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THE DETERMINANTS OF ELECTRIC AND HYBRID VEHICLE ADOPTION: A PERSPECTIVE FROM SERBIA

Petar Mitić[a*], Milena Kojić[a], Aida Hanić[a], Aleksandra Fedajev[b], Magdalena Radulescu[c] and Izabela Dembińska[d]

[a]*Institute of Economic Sciences, Zmaj Jovina 12, Belgrade, Serbia*
[b]*University of Belgrade, Technical Faculty in Bor, Vojske Jugoslavije 12, Bor, Serbia*
[c]*Institute of Doctoral and Post-Doctoral Studies, University Lucian Blaga of Sibiu, Bd. Victoriei 10, Sibiu, Romania*
[d]*Department of Management and Logistics, Maritime University of Szczecin, Wały Chrobrego 1-2, Szczecin, Poland*

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Abstract

This study investigates the factors influencing the intention to purchase electric and hybrid vehicles in Serbia. It draws upon socio-demographic characteristics, social influence, environmental concerns, and policy measures to gain a nuanced understanding of the complexities of adopting sustainable transportation alternatives in Serbia. Using descriptive and inferential statistics, decision tree analysis, and logistic regression enabled a rigorous examination of the determinants influencing attitudes and intentions toward electric and hybrid vehicles (EHVs). The findings emphasized the importance of positive evaluation from influential individuals and the introduction of higher taxes on more polluting vehicles as important factors that impact electric and hybrid vehicle adoption according to all three applied methods. In addition to these factors, the results from the two applied methods further highlight the significance of household income, the positive societal perception of EHVs, and the belief that EHVs contribute to reduced pollution. Since age, residence, education level, and household size do not emerge as significant factors influencing respondents' intention to purchase EHVs and all remaining factors appear to be relevant according to only one of the applied methods, the focus should be placed on the factors identified as significant by either two or all three methods. Such results provide a solid basis for policy recommendations in Serbia to promote electric and hybrid vehicles adoption.

Keywords: electric vehicles, hybrid vehicles, sustainable development, transportation, environment, societal influence

* *Corresponding author: petar.mitic@ien.bg.ac.rs*

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1. INTRODUCTION

The pursuit of global economic development has led to an increased dependence on fossil fuels, resulting in higher greenhouse gas (GHG) emissions and contributing to the rise in average surface temperatures (Anwar et al., 2020; Kojić et al., 2022). This rising economic activity, combined with increased consumption and rapid globalization, industrialization, and urbanization, can intensify existing environmental challenges (Tian et al., 2020) and potentially create new ones. In this context, the automotive industry has a central role, as it gives people a sense of freedom and the opportunity to develop their own patterns of behavior and movement, allowing easier access to markets, jobs, leisure destinations, healthcare facilities, and more. Beyond its impact on individuals and their activities, the automotive industry is also a key driver of economic growth, infrastructure development, and technological innovation, thereby contributing significantly to the socio-economic development of society.

As the mobility landscape evolves, electric and hybrid vehicles (EHVs) are becoming strategic players in shaping the future of transportation. This need was underlined at the United Nations Climate Change Summit (COP26), where participating countries committed to accelerating the transition to zero-emission vehicles to meet the Paris Agreement's climate goals. In addition, the Global Zero Emission Vehicles Transition Roadmap outlines the joint efforts of the ZEV Transition Council and international partners to promote the introduction of zero-emission vehicles in emerging and developing countries by 2030, in line with the goals of the Breakthrough Agenda and the COP27 Global Commitment (ZEV Transition Council, 2024).

Addressing these trends requires the electrification of transportation as a shift towards sustainability in the automotive industry. It emphasizes the broader adoption of EHVs, which are not merely substitutes for conventional vehicles but offer access to revised and entirely new values (Delucchi et al., 2014; Puška et al., 2023). Termed "new energy vehicles" by Wang et al. (2022), they represent a cornerstone of sustainable mobility and depict the envisioned future (Asdrubali et al., 2018).

According to the European Environment Agency, electric vehicles generally emit less noise and air pollutants than their petrol or diesel counterparts (EEA, 2024). Transport in Europe accounts for approximately one-fourth of all GHG emissions, with a 33.5% increase observed between 1990 and 2019 (European Commission, 2024; EEA, 2022). Notably, the adoption of electric vehicles in Europe is steadily rising, with electric car registrations comprising 21.6% of all new registrations in 2022 (EEA, 2024). However, due to insufficient charging infrastructure, poorly developed power transmission systems, and higher power generation costs (Limon et al., 2023), the adoption rates are especially low in developing countries, like Serbia.

Based on the 2023 Report on Municipalities and Regions in the Republic of Serbia, the country has 2,337,498 registered passenger vehicles. The Belgrade region, in particular, leads the way with 664,092 vehicles in 2022 (Statistical Office of the Republic of Serbia, 2024). The outlook for the Serbian market for electric vehicles is promising, with sales of 16.2 million euros expected by 2024. Forecasts

indicate a robust compound annual growth rate of 12.61%, predicting a market volume of €26.1 million by 2028. This growth is attributed to the increasing spread of electric vehicles, promoted by government incentives and the expansion of the charging infrastructure (Statista, 2024).

In terms of agreements and legal regulations, the Republic of Serbia adopted its Nationally Determined Contributions (NDC) in 2015 with the aim of reducing GHG emissions by 9.8% by 2030 compared to 1990 emissions. The updated NDC for 2021-2030 was adopted by the Republic of Serbia in 2020 and increased the ambition to reduce GHG emissions by 33.3% by 2030 compared to 1990 levels (UNFCCC, 2022). In addition, the Republic of Serbia signed the Sofia Declaration on the Green Agenda for the Western Balkans in 2020 and committed to implementing resource-efficient transport and Sustainable Urban Mobility Plans (SUMPs), among others. However, electromobility has not yet fully arrived in Serbian legislation, but some announcements have already been made. Specifically, the Ministry of Construction, Transport, and Infrastructure has prepared two draft strategies, namely the Transport Strategy of the Republic of Serbia and the Strategy for the Road Sector in Serbia, which have not yet been officially adopted.

Slow adoption of necessary legislation has a significant impact on the transition to electric mobility in the Republic of Serbia and could jeopardize the exploration of the numerous advantages of EHVs, which are reflected in their significant environmental and energy benefits, such as reduced emissions, energy and fuel efficiency, and high performance (Chan, 2002; Ehsani et al., 2007; Huang et al., 2019). Electric vehicles also offer advantages such as lower energy consumption over the entire life cycle and lower operating costs. However, challenges such as high purchase prices and limited driving range hinder widespread adoption (Lopes et al., 2014). Therefore, understanding consumer behavior is critical to overcoming these challenges.

