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ASSESSMENT OF KNOWLEDGE OF YOUNG USERS AND THEIR VIEWS ON E-MOBILITY

Summary. The European Union is set to become the world's first climate-neutral continent in 2050. Achieving such an ambitious goal requires cross-cutting measures in all key sectors of the economy, including transport, which is one of the main sources of emissions in Member States, including Poland. Electromobility is a key instrument for reducing the negative impact of transport on climate and the environment. The current automotive market in Poland, for the most part, is made up of old combustion engine cars. The average age of a passenger car in Poland in 2021 was 14.5 years, 0.2 years more than in 2020. An important point to note is that in 2021, nearly twice as many used cars were imported into Poland as new cars were sold, and this was 11.3% higher than the figure recorded in 2020. At the same time, 48% of the cars were equipped with diesel engines. Thus, it is reasonable to identify the current state of knowledge of e-mobility and its assessment by young consumers (18- to 25-year-olds). How they perceive such vehicles is of great importance. Young buyers are a special group in the automotive market - their purchasing preferences will determine the nature of the car market in the future, including whether it will be zero-emission. Learning about the opinions of young consumers is important. On the one hand, it allows knowledge to be gained about the beliefs, feelings, and level of interest in this type of car and the actions young people want to take regarding purchase and use. On the other hand, knowledge of their attitudes towards electric cars can be the basis for creating more relevant information messages. Such information may also be significant for companies and institutions involved in introducing electric cars to the Polish market and those interested in the issues of new technologies in Poland.

1. INTRODUCTION

To meet the expectations of shaping sustainable development, the paradigm of the 21st century, on July 14, 2021, the European Commission (EC) adopted the 'Fit for 55' legislative package, the overarching goal of which is to reduce net CO_2 emissions by at least 55% (compared to 1990) by 2030. The target is to achieve climate neutrality by 2050 in line with the provisions of the "European Green Deal" [14].

Concerning the decarbonization of transport, the regulation adopted on March 28, 2023, by the European Council is groundbreaking, which obliges automotive companies to reduce (relative to 2021) average emissions from new passenger cars (M1) by 55% and 50% from light commercial vehicles (N1) from 2030 onwards. Currently, such vehicles generate around 15% of the EU's CO_2 emissions [14].

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As a result, all newly registered passenger cars and light commercial vehicles (LCVs) in the European Union (EU) must be zero-emission from 2035. This would result in a community-wide ban on the registration of new cars with internal combustion engines.

Against this background, electromobility appears to be a key development trend in the European automotive industry. It is estimated that by 2030, at least half of all cars sold and registered in Europe will be electrically powered. Meanwhile, in 2022, sales of electric cars in the European Union reached 2.1 million (Fig. 1), representing 2% of the EU automotive market (Fig. 2) [12].

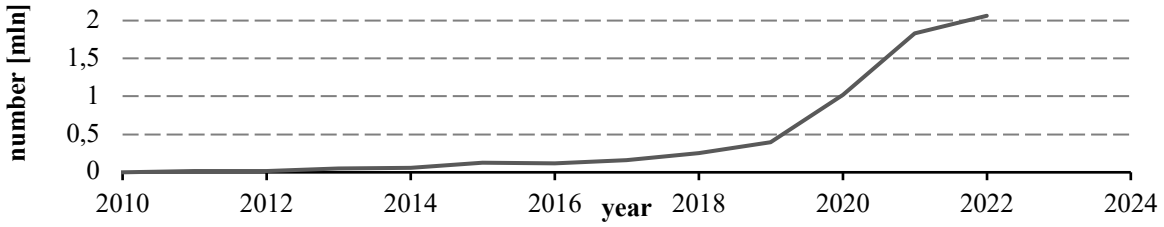

Fig. 1. Number of newly registered M1 and N1 electric cars in the European Union (Own compilation based on [12])

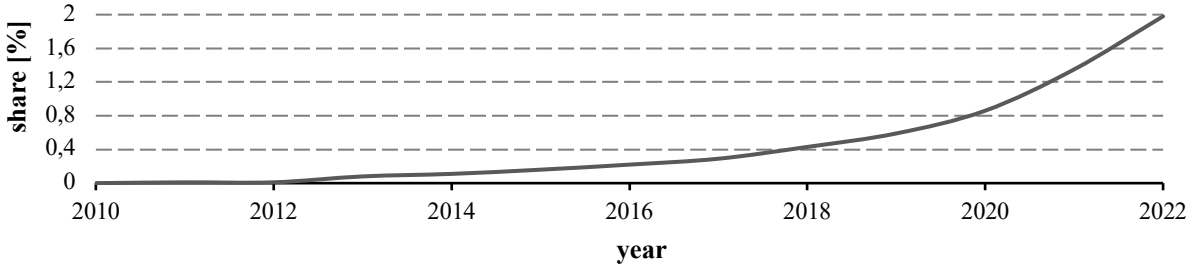

Fig. 2. Share of electric vehicles (M1 +N1) in the automotive market in the European Union (Own study based on [12, 16])

In response to the EU measures, Poland, a member of the European Union, is facing a transformation of the automotive market towards zero-emission mobility.

According to research conducted by the Association of Automotive Distributors and Parts Manufacturers and experts from Frost & Sullivan, e-mobility will be the trend that will most significantly change the automotive trade and service market in Poland (Fig. 3) [1].

