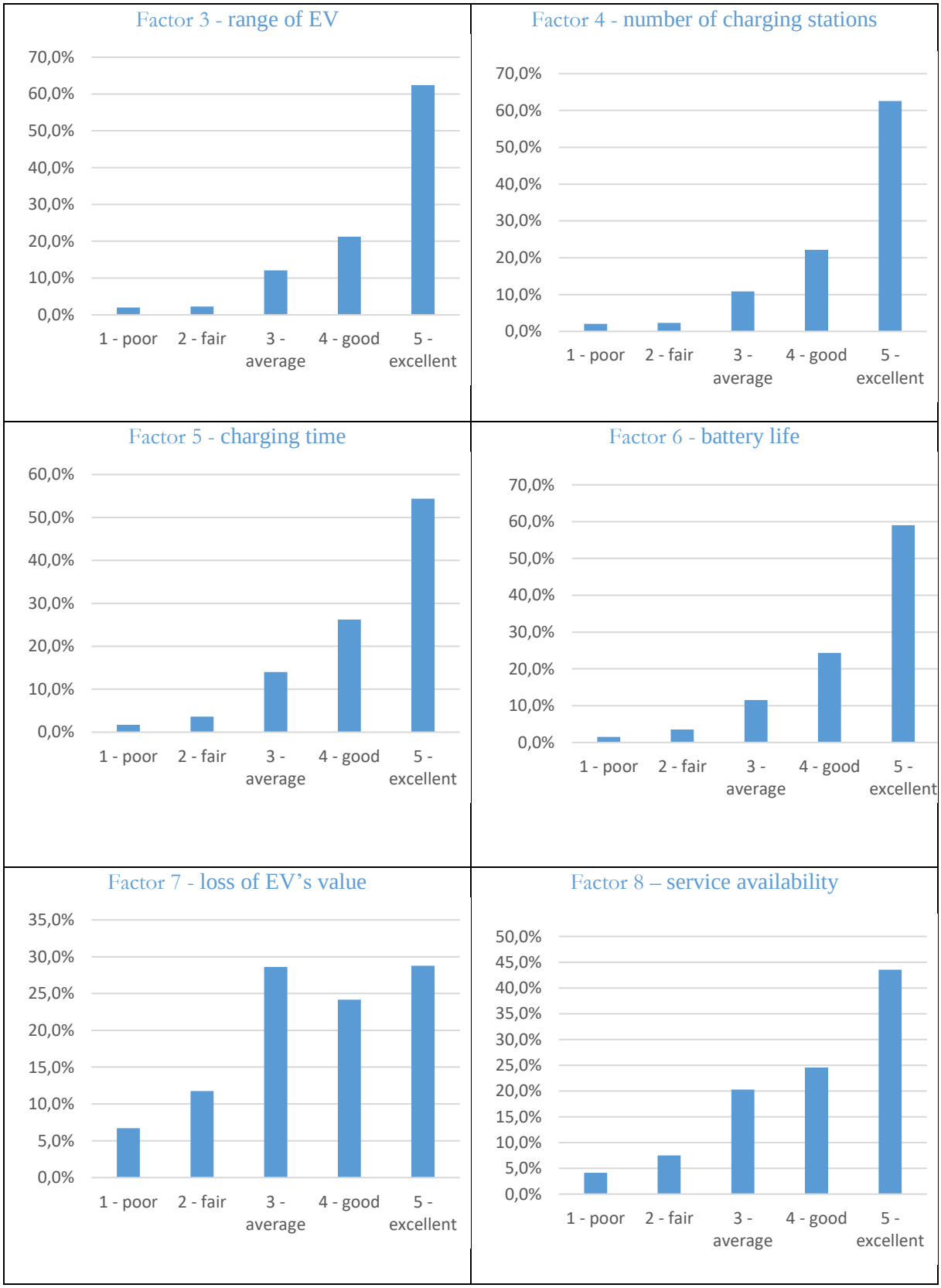
4. EMPIRICAL RESULTS

The respondents declared their willingness to buy a new car based on the preferred type of engine. As the willingness to buy a new EV is determined by people's worries connected with the way of using the car, it has been decided to treat this declaration as a binary dependent variable (1 – "My next car will be electric"; 0 – "My next car will not be electric"). It has been assumed that willingness to buy an EV is strongly affected by the perception and approval of different elements with regard to quality linked with the environment, along with factors such as price, electricity price, range of the EV, number of charging stations, charging time, battery life, loss of the EV's value, and service availability. People were asked to assess these aspects on a five-point Likert scale (1 – poor, 5 – excellent). The results are presented in Figure 1.