Considering the above factors, the primary objective of this study is to comprehensively investigate the factors influencing the intention to purchase EHVs in Serbia. To achieve this aim, based on the existing literature, we explore a wide range of socio-demographic characteristics, social influence, perceived enjoyment, range anxiety, environmental concern, and policy interventions as key determinants that may impact individuals' attitudes and intentions towards adopting EHVs. By examining these diverse factors, we aim to gain a nuanced understanding of the multifaceted barriers and motivations surrounding the adoption of these vehicles in the Serbian context. This holistic approach allows us to identify potential obstacles and opportunities for the widespread adoption of sustainable transportation alternatives in Serbia, thereby informing policy makers, industry stakeholders, and other relevant actors on strategies to promote the uptake of EHVs in the country.

To achieve this and ensure the robustness of the research, the study employs two classification methods to examine the factors influencing the intention to purchase EHVs in Serbia. Data collected from a diverse sample of respondents are analyzed using descriptive statistics to characterize the sample and inferential statistics, including Chi-square tests and independent sample t-tests, to assess relationships between variables. Additionally, decision tree analysis and logistic regression are employed to

identify significant predictors of intention to purchase EHVs. This comprehensive methodology allows for a rigorous investigation into the complex determinants shaping attitudes and intentions towards sustainable transportation options in Serbia.

This study makes several notable contributions to the literature on the attitudes and opinions of potential consumers of EHVs, particularly in the context of the Republic of Serbia. First, this paper provides insights from a developing economy perspective, as most existing research focuses on developed countries. It contributes to understanding the specific challenges and opportunities in Serbia, where literature on EHV adoption, like in many developing countries, remains relatively scarce and outdated. Although Pajic et al. (2024) analyzed this topic on a Serbian example, in terms of attitudes and preferences towards electric vehicles, this research provides a more comprehensive analysis by incorporating a larger sample size, advanced statistical methods, and a broader set of variables that examine both socio-economic and policy determinants influencing EHV adoption in Serbia. Second, the comprehensive survey design includes a wide range of questions and statements on attitudes and opinions related to EHVs, thus providing a detailed examination of consumer perceptions specific to the Serbian context but easily transferable to the regional context. Thirdly, this study uses the term "Electric and Hybrid Vehicles (EHVs)" as a broad umbrella category, encompassing hybrid electric vehicles (HEV), battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV), extended-range electric vehicles (EREV), fuel cell electric vehicles (FCEV), and mild hybrid electric vehicles (MHEV). This unified approach provides a holistic perspective on the full spectrum of electric and hybrid vehicles available on the market. Finally, with over 1000 respondents, this study exceeds the sample size of many existing studies in this area, giving it robust statistical power and allowing for more reliable and generalizable results.

The following sections of this study are structured as follows. After the Introduction, the next section provides a comprehensive Literature Review of the factors affecting the adoption of EHVs as documented in existing academic literature. The Data and Methods section describes the survey data and methods used in this study. The Statistical Modeling Results and Discussion section presents the results derived from the decision tree and logistic regression analyses. The next section describes the Policy Recommendations, and the study ends with a Conclusion.

2. LITERATURE REVIEW

Developing economies like Serbia, with a high dependency on fossil fuel use (Pajic et al., 2024), face not only transportation-related challenges but also broader health risks, particularly due to air pollution. Promoting electromobility as a sustainable alternative to internal combustion engine vehicles will not only reduce road transport emissions but also generate significant overall societal benefits (World Bank, 2023a). Since Serbia is still in the early stages of e-mobility market development (World Bank, 2023b), this literature review will include research primarily focusing on the factors influencing EHV adoption.

In their study conducted on a sample of 350 respondents from Serbia, Pajic et al.

(2024) explored attitudes and preferences toward electric vehicles, finding that key factors influencing vehicle choice included price, maintenance costs, fuel consumption, safety, and performance. Hybrid vehicles with gasoline engines are preferred by 35%, while only 16% would choose an internal combustion engine vehicle as a gift. Pajic et al. (2024) also showed that Serbian citizens are willing to pay approximately EUR 19950 for a new electric vehicle and EUR 8700 for a used one.

A systematic literature review by Ivanova and Moreira (2023) found that consumer characteristics (socio-demographic factors) were the most intensively researched in 63 articles published between 1994 and 2021. For example, Bergantino and Catalano (2016) discovered that factors like age, gender, and working conditions influence the market for EHVs. Also, Pandita et al. (2024) note that socio-demographic factors affect early and late electric vehicle adopters.

However, Plananska et al. (2023) emphasized that it remains to be seen to what extent electric vehicles are perceived as gendered products, as research findings are mixed. For instance, in a study of over 5000 respondents from Denmark, Finland, Iceland, Norway, and Sweden, Sovacool et al. (2018) found that individuals who were predominantly male, possessed higher levels of education, were employed full-time (particularly in civil society or academia) and were below middle age (30–45), tended to favor low-carbon mobility. However, this study also concluded that women with higher incomes are more likely to favor EHVs.

In addition, pro-environmental behavior is more associated with women (Zhao et al., 2021), as they display more altruism and compassion (Luchs & Mooradian, 2012). Women also consider vehicles as practical devices and pay more attention to safety (Anfinsen et al., 2019). To analyze the gender effect in more detail, Plananska et al. (2023) examined this relationship in two dimensions: a) whether countries with a more masculine culture have lower adoption rates for electric cars and b) whether the perceived lack of masculinity influences consumers' purchase intentions for electric cars. Regarding the first question, the findings of a study covering 31 European countries indicate that nations with a relatively more feminine national culture tend to have a higher market share of electric vehicles, such as the Nordic countries. At the country level, a study of 429 respondents from Germany alone shows that German consumers associate electric cars with femininity, with men showing this association significantly more often than women. In other words, national culture is important in accepting electric cars (Novotny et al., 2022), as proven in the example of India and Spain in research done by Higueras-Castillo et al. (2024). Also, these authors note that there is no difference in environmental concerns in both countries, meaning that this issue is equally important for individuals globally.