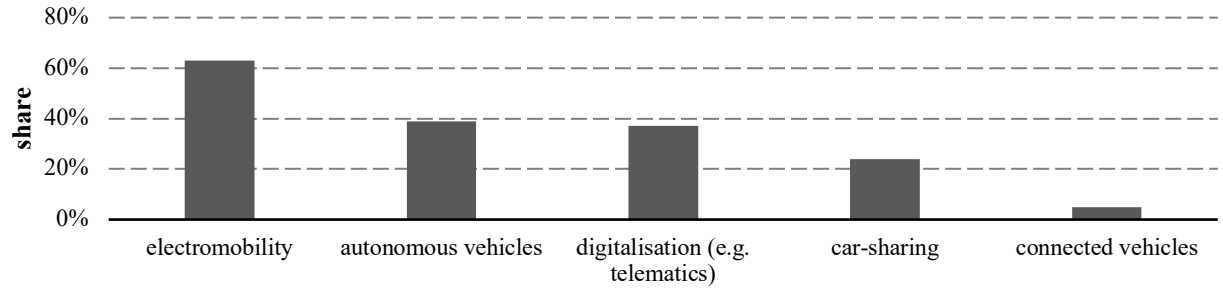

Fig. 3. Megatrends that will most significantly change the automotive trade and services market (Own compilation based on [8])

2. AUTOMOTIVE MARKET IN POLAND

The automotive market in Poland, for the most part, is made up of aging internal combustion engine cars, and the market share of electric vehicles is still lower than in most EU Member States (Fig. 4).

According to [23], the number of motor vehicles registered in Poland in 2021 amounted to 25,063.9 thousand and increased by 3.3% compared to the previous year. Among them, the largest number of registered vehicles were passenger cars (19,160.9 thousand) (Fig. 5).

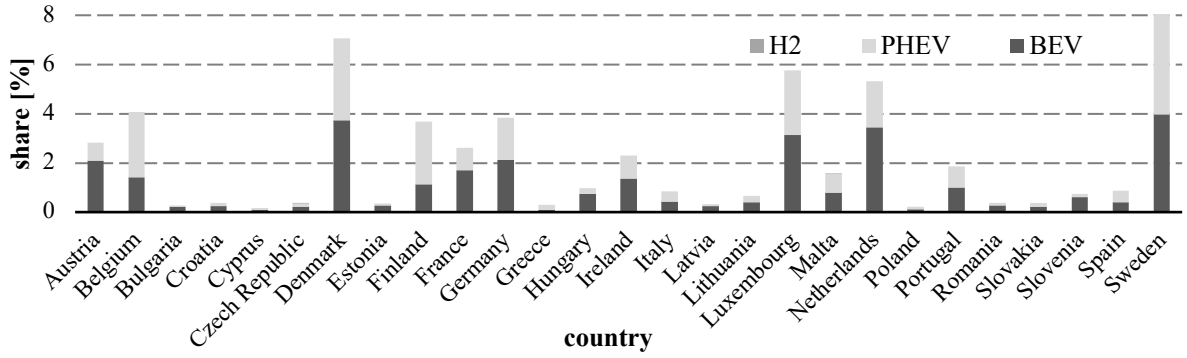

Fig. 4. Fleet of alternatively fuelled (BEV, PHEV, H2) passenger cars (M1) and vans (N1) as a percentage of the total fleet in 2022 (Own compilation based on [12])

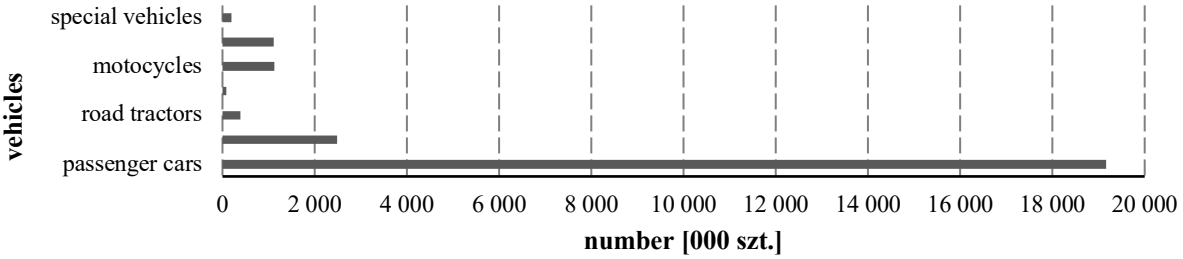

Fig. 5. Motor vehicle fleet in 2021 in Poland [000 units] (Own compilation based on [25])

The average age of passenger cars in Poland in 2021 was 14.5 years (0.2 years more than in 2020), while the median reached 14 years (one year less than the previous year) [24]. The car fleet, which has been aging for many years, is mainly fed by imports from the secondary markets of other countries.

Passenger cars four years old or younger accounted for 12% of the passenger vehicle fleet at the end of 2021, the same as at the end of 2020. Passenger cars between five and 10 years old accounted for 17% of the fleet, while cars between 11 and 20 years old accounted for 50%. The oldest category, over 20 years old, accounted for 21%, which was more than the youngest category (up to four years old). Fig. 6 shows the age structure of passenger cars in operation in Poland in 2021.

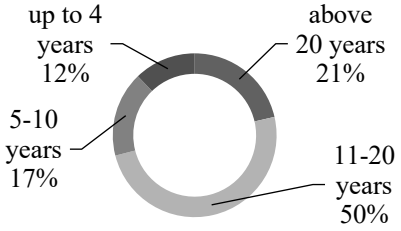

Fig. 6. Age structure of passenger cars in Poland in 2021 (Own elaboration based on [13, 25])

In the passenger car fleet, by fuel type, at the end of 2021, petrol models accounted for 45%, diesels accounted for 40% (with both shares remaining constant), LPG accounted for 13%, and electric propulsion accounted for 0.2% of the fleet (Fig. 7).

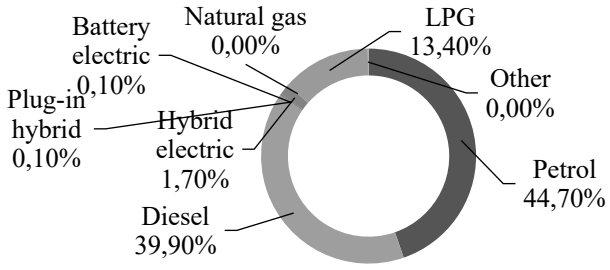

Fig. 7. Passenger cars by fuel type in Poland, 2021 [13]

According to statistics compiled based on [5, 24], in 2021, offices in Poland registered 520,573 new cars and vans up to 3.5 tonnes, 6.7% more than the year before (Fig. 8).