Figure 1

Respondents' perception of different parameters of an EV that affect their willingness to purchase





Source: Authors' results.

In order to reduce the variables, factor analysis was applied. All variables in the factor analysis are illustrated on anti-image matrix (Table 2). It can be concluded that all the variables can be used in further analysis.

Table 2

Anti-image Matrix regarding the decisive factors in purchasing an electric car

		price	electricity price	range of EV	number of charging stations	charging time	battery life	loss of EV value	service availability
Anti-image Covariance	price	0,790	-0,205	-0,052	-0,055	0,003	-0,056	-0,043	-0,021
	electricity price	-0,205	0,753	-0,053	-0,020	-0,018	0,008	-0,117	-0,083
	range of EV	-0,052	-0,053	0,577	-0,168	-0,147	-0,061	0,013	0,000
	number of charging stations	-0,055	-0,020	-0,168	0,527	-0,197	-0,034	0,018	-0,040
	charging time	0,003	-0,018	-0,147	-0,197	0,504	-0,120	-0,026	-0,015
	battery life	-0,056	0,008	-0,061	-0,034	-0,120	0,611	-0,126	-0,142
	loss of EV value	-0,043	-0,117	0,013	0,018	-0,026	-0,126	0,650	-0,228
	service availability	-0,021	-0,083	0,000	-0,040	-0,015	-0,142	-0,228	0,631
Anti-image Correlation	price	**.861**[a]	-0,266	-0,077	-0,084	0,004	-0,081	-0,061	-0,029
	electricity price	-0,266	**.847**[a]	-0,081	-0,031	-0,029	0,013	-0,167	-0,120
	range of EV	-0,077	-0,081	**.851**[a]	-0,305	-0,272	-0,103	0,021	-0,001
	number of charging stations	-0,084	-0,031	-0,305	**.821**[a]	-0,383	-0,060	0,030	-0,069
	charging time	0,004	-0,029	-0,272	-0,383	**.824**[a]	-0,216	-0,045	-0,026
	battery life	-0,081	0,013	-0,103	-0,060	-0,216	**.875**[a]	-0,201	-0,228
	loss of EV value	-0,061	-0,167	0,021	0,030	-0,045	-0,201	**.807**[a]	-0,357
	service availability	-0,029	-0,120	-0,001	-0,069	-0,026	-0,228	-0,357	**.825**[a]

a. Measures of Sampling Adequacy (MSA)

Source: Authors' results.

In the next step of the research analysis, based on a scree plot (Figure 2) the authors decided to reduce the variables to 4 factors. The scree plot is a line plot that shows the eigenvalues for each component in the factor analysis. The analysis of the choice of the number of factors comes down to finding the point (number of components) at which the graph begins to "flatten". In Figure 2 it can be seen that after factor 4, the graph starts to become flat compared to the first components where there is a "steep decline" in the eigenvalue. On this basis, a 4-factor solution was chosen.