Environmental concerns generally represent a combination of personal and societal interests (Doszhanov & Ahmad, 2015). It is about the degree of responsibility regarding environmental issues, which is important since one of the main advantages of electric cars is their environmental impact (Alanazi, 2023). However, in many countries, the opinion prevails that using these cars does not positively impact the environment, considering that the electricity is generated from fossil fuels. Some authors, such as Rafique and Town (2018), reject this and state that even in such cases, reducing

carbon dioxide emissions can be achieved by raising environmental awareness and allowing individuals to develop a greater sense of social responsibility. This is in line with the findings of Okada et al. (2019), where consumer environmental awareness directly influences the purchase intentions of non-electric vehicle users and emphasizes the social influence related to its impact on such a group of people. In this context, many researchers, such as Abbasi et al. (2021), Cui et al. (2021), Khazaei and Tareq (2021) and Lashari et al. (2021) found positive and significant effects of environmental awareness on the individual decision to purchase EHVs by using different variables to describe environmental awareness, which mainly focuses on protecting the environment, where electric vehicles play a crucial role in preserving the environment for future generations (Khazaei, 2019). In addition to concern for the environment, perceived enjoyment of driving is also a significant influential factor, as various advantages of their use were highlighted as having an impact on more positive associations with their use, such as enjoyment or fun of driving the vehicle (Khazaei & Tareq, 2021). In terms of the main aspects of enjoyment when driving an electric vehicle, low noise levels, smooth operation, and immediate acceleration contribute to an enhanced driving experience compared to traditional vehicles. Using a sample of 322 respondents from Malaysia, Khazaei and Tareq (2021) found that social influence and perceived enjoyment positively and significantly impacted the purchase intention of EHVs, with perceived enjoyment being the second-highest predictor after environmental concerns.

One factor that significantly influences the acceptance of EHVs is social influence (Xia et al., 2022). According to Gass (2015), social influence "involves intentional and unintentional efforts to change another person's beliefs, attitudes, or behaviour". Moreover, in an economic context, social influence plays an important role in enduring relationships between products and consumers, as Cheung et al. (2020) noted. In the case of EHVs, there is a positive correlation between individuals and green consumer behavior, as a study by Clark et al. (2019) showed. Different authors use different variables to describe and analyze the social influence. Abbasi et al. (2021), for example, focused primarily on the influence of the immediate environment on the individual, particularly on awareness of sustainable products and environmental issues. Using a sample of 550 Chinese residents, Cui et al. (2021) investigated consumers' purchase motivation using Maslow's hierarchy of needs model. They found that social influence positively influences urban residents' purchase motivation for electric vehicles, as these individuals only purchase an electric vehicle if it is recommended by others and emphasize their sense of belonging by purchasing the same models as others, meaning that the opinions of influential individuals play a significant role. On the other hand, Lashari et al. (2021) focused more on the proposition that using eco-friendly vehicles aligns with current social trends and can position individuals as leaders of these trends. However, in a sample of 1500 respondents in major South Korean cities, the authors found that social influence had no significant impact on the intention to purchase electric vehicles.

Mixed results are also possible in all other factors influencing the intention to purchase EHVs. For instance, the prevailing opinion is

that high-income households are more likely to purchase EHVs, which means that socio-economic characteristics strongly predict the composition of the car portfolio (Fevang et al., 2021). However, it is essential to emphasize that certain studies, such as Lashari et al. (2021), show that individuals with a lower personal income are more interested in purchasing EHVs than those with a higher income. This attitude can be attributed to the perception of a greater financial burden due to fuel, maintenance, and repair costs associated with conventional vehicles. Additionally, it may be linked to social influence, as individuals can be swayed by societal norms.

Range anxiety is an important factor influencing individuals' intention to purchase EHVs. This term refers to the fear that the vehicle's batteries will run out in the middle of the road (Pevec et al., 2020). Several research findings, such as that of Khazaei and Tareq (2021), show that range anxiety significantly impacts the purchase intention of electric vehicles, especially in countries where these vehicles are in the early stages of adoption. However, range anxiety varies based on several factors, including the length of electric vehicle ownership, with long-term owners experiencing it less frequently (Rauh et al., 2014). The second factor relates to range, with an analysis from the Nordic countries showing that place of residence is very closely linked to range anxiety. People with a longer commute tend to be less inclined to adopt fully electric vehicles due to range anxiety (Qorbani et al., 2024). The third factor is closely related to charging stations (Yuan et al., 2018), while He and Hu (2023) add driver experience to the list. They investigated the trade-off between range anxiety and charging times and concluded that expanding charging infrastructure and increasing practical experience with electric cars could change drivers' behavior to reduce range anxiety.

According to Abas and Tan (2024), while all previous factors and variables significantly influence the intention to purchase an EHV, effective and targeted policy measures are needed for widespread adoption. Several authors have found that various factors such as tax credits or subsidies, expansion of charging infrastructure, improvement of battery technology, and promotion and implementation of regulatory frameworks influence the adoption of EHVs (Mastoi et al., 2022; Mohammadzadeh et al., 2022; Abas & Tan, 2024). One of the most widely used government policy interventions is subsidies. Mohammadzadeh et al. (2022) analyzed three types of subsidies: the purchase subsidy, the electricity subsidy, and the simultaneous purchase and electricity subsidy. The results suggest that the optimal subsidy schedules for the government can be determined based on different budget levels. When the budget is limited, electricity subsidies are the predominant policy, except in cases of high customer acceptance and low fuel prices. On the other hand, when customer uptake is low, purchase subsidies become the primary policy option when budgets are limited. It is recommended that the government subsidize purchase and electricity costs in more than 50% of the possible scenarios, especially when customer uptake and fuel prices differ. If both types of subsidies are used, more than 70% of the budget should be used to purchase subsidies in more than 50% of cases. However, Mekky and Collins (2024) examined three types of electric vehicle adoption policies, including policies that reduce the environmental impacts of energy production, policies that

provide financial incentives for consumers to purchase EHVs, and policies that facilitate the availability of publicly accessible charging infrastructure. Using a sample of 50 US states from 2012-2020, the authors found that environmental policies have a greater impact on electric vehicle adoption than financial incentives or publicly accessible infrastructure.

The literature review to date has shown that socio-economic factors play a decisive role in adopting EHVs. It is evident that within this group of factors, there is a variety of influencing factors that underline the complexity of the decision-making process in the adoption of EHVs.

3. DATA AND METHODS

3.1. Questionnaire and data collection

The data gathering methodology employed in this study involves conducting surveys using a questionnaire originally developed for an internal project at the Institute of Economic Sciences in Belgrade entitled "Subsidies for the Purchase of Electric and Hybrid Vehicles." The project aimed to investigate the attitudes, opinions, and intentions of the population of the Republic of Serbia about EHVs, thus filling a significant gap in previous academic and professional research. Aspects of awareness, intentions, and broader socio-economic, environmental, and policy aspects were considered in order to gain a comprehensive understanding of the factors influencing the adoption of EHVs. Data collection was conducted online by the Deep Dive Research & Consulting agency in May 2022, using a computer-assisted web interviewing (CAWI) approach. A total of 1004 valid responses were obtained. Ethical considerations were also carefully considered during data collection, including obtaining informed consent from participants and ensuring the confidentiality of their responses.