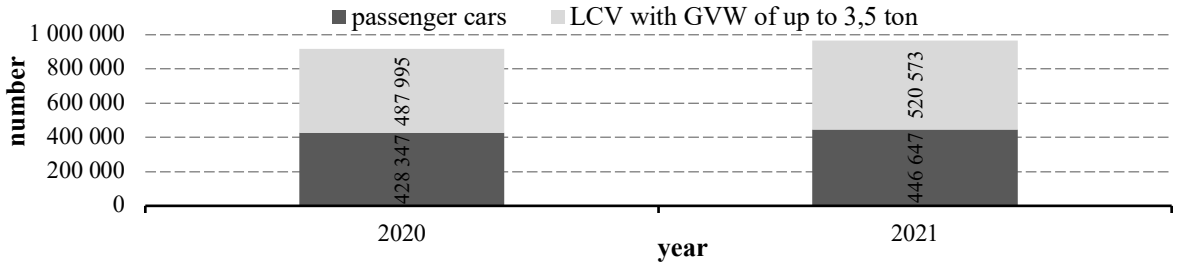

Fig. 8. Number of new vehicles registered in Poland

An important point to note is that in 2021, nearly twice as many used cars were imported into Poland (i.e., 859.1 thousand) as new cars were sold. This was 11.3% higher than the result recorded in 2020. At the same time, 48% of cars were equipped with diesel engines [25].

Polish customers are keen to take advantage of the opportunity to import used passenger cars, and this situation has prevailed since Poland's accession to the European Union in 2014. Importantly, Poland has not yet introduced effective measures to counteract the import of used vehicles.

Thus, it is reasonable to identify the current state of knowledge on e-mobility and its assessment by young consumers (persons aged 18-25). How they perceive such vehicles is of great importance. Young buyers are a special group in the automotive market, and their purchasing preferences will determine the nature of the car market in the future, including whether it will be zero-emission.

However, there is a lack of broad research into young people's attitudes towards this type of vehicle. There are various research papers and reports produced by survey companies on electric cars showing the state of interest, as well as the volume of their purchase concerning various determinants [9, 18, 29]. They present results for one country or compare data from different countries.

In the study [28], it was shown that among the Europeans analyzed, Poles are least familiar with electric cars. In contrast, a survey of drivers of internal combustion engine and electric vehicles in Kuwait showed that more than half of the survey participants would buy an electric car in the next three years if several conditions were met, namely: a lower purchase price, subsidies for the purchase, and the availability of adequate infrastructure for electric vehicles related to charging stations, fast lanes, and free parking spaces [19]. More than 40% of the participants in the survey would seriously start thinking about purchasing an electric vehicle if fuel prices increased by 50-199%. More than 40% of the participants felt that electric vehicles were safe regarding fires and accidents. Furthermore, around half of the participants would pay 6-20% more for an electric vehicle, which is both environmentally friendly and much faster than petrol cars. Furthermore, respondents would prefer electric vehicles to petrol cars in the future due to their environmental, economic, and technological value.

In [2], based on a multiple regression analysis performed using a hierarchical method, it was confirmed that the willingness to purchase an electric car is highly influenced by the comfort of driving such a vehicle and environmental concerns. In contrast, it is negatively influenced by attachment to traditional vehicles and limited knowledge of electric vehicles. Meanwhile, discrete choice models were developed to relate the decisions and attitudes of EV users to their socio-demographic characteristics and the size of the city (large, medium, small) from which they came [20]. The results suggest that the place of residence was a statistically significant factor influencing the decisions and attitudes of respondents. In addition, the paper discusses potential applications of the results of the surveys carried out in policy-making and infrastructure planning.

Other surveys conducted among consumers (car drivers), industry actors (car manufacturers, suppliers), policymakers, and the public (citizens, employees, trade unions, environmental organizations, NGOs) reveal that electric cars are currently evaluated as a social status symbol and innovation and environmentally friendly in terms of decarbonizing transport while providing an opportunity for companies to exploit new opportunities and business models [7].

Other research [27] aimed to indicate whether the determinants of electric car use differed between drivers of only electric cars and drivers of both electric and conventional cars and only conventional cars. The MANCOVA results show that the largest differences were between owners of only electric cars and owners of only conventional cars, while the differences between those who own only an electric car and those who own both an electric car and a conventional car were small. Compared to conventional car owners, electric car owners were younger, with higher education and income levels. They also reported more frequent car use and higher levels of knowledge about electric cars. In addition, electric car owners were more aware of the positive features of electric cars and the consequences related to the environmental impact of car use. In addition, using multinomial logistic regression, it was shown that electric car attributes were the strongest group of variables that increased the likelihood of owning such a vehicle. In the paper [26], using a model of the regulatory role of latent attitudes, it was investigated whether electric car purchase decisions could be predicted by variables such as personal and social norms, perceived usefulness of electric vehicles, and consumer latent attitudes. In addition, it analyzed whether attitudes depend on socio-demographic variables and aspects of attentiveness. The results suggest that attentiveness is not significantly related to respondents' attitudes, while goal intention can be predicted by considering both explicit and latent attitudes, personal norms, and the perceived usefulness of the model. Meanwhile, in a paper [4], gamification theory was used to show a weak relationship between attitudes towards EVs and intention to purchase them. Surveys on attitudes towards electric cars have also been carried out in Poland [3, 6, 11, 15]. A social survey carried out cyclically every year by the Polish Alternative Fuels Association showing Poles' preferences related to electromobility [21] revealed that Poles are increasingly open to electromobility. Each year, more respondents express interest in purchasing electric cars and see their advantages. Importantly, the vast majority of current electric car owners declare that the next cars they buy will also be electrically powered. At the same time, diesel engines are becoming less popular. Almost 75% of the beneficiaries indicated that electric cars will replace internal combustion vehicles. However, in both domestic and foreign publications, studies concern statistical samples, and the units surveyed were not exclusively young consumers (18-25 years old). They all involve surveys of consumers of different ages. Hence, learning about the opinions of young consumers is important, as it provides knowledge of the beliefs, feelings, and level of interest in this type of car and the actions young people wish to take regarding the purchase and use of them. Also, knowledge of their attitudes towards electric cars can be the basis for creating more relevant information messages directed towards a better understanding of the specific object of the attitudes and, as a result, can cause increased interest in it [17].