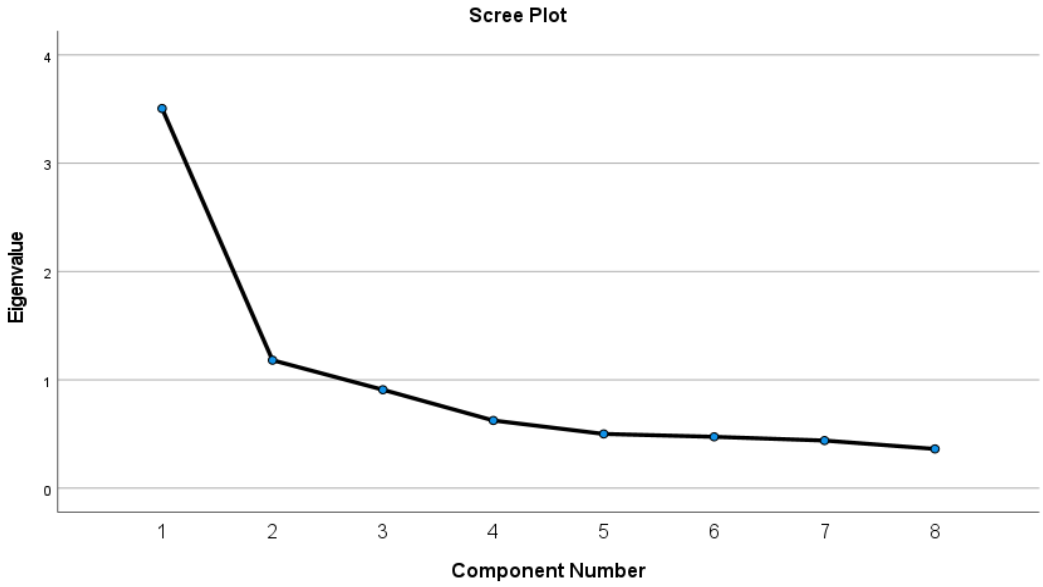


Figure 2. Scree plot regarding the decisive factors in purchasing an electric car

Source: Authors' results.

The 4 factors based on the pattern matrix are as follows:
1 – range of EV, number of charging stations, charging time (internal factors),
2 – loss of EV's value, battery life, service availability (infrastructure),
3 – EV price,
4 – electricity price.

Table 3 shows that 8 analyzed selection factors were reduced to 4 groups. In one of these groups there are factors such as: range of EV, number of charging stations and charging time. These factors are internal elements and referred to hypothesis H1. *Internal factors affecting consumers' decisions to purchase EVs (such as: driving range charging time, the EV price) are more important than external ones (such as: fuel prices, consumer characteristics, charging networks, public visibility and social norms)* and H2. *Driving range is the first priority in purchasing the EV in Poland.*

Table 3

Pattern matrix (factors reduced to 4 groups)

	1	2	3	4
range of EV	**0,858**			
number of charging stations	**0,848**			
charging time	**0,831**			
loss of EV value		0,852		
service availability		0,832		
battery life		0,610		
EV price			1,000	
electricity price				-0,866
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.				
a. Rotation converged in 7 iterations.				

Source: Authors' results.

In the conclusions of the factor analysis (based on Table 4.), factor group 1 (range of EV, number of charging stations, charging time) explains 43% of the variance and all 4 factors explain 78% of the variance. This means all the factors (internal factors, infrastructure, EV price and electricity price) are important when buying an EV and hypothesis H1. *Internal factors affecting consumers' decisions to purchase EVs (such as: driving range charging time, the EV price) are more important than external ones (such as: fuel prices, consumer characteristics, charging networks, public visibility and social norms)* and H2. *Driving range is the first priority in purchasing the EV in Poland.* may be assessed as proven.

Table 4

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3,506	43,824	43,824	3,506	43,824	**43,824**	2,851
2	1,182	14,774	58,598	1,182	14,774	58,598	2,524
3	0,909	11,363	69,961	0,909	11,363	69,961	1,689
4	0,625	7,816	77,777	0,625	7,816	**77,777**	1,100
5	0,501	6,263	84,040				
6	0,474	5,930	89,970				
7	0,440	5,499	95,469				
8	0,363	4,531	100,000				
Extraction Method: Principal Component Analysis.							
a. When components are correlated, the sums of squared loadings cannot be added to obtain a total variance.							

Source: Authors' results.

In order to verify the hypotheses H3. *The awareness of new technological solutions has an influence on the purchase of EVs* and H4. *The gender of consumers has an influence on the purchase of EVs*, on-way ANOVA, U Mann-Wnhitney test and ANOVA Kruskal-Wallis test were used.