The questionnaire consisted of a combination of closed-ended and 4-point Likert-scale items focusing on socio-demographic data, attitudes towards EHVs and policy preferences. The survey was designed to ensure its reliability and clarity through pilot testing. The scope of the survey was nationwide, targeting a representative sample across Serbia in terms of gender, age, education and urban-rural distribution. The design of the questionnaire and the process of data collection were carefully designed to reflect considered demographic factors and ensure that the results could be generalized to the wider population.

The measurement items for key constructs were adapted from previous research on EHV adoption. Social influence items were adapted from Cui et al. (2021) and Abbasi et al. (2021), while environmental concern measures were based on Khazaei and Tareq (2021). Policy intervention items were developed specifically for the Serbian context based on existing literature on EHV adoption policies (Mohammadzadeh et al., 2022).

3.2. Methods

The collected data are summarized and analyzed using various statistical methods. The mean and standard deviation are calculated for numerical variables to obtain a clear overview of the central tendency and variability. Frequencies and percentages are provided for categorical variables to gain insight into their distribution. The Chi-square test of independence is used to examine the

relationships between two categorical variables. In addition, the independent samples t-test is used to examine the differences in means between two independent samples.

Two classification models, namely a decision tree and a binary logistic regression, were developed to address the main research objectives and to identify the factors influencing the EHVs' purchase intention. Decision tree analysis was chosen because it handles complex, non-linear relationships and provides clear, interpretable results. Binary logistic regression was selected for its effectiveness in modelling binary outcomes and for its ability to handle both continuous and categorical variables, providing accurate probability estimates. Together, these methods offer complementary strengths in analyzing the factors influencing EHV purchase intentions.

The decision tree is used as a systematic approach to understanding the key factors influencing consumers' likelihood of purchasing an EHV. Decision trees consist of a root node, multiple branches, and leaf nodes. The trees feature internal nodes that represent different test scenarios. Each internal node of the tree corresponds to an input variable, each branch represents a decision rule, and each leaf node represents the result. The decision tree recursively splits the data set and forms a binary structure that organizes the input variables into a hierarchy based on their contribution to the predictive accuracy of the model (Breiman et al., 1984). The algorithm functions as a tree-shaped graphical structure that uses a range of optimized parameters for prediction. The Chi-squared Automatic Interaction Detector (CHAID) method is used to identify the best splits for categorical variables by creating a tree-like model that shows multi-way splits that best explain the variance in the dependent variable. A top-down method is applied to the dataset provided during the training phase in decision trees. For validation and testing, the dataset is split into a training set comprising 70% of the data and a validation (test) set comprising the remaining 30%. This split allows for thorough training and subsequent performance evaluation of the decision tree model and ensures robustness and generalizability to new, unseen data (Hastie, 2009).

Logistic regression, on the other hand, is employed for binary classification problems and aims to predict a binary target: the likelihood of purchasing an EHV. It models the probability of the default class (the intention to purchase) based on a set of independent variables. The logistic function, which is crucial for this model, is formulated as shown in Formula 1.

where *P(Y=1)* is the probability of the

$$log\left(\frac{P(Y=1)}{1-P(Y=1)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \quad (1)$$

dependent variable equaling intention to buy an EHV, β_0 is the intercept, and β_1,...,β_k are the coefficients of the independent variables X_1,...,X_k. The forward likelihood ratio (LR) method was utilized, in which the variables were sequentially added to the model and tested for statistical significance based on the likelihood ratio. Subsequently, only the variables that significantly contributed to the explanatory power of the model were retained. Various statistical measures were employed to evaluate the fit of the model. The -2 Log likelihood served as a baseline measure of model fit, with lower values indicating better fit (Hosmer et al., 2013).

Pseudo-R-squared values such as Cox & Snell R Square and Nagelkerke R Square are used to explain the explanatory power of the model, with the latter adjusting the scale to allow a maximum value of 1 for easier interpretation (Nagelkerke, 1991). The Hosmer and Lemeshow test specifically evaluates the goodness-of-fit, testing whether the observed sample frequencies match the expected frequencies from the model. Finally, a classification table or confusion matrix is used to compare the predicted with the actual outcomes (Allison, 2012). The outcomes of the logistic regression analysis are presented via the regression coefficient (B), the standard error (S.E.), the Wald chi-square test statistic (Wald), the degrees of freedom (df), the significance level (p), and the exponentiation of the B coefficient (Exp(B)), which represents the odds ratio for each predictor. The odds ratio is interpreted as the change in odds resulting from a one-unit change in the predictor variable, with all other variables held constant. If the odds ratio is greater than 1, the odds of the outcome occurring increase with each additional unit of the predictor variable. If the odds ratio is less than 1, the odds of the outcome decrease with an increase in the predictor.

3.3. Survey data screening and exploration

As the first step, we evaluated the influence of each analyzed respondents' characteristics on intention to purchase EHVs individually, using the Chi-square test and independent sample t-test. The survey revealed that 29.3% of participants (294 respondents) expressed a definite interest in purchasing an EHV in the next 5 years. Conversely, a majority of 70.7% (710 respondents) stated that they were reluctant or lacked the intention to purchase such a vehicle. The respondents' answers to this question served as the basis for conducting the mentioned tests. We began by analyzing the respondents' demographic characteristics: age, gender, residence, education, employment status, number of people in household and household income.

The first demographic characteristic was age. The average age of participants was 39.41 years, with a standard deviation of approximately 12 years, indicating a moderately broad age distribution among survey participants. The average age of participants who do not intend to purchase an EHV is slightly lower, at 38.96 years, than those who intend to buy such a vehicle, at 40.48 years on average. Considering that only this characteristic was numerical, an independent t-test was used to assess the influence of age on intention for EHVs purchase. This difference is not statistically significant, with a p-value of 0.069. However, this subtle trend indicates that age is a potentially noteworthy factor when considering the market for EHVs.

The rest of the characteristics were categorical, so the impact of these characteristics on intention to purchase EHVs was accessed by application of the Chi-square test. The sample structure according to these socio-demographic characteristics and the p-value for the Chi-square test are presented in Table 1.

The survey included an equal representation of men and women, with each group comprising approximately 50% of the total sample. The intention to purchase EHV did not differ significantly between the genders (p=0.333). The type of residence (urban or rural) also had no significant influence on purchase intentions (p=0.164).

This indicates that the decision to buy EHVs in Serbia is relatively uniform between genders and different types of residence. The participants' educational backgrounds varied, with the majority having a high school diploma (45%) or a bachelor's degree (41%). However, no significant difference in the intention to purchase EHVs was observed across different education levels (p=0.314), suggesting that education level also does not play a major role in influencing this decision. Most respondents were employed full-time (62%). There is a trend that employment status may influence purchase intention, although this influence is not strong enough to be considered statistically significant (p=0.090). The number of people in a household varied, but this factor also had no significant influence on the intention to purchase EHVs (p=0.265).