Such information may also be significant for companies and institutions involved in introducing electric cars to the Polish market and for people interested in new technologies in Poland. Today, decision-making based on facts is becoming more important. This study may be a source of reliable data on electromobility to support informed decision-making on the future of the automotive market in Poland.

3. METHODOLOGY AND RESULTS OF THE STUDY

Research on identifying the level of knowledge about electromobility and the emotions it evokes in young consumers was conducted using a socio-psychological method (i.e., a survey). The research instrument was a standardized survey questionnaire, which included specific questions and questions of a metric nature. The pertinent questions were closed and open-ended. Closed questions with a cafeteria of answers allowed for categorized answers, while open-ended ones were more detailed and richer in content. The questionnaire included questions on knowledge of electric cars, preferences for these vehicles, and opinions on their importance in the future. The empirical research was carried out in February 2023 in the area of Kielce city in a direct form (i.e., using the paper and pencil interviewing technique), which required personal contact between the interviewer and the respondents, owing to which a high value of the return rate of completely filled questionnaires was obtained.

3.1. Description of the research object

The subject scope of the research included respondents representing adult purchasers of motor vehicles. The selection of specific individuals for the research sample was random, and the only

condition imposed on them was their age (18-25 years). The choice of purchasers of motor vehicles as subjects was primarily due to their dominant importance in shaping the future automotive market. A total of 275 people were surveyed. The collected data were then verified, resulting in data from 241 questionnaires being used for further analysis. Among the people surveyed, there were 123 women (51%) and 118 men (Fig. 9). Also, 208 people had a category B driving license (i.e., 86% of the respondents, 44% women and 42% men) (Fig. 10).

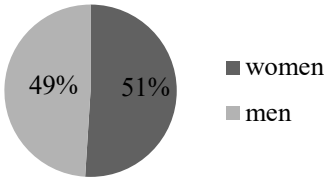

Fig. 9. Structure of the study population by gender

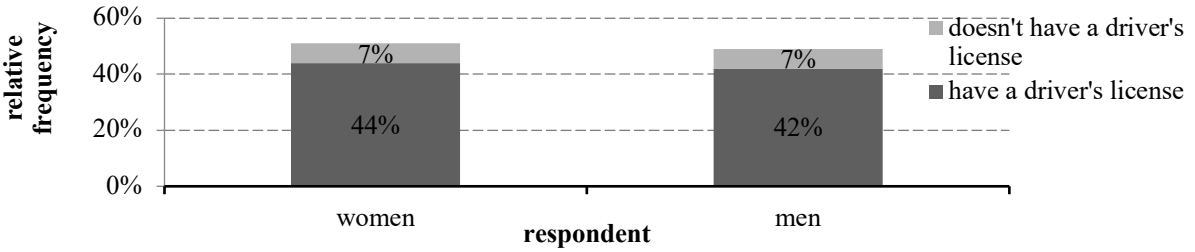

Fig. 10. Respondents by driver's license ownership

A total of 185 respondents (77%) declared that they drive a combustion vehicle. Four women and two men (2%) drive hybrid vehicles, and 50 respondents (21%) do not own a car. No respondents indicated that they drive an electric car (Fig. 11).

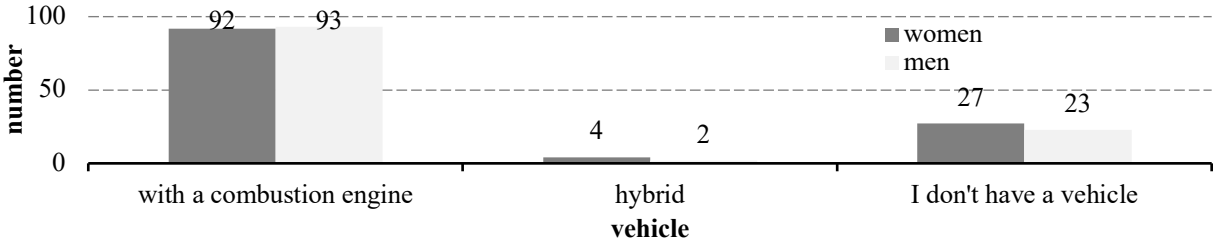

Fig. 11. Distribution of responses to the question "What kind of vehicle do you drive?"

Seventy-nine respondents indicated that they drive daily (33%), 82 drive at least once a week (34%), 18 drive at least once a month (8%), and 21 drive occasionally (9%). Furthermore, 41 respondents do not drive tall (17%) (Fig. 12).

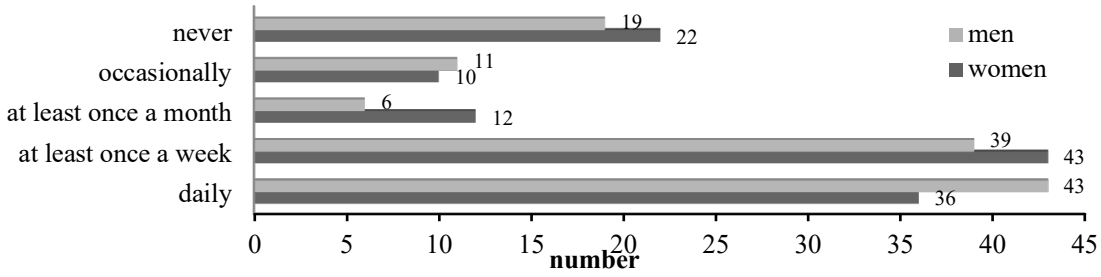

Fig. 12. Frequency of driving by respondents

3.2. Knowledge of respondents about electromobility in Poland

The core part of the survey contained 15 questions, including questions testing young consumers' knowledge of e-mobility.