In the presented analysis (Figure 3), the dependent variable is the statement "My next car will be an EV". The factors are related to the list of answers in the question "The most important factors when choosing an EV". In the presented analysis, all factors are significant at the level p = 0.01. It is worth noting that the most important factor was the "awareness of new technological solutions". Potential buyers of EVs also noted the importance of the vehicle brand and lower emissions. The results prove the hypothesis H3. *The awareness of new technological solutions has an influence on the purchase of EVs.*

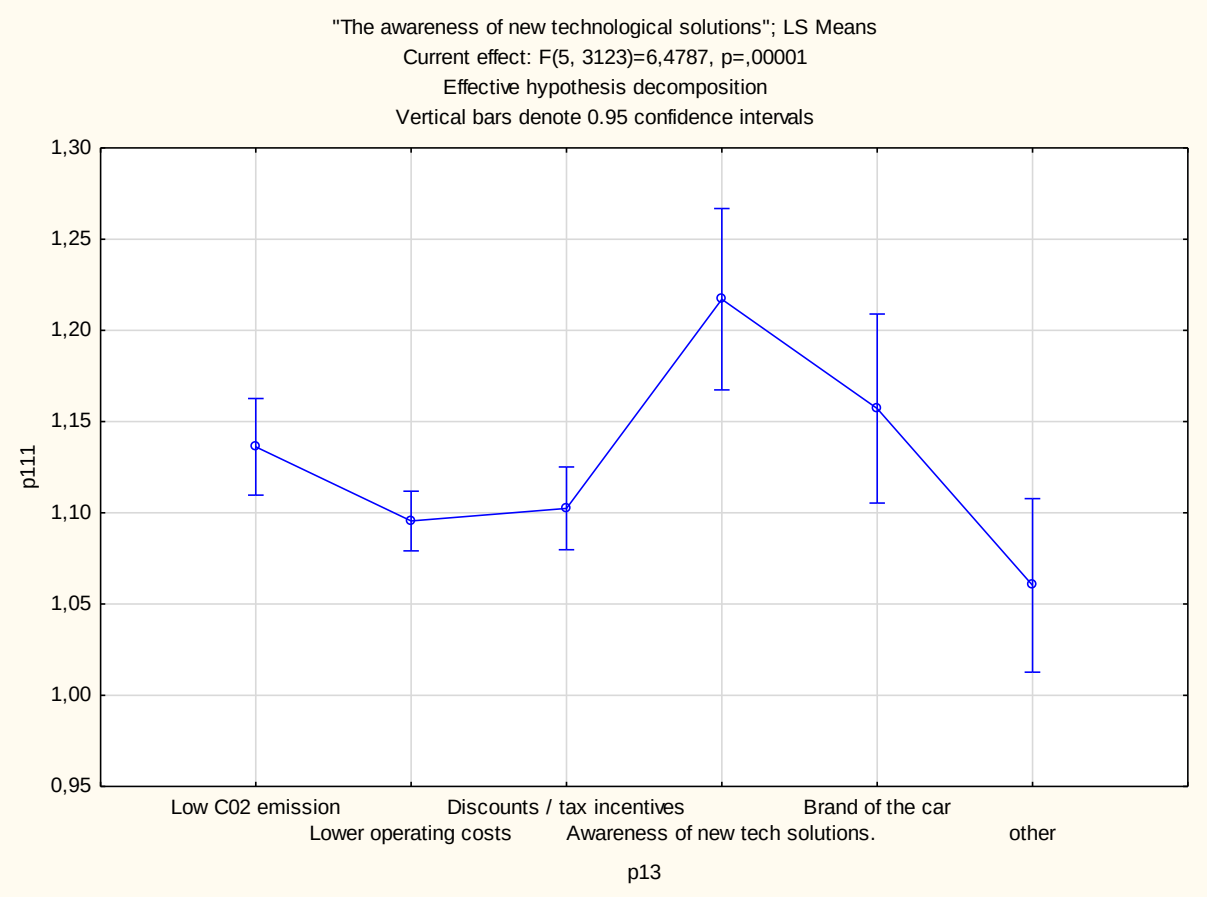


Figure 3. The awareness of new technological solutions (as a factor to consider when purchasing EVs); LS Means

Source: Authors' results.

In the presented analysis (Table 5), the dependent variable is the statement "My next car will be an EV". The factor is "Gender". In the presented analysis, all factors are significant at the level p = 0.010.