The most notable result comes from the household's monthly income. The results indicate a statistically significant difference in purchase intentions depending on monthly household income levels (p=0.024). The likelihood of intending to purchase an EHV decreases as household income increases, with the highest purchase intention rate of 43.7% among those with an income of less than 340 EUR and the lowest purchase intention rate of 23.2% among individuals with a household income of between 851 and 1020 EUR (see Figure 1). However, this trend reverses slightly in the higher income brackets, where purchase intent stabilizes at around 30%, suggesting that other factors

Table 1. Socio-demographic characteristics

Characteristics	Categories	N	%	p-value
Gender	Male	501	50%	0.333
	Female	503	50%	
Residence	Urban	614	61%	0.164
	Rural	390	39%	
Education	Less than a high school diploma	17	2%	0.314
	High school graduate	452	45%	
	Bachelor's degree	406	41%	
	Master's degree	104	10%	
	Ph.D. degree	18	2%	
Employment status	Full time employed	607	62%	0.090
	Part time employed	97	10%	
	Unemployed	113	11%	
	Retired	71	7%	
	Student	83	8%	
	Homemaker	15	2%	
Number of people in a household	1	82	8%	0.265
	2	161	17%	
	3	262	27%	
	4	288	30%	
	5	106	11%	
	More than 6	67	7%	
Household income	Less than 340 EUR	87	11%	0.024
	341 – 510 EUR	87	11%	
	511 – 680 EUR	110	14%	
	681 – 850 EUR	149	18%	
	851 – 1020 EUR	125	15%	
	1021 – 1190 EUR	79	10%	
	More than 1191 EUR	166	21%	

may influence the decision in the highest-income households.

The survey shows that the intention to purchase EHVs in Serbia is influenced by income level. This result underlines how important it is for stakeholders in the automotive industry and policymakers in Serbia to consider household income when promoting or implementing EHV policies. The likelihood of purchasing an EHV decreases as household income increases to a certain threshold, possibly due to perceived affordability and access to subsidies. Lower-income individuals in Serbia may prioritize cost savings and environmental benefits, leading to a higher purchase intention. In contrast, higher-income individuals may consider performance, lifestyle preferences, and affordability. As income rises beyond a certain point, practical considerations, social perceptions, and access to infrastructure may influence purchase intent, stabilizing purchase intent in higher income brackets. This link between income and purchase intent is consistent with global trends, where affordability often plays an important role in consumers' decision to purchase EHVs.

However, the results also reveal that gender, place of residence, education, employment status, and household size do not significantly influence the intention to purchase EHVs in Serbia. This suggests that these demographic and socio-economic variables do not significantly shape consumer preferences for EHVs in Serbia. Even though these results contradict previous knowledge about the influence of these factors on the purchase intentions of EHVs, further investigation within this study sheds additional light on these factors and their specific dynamics in the Serbian context.

After analyzing demographic characteristics, the influence of other characteristics was assessed using independent sample t-tests. Table 2 compares attitudes and perceptions towards EHVs between those who do not intend to purchase a vehicle (marked 'no') and those who do (marked 'yes'). The results show significant differences between the two groups regarding positive societal image, perceived driving enjoyment, range anxiety, environmental concerns, and policy interventions.

Respondents with no intention of purchasing EHVs tended to assign lower ratings to factors such as positive societal perception, endorsement by influential figures, and anticipated driving enjoyment compared to those who expressed an intention to purchase them. This observation

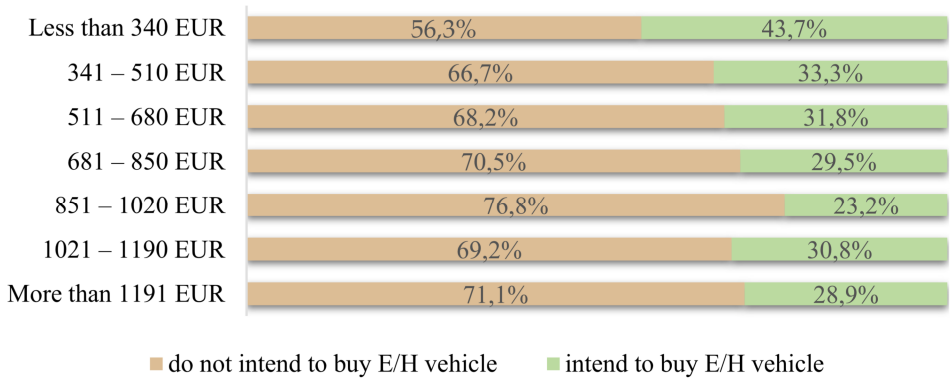

Figure 1. Intention to buy EHV vs total monthly income

is supported by comparatively higher mean scores on the Likert scale among respondents who intend to purchase EHVs.

Inadequate infrastructure for EHVs, e.g., insufficient charging stations and limited services, is a more pressing concern for those considering the purchase of an EHV. In contrast, the concern of not reaching the destination is slightly more pronounced for those not considering the purchase. In addition, individuals intending to purchase these vehicles also exhibit significantly higher concerns about environmental impacts.

Policy measures such as existing purchase subsidies, additional financial subsidy incentives, the government's role in raising public awareness of subsidies, the government and local authorities as users of EHVs to emphasize their importance, the introduction of higher taxes on more polluting vehicles, free parking privileges, and exemption from highway tolls are viewed more positively by individuals who intend to purchase EHVs. This suggests that such measures have the potential to influence purchasing decisions and highlights the importance of government policies in influencing consumer behavior toward sustainable transport options.