One of them concerned the charging time of battery electric vehicles (BEVs). Respondents were asked to indicate approximately how long they thought it would take to charge such a vehicle (from 0-100% of the battery capacity installed in the BEV) at a publicly available direct current (DC) charging station using a private wall-mounted charger (Walbox) and a mains socket at home. Fig. 13 shows the actual charging time of the most frequently purchased electric car in Poland in 2022, while Fig. 14 shows the distribution of answers that respondents gave.

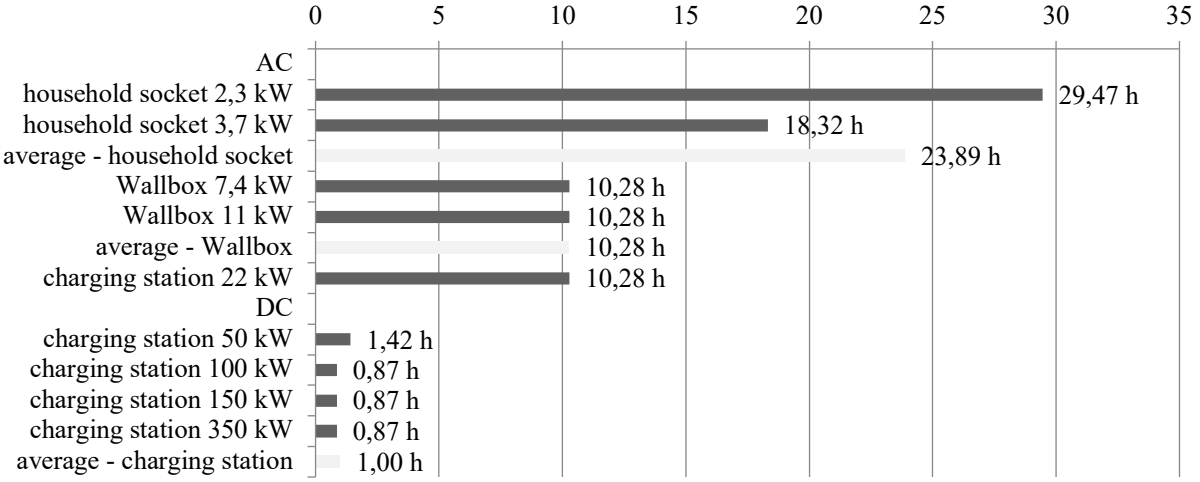

Fig. 13. Real charging time for Nissan LEAF 217 hp / 59 kWh

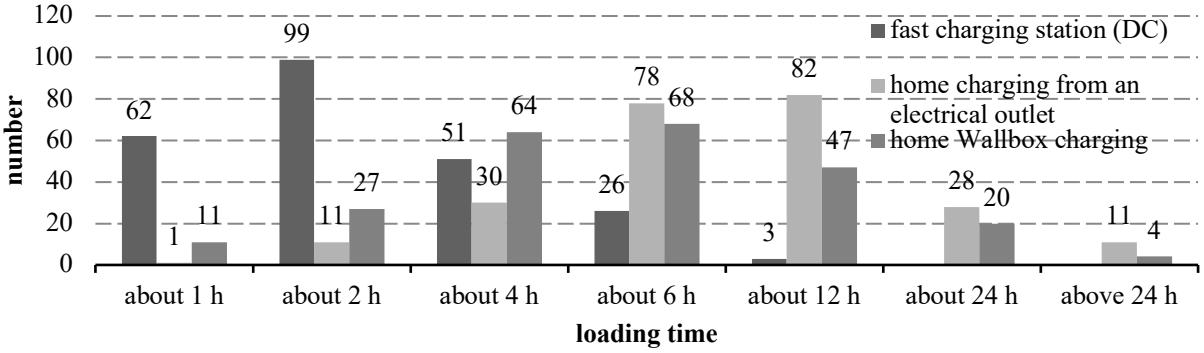

Fig. 14. Average charging time for a battery installed in an electric car (0-100% capacity) estimated by respondents

According to the largest number of respondents, charging a BEV takes about 12 h from a home electric socket (AC) (82 respondents, 34%), 6 h using the Wallbox (68 respondents, 28%), and about 2 h at a public DC charging station (99 respondents, 41%). Only 12% of respondents indicated that it takes about 1 h to charge from a home electrical socket, about 12 h using the Wallbox (20%), and about 1 h at a DC station (26%). In addition, respondents were asked to select the maximum number of kilometers a BEV can be driven with a fully charged battery (Fig. 15). In Poland in 2022, consumers could choose from 108 BEV models with an average range of 233 to 571 km. Fig. 16 shows the average range of BEVs available on the Polish market.

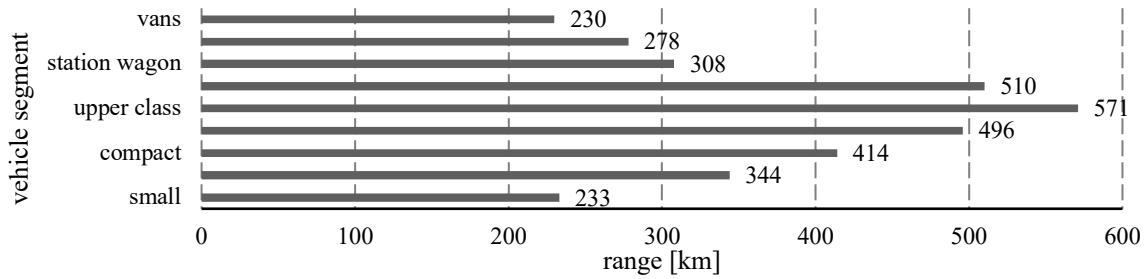

Fig. 15. Average range of BEVs available in Poland in 2022 [22]

According to [10], among the 10 most frequently purchased all-electric cars in Poland, the vehicle with the longest range (i.e., 610 km) is the 98 kWh Ford Mustang Mach-E RWD (Fig. 21).