Table 5

Gender (as a factor to consider when purchasing EVs)

Ranks

	Gender	N	Mean Rank	Sum of Ranks
My next car will be an EV	Men	2466	1576.75	3888273.00
	Women	663	1521.29	1008612.00
	Total	3129		

Test Statistics[a]

	My next car will be an EV
Mann-Whitney U	788496.000
Wilcoxon W	1008612.000
Z	-2.581
Asymp. Sig. (2-tailed)	.010

a. Grouping Variable: Gender

Source: Authors' results.

In order to check whether other demographic characteristics (age, education) also influence the purchase of an EV (as in the case of gender) ANOVA Kruskal-Wallis was used. The results of the analysis are presented in Table 6.

Table 6

Age, Education (as factors to consider when purchasing EVs)

Age across My next car will be an EV

Independent-Samples Kruskal-Wallis Test Summary

Total N	3129
Test Statistic	.517[a,b]
Degree Of Freedom	1
Asymptotic Sig.(2-sided test)	.472

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

Education across My next car will be an EV

Independent-Samples Kruskal-Wallis Test Summary

Total N	3129
Test Statistic	1.074[a,b]
Degree Of Freedom	1
Asymptotic Sig.(2-sided test)	.300

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

Source: Authors' results.

Purchasing an EV varies only by gender (not by education or age). There is no such relations with regard to age ($p = 0.472$) and education ($p = 0.300$). This leads to the conclusion that hypothesis H4. *The gender of consumers has an influence on the purchase of EVs* may be assessed as proven.

5. DISCUSSION AND CONCLUSION

Climate change concern has grown in recent years, and the EU, as a first region in the world, decided to take all efforts and actions necessary to become a net-zero emission region by 2050. This policy impacts on all industries and people. The EC and the automotive industry are currently pushing for the adoption of the EVs, which are recognized as a key element of achieving the full electrification of the industry, and following that the greenhouse gas emission reduction. In the first years of the transformation change, the EU's climate policy was clear and no room was left for negotiations by the automotive industry. The only concern not totally examined was the willingness of the customers to adopt a new technology quickly. The research indicated that some barriers in adopting the EV were: price, the one-time range and the charging infrastructure. The consumers worry about the EVs having a lower driving range than ICEs.

Due to the great interest in EVs, many studies have been conducted from the perspective of consumers to assess their expectations and purchasing preferences. Analysing the results of empirical research conducted by various groups of researchers in many countries, it can be noticed that national groups of potential buyers of EVs have their own specificities. Therefore, Poland, which is a large market, with a population of over 37 million inhabitants, should be thoroughly researched and described. So far, Poland and Polish consumers have not been the subject of more detailed research.

The article emphasizes the fact that the perceived values, behaviour and attitude of consumers are among the key elements in the implementation of the electrification policy of the automotive industry in Europe, especially in the current political and economic environment after the Russian aggression in Ukraine. In the conducted empirical study, a multidimensional model was used in accordance with the concept of Han et al. (2017, pp. 186-187), Sheth et al. (1991) and Leroi-Werelds et al., (2014). Following the concept of Coffman (2017, p. 80-88) to divide discussed key factors affecting consumers' decisions to purchase EVs, internal and external factors were distinguished. The survey conducted on a sample of 3,170 respondents clearly shows that *internal factors affecting consumers' decisions to purchase EVs (such as: driving range charging time, the EV price) are more important than external ones (such as: fuel prices, consumer characteristics, charging networks, public visibility and social norms) (H1)*. Moreover, among internal factors, *driving range is the first priority in purchasing the EV in Poland* (H2). Polish consumers perceive them as key functional values necessary for the adoption of EVs. The results obtained from Polish customers are similar to those for Germany, where price and driving range are two top priorities (Lieven et al., 2011, p. 239), and Spain where purchase price, driving range and recharging time are the most important determinants for the adoption of EVs (Junquera et al., 2016, p. 7). However, it is worth noting that conclusions from commercial research already conducted in Poland have indicated that the EV price was the most important factor for private buyers, although the range and operating costs were the next most important (Raport EV Klub Polska, 2021; PSPA, 2022). It can be assumed that the cost of EVs and electricity will become even more important in the future related to the Russian aggression in Ukraine last February. This factor may strongly influence customers' approach.