Table 2. Attitudes and perceptions towards EHVs

Attitudes and perceptions	Intention	Mean	Std. Dev.	t	Df	p
Social Influence						
Positive societal image of EHVs.	No	2.39	0.95	45.019	709.25	0.000
	Yes	4.00	0.00			
Positive evaluation from influential individuals regarding the use of EHVs.	No	2.32	0.96	25.790	789.28	0.000
	Yes	3.68	0.65			
Perceived Enjoyment						
Anticipation of enjoyable and pleasant experiences while driving an EHV.	No	2.66	1.05	24.473	1001.86	0.000
	Yes	3.81	0.44			
Range Anxiety						
Inadequate infrastructure for EHVs (e.g., insufficient charging stations, limited services).	No	3.12	1.04	6.578	743.90	0.000
	Yes	3.51	0.76			
Fear of not reaching the destination with an EHV.	No	2.37	1.20	-2.148	451.43	0.032
	Yes	2.15	1.51			
Environmental Concern						
Perception that EHVs cause less pollution.	No	2.95	1.05	18.771	990.84	0.000
	Yes	3.86	0.48			
Policy Interventions						
Adequacy of existing subsidies; whether additional incentives are deemed necessary.	No	1.72	1.15	5.873	490.73	0.000
	Yes	2.24	1.30			
Government's role in increasing public awareness of subsidies.	No	3.18	1.00	10.558	857.41	0.000
	Yes	3.73	0.61			
Government and local authorities as users of EHVs to highlight their importance.	No	2.97	1.07	8.802	655.33	0.000
	Yes	3.55	0.88			
Introduction of higher taxes on more polluting vehicles in favor of less polluting ones.	No	1.87	1.39	9.031	1002.00	0.000
	Yes	2.75	1.43			
Free parking available in areas where parking fees apply.	No	2.58	1.37	7.406	598.67	0.000
	Yes	3.23	1.24			
Toll exemption on highways in the Republic of Serbia.	No	2.47	1.42	8.421	627.40	0.000
	Yes	3.22	1.22			
Permission to use lanes designated for public transport and taxi vehicles.	No	1.72	1.41	4.876	482.59	0.000
	Yes	2.25	1.63			

4. STATISTICAL MODELING RESULTS AND DISCUSSION

To ensure a thorough and detailed analysis, the influence of the examined characteristics was evaluated as a whole, considering their interconnections. For this purpose, decision tree and logistic regression were applied. The decision tree analysis provides additional in-depth insights into the factors influencing purchase intentions for purchasing EHVs in Serbia. The results for the test sample are shown in Figure 2. Looking at the tree closely, it can be determined which variables are most important in this predictive analysis.

At the root, individuals' purchase intention for EHVs is initially split based on their perception of the societal image of these vehicles. Since the positive societal image regarding the use of EHVs is at the top of the tree, it is the most important variable in predicting the purchase intention for EHVs. This also indicates that this variable was used for the initial split. Respondents who strongly agree with this statement are more likely (78.0%) to intend to purchase this type of vehicle, which is in line with the independent samples t-test results in Table 2.

The next influential factor is the positive evaluation from influential individuals regarding EHVs. Respondents who strongly agree with such evaluations are more likely (89.0%) to intend to purchase one. This intention is further reinforced among those who also support the idea of higher taxes on more polluting vehicles, where a substantial 90.0% indicate an intention to purchase. These results also align with the independent samples t-test results.

The decision tree model, which uses the CHAID growing method, accurately predicted 100% of the cases where respondents had an intention to purchase and 88.8% of cases where they had no intention to purchase. Overall, the model correctly classified 92% of the cases in the test sample, indicating a high level of predictive accuracy for the intention to purchase an EHV.

The statistical significance of the decision tree's nodes highlights the robustness of the identified predictors. The results indicate that a positive societal image of EHVs, in combination with the endorsement of influential individuals, clearly impacts consumers' purchase intentions. In addition, agreement with policy measures such as higher taxes on more polluting vehicles further strengthens this intention.

After explaining the decision tree results, the following part deals with the results of the logistic regression analysis. It thus provides a more detailed examination of the factors influencing the intention to purchase EHVs in the Serbian context. The logistic regression analysis revealed a statistically significant overall model (Chi-square=795.526, df=6, p<0.001), with the introduction of additional variables also proving significant (Chi-square=4.303, df=1, p=0.038). The model demonstrated a good fit, indicated by the Cox & Snell R Square of 0.635 and the Nagelkerke R Square of 0.893. In addition, the non-significant result of the Hosmer and Lemeshow test (Chi-square=3.068, df=8, p=0.930) confirms the adequacy of the model in predicting the intention to use EHVs, supporting its reliability and fit to the observed data. The predictive accuracy of the logistic regression model is 94.2% for non-purchase intentions and 97.2% for purchase intentions correctly classified, resulting in an overall accuracy of 95.2%. The model demonstrated high precision in predicting purchase intentions for EHVs.

The logistic regression results (Table 3) highlight several key factors that influence the intention of Serbian residents to use EHVs. The following group of factors – socio-demographic characteristics, social influence, environmental concern, and policy interventions were found to be statistically significant in the final model. This section may be divided by subheadings. It should provide a concise and precise description of