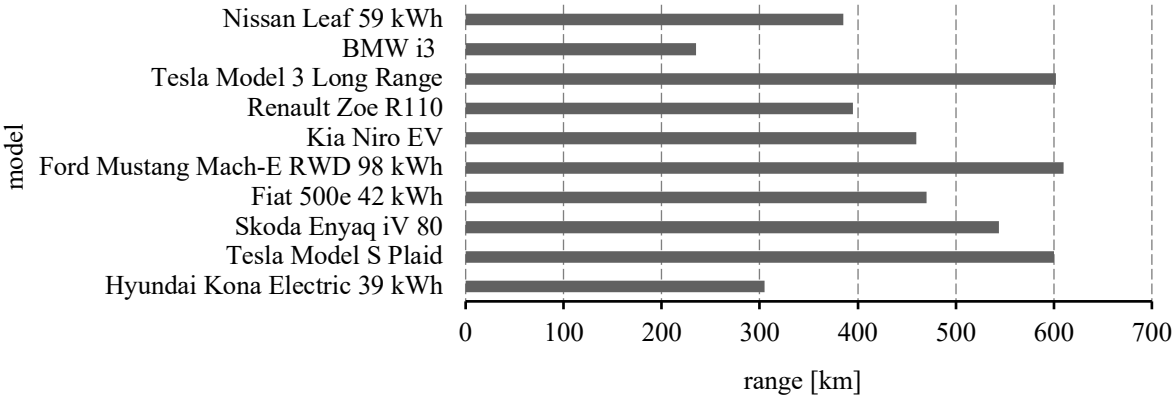

Fig. 16. Top 10 most-sold electric cars in Poland in 2022

Fig. 17 shows that respondents were least likely to select an answer reflecting the maximum coverage. Only 16 respondents (7%) gave such an answer. The largest number of respondents (118) provided a range between 200 and 400 km.

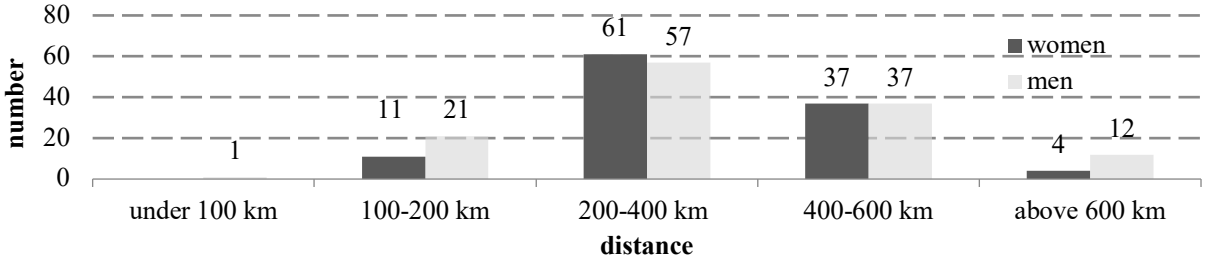

Fig. 17. Maximum distance an electric vehicle can travel on a full charge given by survey respondents

In Poland, as of January 1, 2020, newly registered electric and hydrogen cars are marked with green number plates with black numbers. Hence, in the next question, respondents were asked to indicate their color. Fig. 18 shows the distribution of responses to the question, "What color are the license plates of newly registered electric vehicles?" Their responses show that the vast majority know how electric cars are correctly labeled. The number of correct answers was 227, representing 94% of all answers.

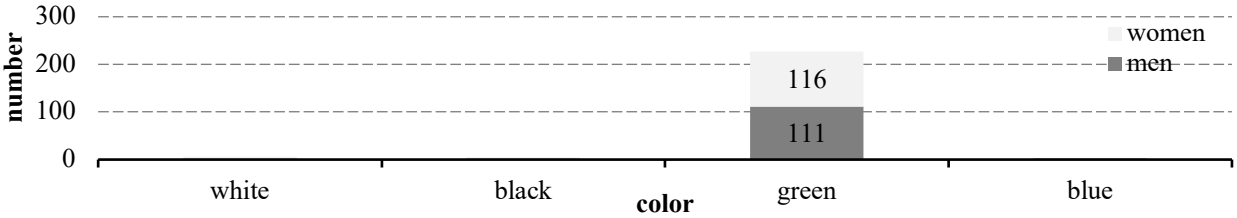

Fig. 18. License plate color of newly registered electric vehicles according to respondents

Another question concerned the cost of recharging an electric car from a home electrical socket. Table 1 shows the actual cost of topping up from 0 to 100% of the battery installed in a BEV with a maximum range of 350 km from a power socket at home. The responses show that irrespective of energy tariff and vehicle, the cost of home charging is less than 100 PLN.

This is the opinion of 83 respondents (34%), 77% of whom are men. The largest number of respondents answered "PLN 100 - 200". (Fig. 19).

Further questions to assess respondents' knowledge of e-mobility were open-ended. One of them asked for several models of electric cars to be given by the respondent. Table 2 contains all the car models given by the respondents. It should be noted that almost six times more models were mentioned

by men than by women. In the survey questionnaire, in addition to the option to list known EV models, the respondent could select the answer "do not know." This option was chosen by 113 women and 80 men, which shows that only 48 people (20% of the respondents) listed the EV models they knew.