When analyzing the importance of non-technical values in the adoption of electric vehicles by consumers in Poland, the most important is the awareness of new technological solutions (H3. *The awareness of new technological solutions has an influence on the purchase of EVs*). This is the most important factor when considering purchasing an electric car. Other significant arguments are the brand of a car manufacturer implementing pro-ecological solutions and lower emissions. It seems that potential EV buyers in Poland pay attention to environmental problems where they live. This statement corresponds with the opinion of researchers who in their research noticed the importance of emotional factors such as a sense of pride, positive awareness of consequences, satisfaction with contributing to a cleaner environment, and creating a pro-ecological self-image (Bennet and Vijaygopal, 2017, p. 502; Moons and De Pelsmacker, 2012, p. 201; Schuitema et al., 2013, p. 9-10; Rezvani et al., 2015b, p. 131; Li et al., 2021, p. 782; Perera et al., 2022b, p. 2;

Perera et al., 2022a, p.4-5). This is in line with the point of view of Graham-Rowe et al. (2012, p. 150) and Hahnel et al. (2014, p. 326) that the presence of feeling good due to having an environmentally friendly EV could encourage a purchase. EV owners have a stronger approach to environmental protection and energy security, and they are attracted to novelty and the possibility of being among the early adopters of new technology (Brase, 2019, p. 216-217; Carley et al., 2013, p. 42; Rezvani et al., 2015b, p. 131; Cui et al., 2021, p. 6).

Finally, it is worth noting that gender plays a role when purchasing EVs (H4. *The gender of consumers has an influence on the purchase of EVs)*. Ghasri (2019, p. 283) came to a similar conclusion. The greater interest in men may be associated with their greater propensity to innovate (He et al., 2018; Kumar and Alok, 2020; Wang et al., 2021, p. 3).

Having in mind managerial implications, it is worth analyzing the similarities and differences between customers from different countries. This will be important information for EV manufacturers and policy makers who are boosting their attention and actions related to the EVs, which are attractive options to reach environmental objectives (Konewka et al., 2021). These applications will allow EV manufacturers to make their EVs offer even better, in line with the preferences and expectations of domestic customers, and for the policymakers to allocate the EV subsidies in the right way.

In addition, in Poland, the unfavorable country energy mix influences the high energy cost. In the last years, renewable energy actions have not been considered and developed by the government. That policy and the war in Ukraine have a huge impact on rising energy costs in the country and could shrink the slow-developing EV market. Having committed to the EU climate policy, the Polish government needs to introduce serious green renewable energy regulations and implement appropriate solutions to support the development of the EV industry and maintain the interests of the consumers in purchasing the EVs. The policymakers must understand that the EV range and charging network affect each other. Increasing the number of EVs requires a fast development of a charging network. The EVs have currently a lower single range than the ICEs which becomes a significant factor for potential customers. Increasing one-single range is also important for the process of the electrification of the vehicle industry.

5. LIMITATIONS AND FURTHER RESEARCH

Although this research provides certain findings and implications, the authors are aware of the research limitations. This mainly concerns the fact that the research sample is purposefully selected. The lack of representativeness is the main obstacle to recognizing the results of the study as possible to be extrapolated on the scale of the whole country, which is Poland. Second, developing an in-depth empirical model, it requires further expansion to include more variables. Future research should consider multidimensional values such as: monetary, performance, convenience, emotional, social, epistemic, attitudes, and adoption intention, as well as more specific variables such as brand preferences. Third, the environmental responsibility of buyers of EVs needs to be further explored.

Moreover, it is worth making a distinction between "the use of an intent to purchase measure rather than an actual behaviour measure" (Carley et al., 2013). In the research, the respondents could provide answers that corresponded to their current intentions, which, in turn, could be different from those that they would have been guided by at the time of making the purchase.

It would also be interesting and legitimate to conduct a similar study among the inhabitants of other Central and Eastern European countries – the Czech Republic, Slovakia and Hungary. Despite the differences that certainly exist between these inhabitants, it would be interesting to check what the similarities are and to what extent they correspond to the results of the research conducted among respondents from Western European countries.

More similar studies need to be done to monitor changes in customer behaviour. In the current difficult situation with energy supply and its price, another factor – the price of electricity – will become a more important determinant of consumers' decisions. And governments must take this into account when implementing an additional subsidy policy for the development of the EV market.

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