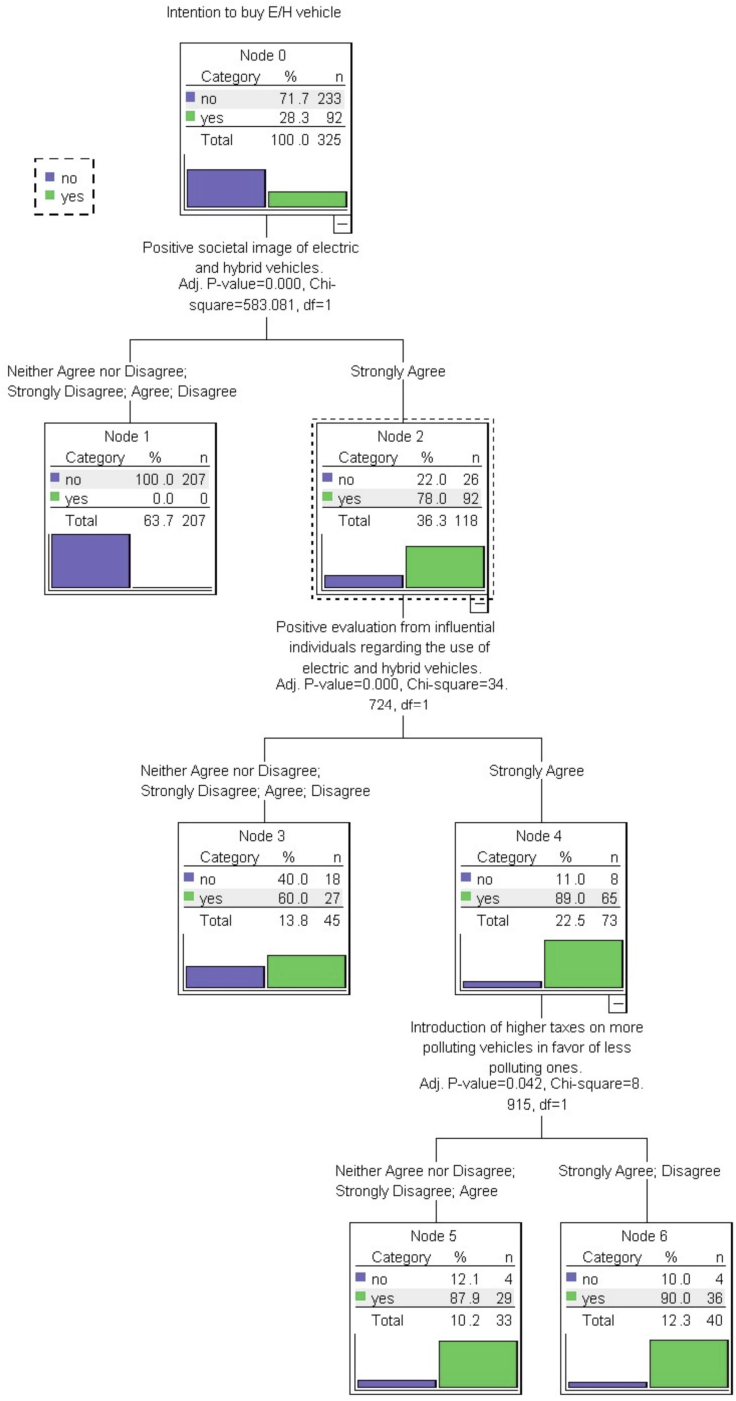

Figure 2. Decision tree

the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

Socio-demographic characteristics. The coefficient for gender is negative (-0.829), with a significance level of 0.044, indicating that being male is associated with lower odds of intending to purchase an EHV. This is a different result than the Chi-square test of independence (Table 1), where gender did not exhibit statistical significance regarding the intention to purchase. This inconsistency suggests that while gender may not have appeared influential when examined in isolation, its impact becomes apparent when considered within the context of other variables in the logistic regression model. In addition, the household income variable also has a negative coefficient (-0.271) and is significant (p=0.011), indicating that a higher income is associated with a lower likelihood of intending to purchase EHVs, which is consistent with the results of the Chi-square test of independence. Also, it is worth noting that socio-demographic factors have not been selected as determining ones in the decision tree.

The results regarding gender and household income in relation to the intention to purchase EHVs provide valuable insights into the socio-economic factors that influence consumer behavior in relation to the choice of a sustainable transport option in the case of Serbia. First, the negative coefficient for men indicates a gender disparity in the willingness to purchase EHVs. Men are less inclined to make such purchases, which contrasts with the findings of Sovacool et al. (2018), who found that men are more willing to purchase these vehicles. However, this study's results align with the findings of Plananska et al. (2023), who have different results on the perception of electric vehicles as gender-specific products but conclude that EHVs are more likely to be purchased in culturally more feminine countries. This gender gap could be due to several factors, including different attitudes toward environmental issues, perceptions of vehicle performance, or preferences for certain vehicle features (Zhao et al., 2021; Luchs & Mooradian, 2012). Removing gender-specific barriers and adapting marketing strategies that better appeal to male consumers could help bridge this gap and encourage wider adoption of EHVs. In addition, initiatives to increase adoption among women could address specific needs or preferences, such as safety features, environmental awareness, or affordability concerns.

Secondly, the negative coefficient for household income indicates that a higher income is associated with a lower likelihood of intending to purchase an EHV. While Lashari et al. (2021) showed that low-income individuals express greater interest in EHVs, Fevang et al. (2021) found that high-

Table 3. Logistic regression results

Variables in the Equation	B	S.E.	Wald	df	Sig.	Exp(B)
Gender	-0.829	0.412	4.04	1	0.044	0.436
Household income	-0.271	0.106	6.52	1	0.011	0.763
Positive evaluation from influential individuals regarding the use of EHVs.	0.821	0.229	12.88	1	0.000	2.272
Perception that EHVs cause less pollution.	1.009	0.306	10.92	1	0.001	2.742
Introduction of higher taxes on more polluting vehicles in favor of less polluting ones.	0.464	0.126	13.60	1	0.000	1.59

income households are more likely to adopt these vehicles. This discrepancy can be explained by factors such as vehicle affordability, lifestyle preferences, and access to charging infrastructure. Higher-income households may prioritize luxury, performance, or brand reputation over environmental considerations, affecting their purchasing decisions.

Societal influence. The significant positive coefficient associated with the positive EHVs evaluation by influential individuals (0.821, $p<0.001$) indicates that as positive evaluations by influential individuals increase, the likelihood of purchase intention for EHVs increases. This result is in line with the results of the decision tree, where respondents who strongly agree with the positive evaluation by influencers are more likely to intend to purchase an EHV.

The results indicate a noteworthy trend regarding the impact of positive evaluations of influential people on the purchase intentions of EHVs. Although Lashari et al. (2021) found no significant influence of social influence on the adoption of electric vehicles in South Korean cities, the vast majority of the literature, e.g., Abbasi et al. (2021) and Cui et al. (2021), found that the persuasion of social influencers and recommendations on purchase intentions of EHVs is positive.

Environmental concern. Stronger agreement with the statement that EHVs cause less pollution than conventional ones is associated with a statistically significantly higher probability that a person intends to buy an electric vehicle (1.009, $p=0.001$), which is consistent with the Chi-square test of independence results.

The finding that stronger agreement with the notion that EHVs cause less pollution correlates with a significantly higher likelihood of intending to purchase such a vehicle is in line with the literature (Rafique & Town, 2018; Khazaei, 2019). This result underscores the pivotal role of environmental factors in consumers' vehicle purchase decisions. Those prioritizing environmental aspects are more inclined to choose EHVs. This reflects a broader societal trend towards increased environmental awareness and the growing importance of reducing carbon emissions.

Policy interventions. As individuals move toward agreement that higher taxes should be introduced on more polluting vehicles, the likelihood of them intending to purchase an EHV increases (0.464, $p<0.001$).

The observation that support for higher taxes on more polluting vehicles also increases the likelihood of purchasing an EHV has several notable implications. First, this suggests a significant influence of policy attitudes on consumer behavior in the area of sustainable transport. Individuals who support measures designed to discourage the use of polluting vehicles, such as higher taxes, appear to be more inclined to choose alternative, eco-friendly options such as EHVs. This underscores the potential synergies between policy measures and consumer preferences in promoting the transition to greener modes of transportation.

5. POLICY RECOMMENDATIONS

The research results provided a comprehensive and robust basis for formulating recommendations for policymakers in the Republic of Serbia. The importance of socio-demographic factors in the design of sustainable transport solutions underlines the need for inclusive policies.

The factors identified as important across all applied methods are positive evaluations from influential individuals regarding using EHVs and introducing higher taxes on more polluting vehicles in favor of less polluting ones. Hence, special emphasis should be placed on measures targeting these aspects.