Table 1

Charging costs for BEVs, [PLN]

BEV / Cost	Tariff			
	G11	G12	G12w	G12n
BMW i3	30.17	25.12	26.97	28.78
Nissan LEAF 150KM / 39 kWh	28.60	26.43	28.70	30.52
Opel Corsa-e e136 KM / 50 kWh	35.75	34.61	36.60	38.15
Peugeot e-208 136 KM / 50 kWh	35.75	34.61	36.60	38.15
Renault ZOE E-Tech R110	37.18	36.24	38.31	39.68
ŠkodaCITIGOeiV 83 KM / 36,8 kWh	26.31	23.81	25.34	28.08

G11 - the rate for consumed energy is constant 24 hours a day; G12 - electricity charges are lower during the night (22:00-6:00) and in the afternoon (13:00-15:00); G12w - billing is analogous to the standard G12 tariff, additionally includes an extension to weekends (w); G12n - billing is analogous to the standard G12 tariff, additionally includes an extension to Sundays (n)

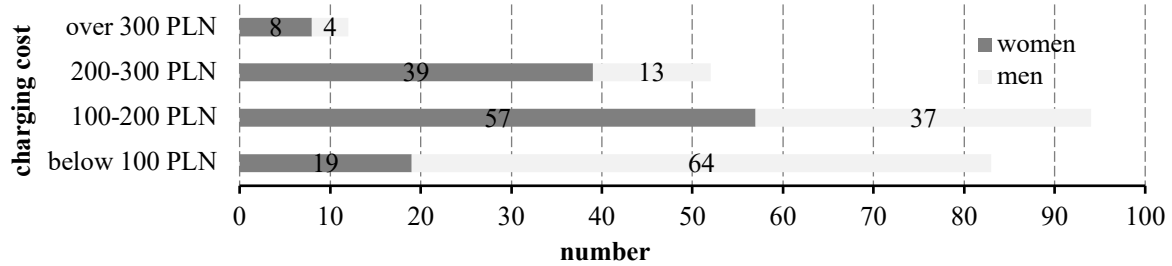

Fig. 19. Distribution of answers to the question "How much does it approximately cost to fully charge (from 0 to 100%) from a "home" outlet an electric car (350 km range)?"

Table 2

Electric car models given by respondents

Model	Number of answers provided		Total
	Female	Male	
Tesla model s	2	25	27
BMW i3	4	13	17
Audi e-tron	2	13	15
BMW i8	2	12	14
Tesla model x	1	10	11
Nissan Leaf	2	8	10
Toyota Prius	0	6	6
Porsche Taycan turbo s	1	4	5
tesla 3	0	5	5
Toyota hybrid	0	4	4
BMW ix	2	1	3
Ford Mustang mach-e	1	2	3
Mercedes EQS	0	3	3
tesla model y	1	2	3
Toyota Yaris	1	2	3
Volkswagen id.4	0	2	2
Razem	19	112	131

In another open-ended question, respondents were asked to identify three advantages and disadvantages of electric cars. Table 3 demonstrates all the advantages mentioned by the respondents, while Table 4 contains the disadvantages of electric cars indicated by them.

Table 3

Advantages of electric cars as indicated by those surveyed

Advantages	Number of answers provided		
	Female	Male	Total
ecological	56	34	90
quiet	41	40	81
cheap to charge	25	41	66
no local emissions	25	29	54
lower exhaust emissions locally	27	19	46
quick acceleration right from the start	3	29	32
comfortable and convenient driving	14	8	22
possibility of driving in bus lanes	7	13	20
smart car	1	4	5
special parking spaces	1	4	5
nice	2	1	3
home charging	3	0	3
possibility of using renewable energy sources	0	2	2
Total	205	224	429

Table 4

Disadvantages of electric cars mentioned by respondents

Disadvantages	Number of responses		
	Female	Male	Total
high purchase price of the vehicle	49	39	88
long charging time	29	33	62
small number of charging points	33	29	62
short range	25	31	56
problem with the disposal of batteries	9	33	42
frequent need to recharge	18	20	38
more expensive spare parts	3	13	16
quiet	5	9	14
high power consumption	10	2	12
higher failure rate, fires	3	9	12
larger carbon footprint during production	4	8	12
lack of service availability	3	8	11
weaker acceleration	2	6	8
little choice	2	3	5
harmful battery production	0	4	4
ugly	1	2	3
Total	196	249	445

It is clear that the biggest advantage of electric vehicles, according to the respondents, is that they are "green." The most frequently indicated advantage by women was the attribute "green," while the most frequently indicated advantage by men was "cheap charging." Additionally, men listed 19 more advantages than women.

Meanwhile, according to both men and women, the most significant disadvantage of electric cars is their high purchase price. In addition, men listed 53 more disadvantages than women.

3.3. Respondents' opinions on e-mobility

Respondents were asked to express their opinion on the harmfulness of manufacturing vehicles with different types of propulsion (combustion, hybrid, electric) and their operation. The responses given by the respondents are presented in Fig. 20 and Fig. 21, respectively.

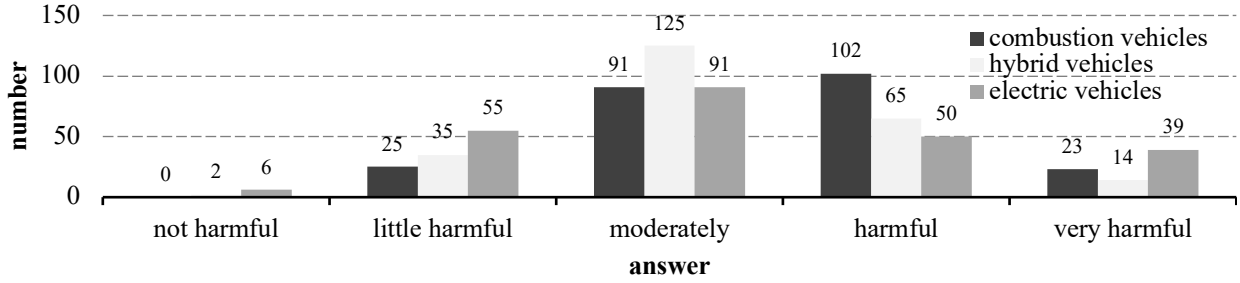

Fig. 20. Respondents' opinions on how environmentally harmful the production of vehicles with different types of propulsion is

According to the highest number of respondents, the production of a combustion vehicle is harmful to the environment (42%), while the production of a hybrid and electric vehicle is moderately harmful (52% and 38%, respectively). The production of a vehicle with a pure combustion engine is harmful or very harmful, according to 52% of respondents, while a vehicle with an electric engine is harmful or very harmful, according to 37% of respondents.

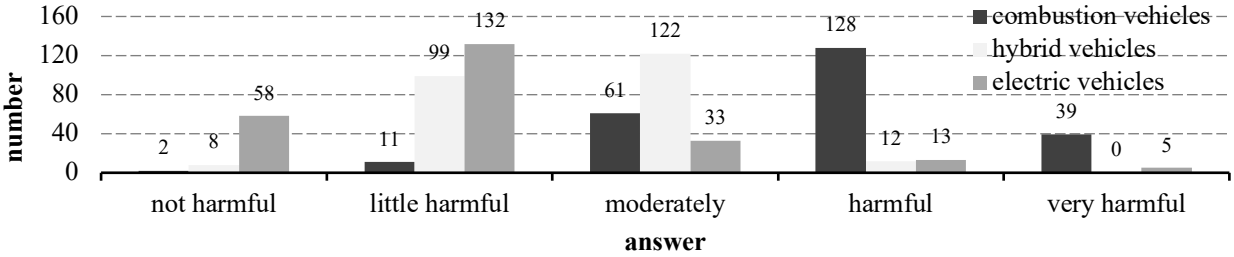

Fig. 21. Respondents' opinions on the environmental impact of using cars with different propulsion types

Most respondents consider the use of internal combustion vehicles to be harmful to the environment (53%), the use of hybrid vehicles to be moderately harmful (51%), and the operation of BEVs to be not very harmful (55%). Only 7% of those surveyed believe that using electric cars is harmful or very harmful.

Additionally, in order to find out respondents' attitudes about the future of the automotive market, we asked respondents whether they thought electric cars would completely replace combustion vehicles in the future. Most respondents (56%) believe that they will. In contrast, 32% of respondents believe that such vehicles will not be the future of the automotive market (Fig. 22).

4. SUMMARY AND CONCLUSIONS

The consumer and their behavior are of interest to market actors (producers and sellers). The consumer is an individual who, by making a purchase, their perceived needs in accordance with their own expectations, tastes, or preferences and directly influences the success or failure of a given

undertaking. The behavior of young consumers is of particular importance here. Young people are characterized by high purchasing and non-purchasing activity, manifested, for example, in their market behaviors, as well as in influencing the shaping of new phenomena in the marketing and production activities of companies. The attractiveness of this segment is significantly enhanced by the prospective character of youth as consumers and customers in a few or more years, when they will become more affluent and have well-established attitudes towards various products, brands, and their manufacturers shaped precisely during youth. Hence, the primary aim of this study was to find the current state of knowledge and opinions of young consumers in Poland on e-mobility. The analysis of the questionnaire showed that the level of knowledge young people have on this subject is average.

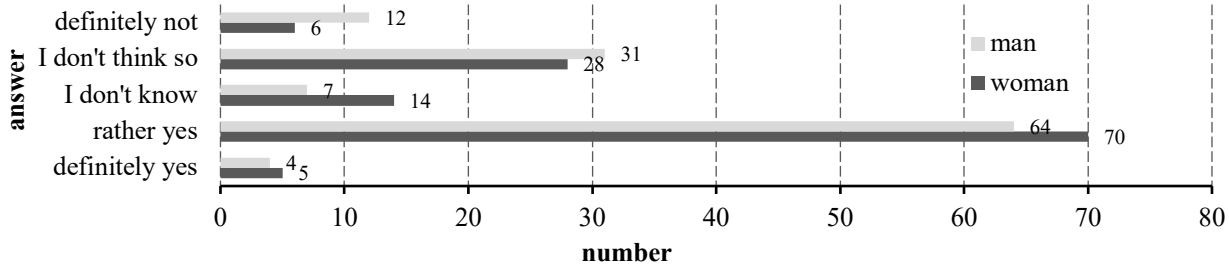

Fig. 22. Distribution of responses to the question "Do you think electric vehicles will completely replace internal combustion vehicles in the future?"

Most often, when asked to test their knowledge of electromobility, respondents gave answers that were inconsistent with the actual state of affairs. At the same time, they were able to list all significant advantages and disadvantages of electric cars (i.e., ecological, quiet, no local emissions, high purchase price, and long charging time). It is worth noting that the largest number of respondents indicated the most important advantages and disadvantages of such vehicles.

According to the majority of respondents, producing an electric vehicle is less harmful to the environment than a car with a conventional engine, and their operation has little negative impact on the environment. Although respondents are aware that electric cars have a lower environmental impact than conventional vehicles, only 61% of respondents believe that they will replace combustion engine cars in the future.

Thus, from the analysis of the survey, it can be presumed that, from the point of view of young consumers, the process of manufacturing and operating cars is not a factor that will significantly influence their purchasing decisions in the future. This undoubtedly illustrates that consumer, despite a certain degree of environmental awareness and knowledge on the subject, show ignorance in their planned purchasing processes. Perhaps the skeptical approach to BEVs in creating the automotive market in Poland stems from the awareness of the disadvantages of electric vehicles (high purchase price, poorly developed network of public charging stations, etc.).

In view of the above, it is important to develop awareness and education among potential customers to make them decide to purchase an electric car in the future. Given that Poland's energy mix is based on the generation of energy in coal-fired power plants, it should be borne in mind that the vehicles on the roads in Poland are second-hand cars imported from other EU countries, with an average age of 14.5 years. Therefore, switching to electric vehicles would allow for a significant reduction in uncontrolled emissions of pollutants into the atmosphere, which are, among other things, the cause of smog. It should be noted, however, that the basic impulse to purchase an electric car is not only various types of subsidies but also, above all, widely developed infrastructure and availability of charging points, which the interviewees also pointed out.

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