Endorsements from influential individuals, such as celebrities, industry leaders, and environmentalists, can significantly boost consumer confidence and interest in EHVs by alleviating concerns, dispelling misconceptions, and adding credibility to the benefits of these vehicles. Recognizing the role of influential individuals in shaping consumer attitudes and intentions, policymakers can design targeted policies and incentives to harness this influence effectively. Prominent individuals act as catalysts for promoting positive perceptions of environmentally friendly products, encouraging widespread adoption, and facilitating the transition to a greener transportation ecosystem. Collaborating with influencers who advocate for EHVs and sustainable practices can further enhance these efforts, driving meaningful change. By strategically partnering with influencers who resonate with target audiences and embody sustainable values, brands can amplify their message and increase their credibility, building a stronger connection with environmentally conscious consumers. However, to maximize their impact, it is essential to understand the specific characteristics and preferences of the target audience. A nuanced understanding of their motivations and barriers allows for developing tailored marketing strategies that effectively engage and inspire them.

Environmental policies such as higher taxation on polluting vehicles also represent a very important policy segment that can provide a tangible impact for consumers to switch to these vehicles. Higher taxes on polluting vehicles can effectively change the cost dynamics and make EHVs more economically attractive alternatives. This implies that policies aimed at internalizing environmental costs and incentivizing sustainable choices can play a crucial role in influencing consumer behavior and market dynamics.

The next characteristics that appear important according to the two applied methods are household income, positive societal image of EHVs, and perception that EHVs cause less pollution. Targeted measures are needed to overcome the apparent obstacle of higher income being associated with a lower likelihood of intending to purchase EHVs. Understanding the underlying reasons, such as affordability concerns or preference for conventional vehicle features, is central to policy formulation. In addition, educating higher-income individuals about long-term cost savings and investment in charging infrastructure can alleviate concerns and increase attractiveness.

Efforts to improve the societal image of these vehicles could also play a crucial role in increasing consumer acceptance and adoption. This could include targeted campaigns emphasizing the environmental benefits, cost savings, and technological advances associated with these vehicles. In addition, the environmental messages in marketing campaigns resonate well with environmentally conscious consumers and positively influence their purchase intentions, highlighting the potential effectiveness of such strategies. The use of such messages could be a strategic approach for stakeholders seeking to promote the

uptake of EHVs. Furthermore, the significant association between approval of the green aspects of EHVs and purchase intentions underlines the importance of providing transparent and accurate information to address misconceptions. Understanding consumer attitudes enables targeted interventions to promote a more positive perception of EHVs. Overall, addressing environmental concerns and promoting the eco-friendliness of EHVs accelerates the transition to a more sustainable mobility landscape.

Finally, it should be emphasized that age, residence, education level, and household size do not appear to be significant factors influencing respondents' intention to purchase EHVs, while all other factors seem important according to only one of the methods. Hence, attention should be directed toward the factors identified as important by all or two of the applied methods. Tailoring incentives and strategies based on these factors could lead to more effective policy interventions to accelerate the adoption of EHVs in Serbia.

6. CONCLUSION

This study comprehensively investigated the factors influencing the intention to purchase EHVs in Serbia. By examining socio-demographic characteristics, social influence, environmental concerns, and policy measures, we aimed to gain a nuanced understanding of the complexities involved in adopting sustainable transportation alternatives in Serbia. The mixed-methods approach, which combined descriptive and inferential statistics, decision tree analysis, and logistic regression, enabled a rigorous investigation of the determinants influencing attitudes and intentions towards EHVs. Significant predictors of purchase intentions were identified, illustrating the complexity of consumer behavior in the Serbian context.

The research results provide a strong foundation for policy recommendations to accelerate the adoption of EHVs in Serbia. Key factors identified across multiple methods include endorsements from influential individuals and introducing higher taxes on polluting vehicles to encourage the adoption of more environmentally friendly alternatives. Policies that leverage the influence of celebrities, industry leaders, and environmental advocates can significantly boost consumer confidence and drive interest in EHVs. Additionally, higher taxes on polluting vehicles can create economic incentives for consumers to switch to EHVs, while efforts to improve the societal image of these vehicles can increase acceptance. The findings also suggest that targeting specific factors, such as household income, societal perceptions, and the environmental benefits of EHVs, will be crucial in shaping effective policies to accelerate their adoption in Serbia. On the other hand, age, residence, education, and household size do not appear to be significant factors influencing respondents' intention to purchase EHVs.

While the findings offer valuable insights specific to Serbia, they are also more generally applicable as they provide a framework for understanding consumer behavior and informing sustainable transport initiatives across the region. However, it is vital to recognize the limitations of this study. First, like all survey-based research, this study provides a snapshot of attitudes and intentions at a single point in time. This warrants future longitudinal studies to track changes over time. In addition, self-reporting carries the possibility of response bias,

pointing to the need for more objective measures or qualitative approaches to validate findings. Furthermore, the scope of variables examined in this study may be limited, so future research should investigate additional factors that may influence adoption intentions, such as cultural influences and perceived technical performance of the vehicles.

Several directions for future research emerge from the results of this study. Longitudinal studies can provide a more dynamic understanding of how attitudes and intentions towards EHVs evolve over time, offering insights into the effectiveness of interventions and policies. Qualitative research methods like interviews or focus groups can complement quantitative analysis by uncovering the underlying motivations and barriers influencing consumer decision-making. Comparative studies between different countries or regions can shed light on cultural and contextual factors influencing uptake, thus identifying tailored strategies to promote sustainable transportation solutions. In addition, evaluating existing policies' effectiveness and researching emerging technologies' impact on consumer perceptions can guide future policy decisions and industry initiatives. Finally, examining the role of psychological factors, such as perceived risk and innovation acceptance, can provide deeper insights into consumer behavior and enable targeted marketing and communication strategies. By addressing these research directions, we can improve our understanding of the complexities surrounding the adoption of EHVs and develop more effective strategies to accelerate their uptake, contributing to a greener and more sustainable mobility landscape.

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ОДРЕДНИЦЕ УСВАЈАЊА ЕЛЕКТРИЧНИХ И ХИБРИДНИХ ВОЗИЛА: ПЕРСПЕКТИВА ИЗ СРБИЈЕ

Petar Mitić, Milena Kojić, Aida Hanić, Aleksandra Fedajev, Magdalena Radulescu, Izabela Dembińska

Извод

Овај рад истражује факторе који утичу на куповину електричних и хибридних возила у Србији. У раду се истражују социо-демографске карактеристике, друштвени утицај, еколошки фактори и мере јавних политика како би се олакшало разумевање многоструких фактора који утичу на усвајање одрживих алтернатива транспорта у Србији. Коришћење дескриптивне и инференцијалне статистике, стабла одлучивања и логистичке регресије омогућило је објективно истраживање детерминанти које утичу на ставове и намере грађана да купе електрична и хибридна возила. Резултати наглашавају значај позитивног става од стране утицајних појединаца и увођење виших пореза на возила која више загађују као важне факторе који утичу на усвајање електричних и хибридних возила према све три примењене методе. Поред ових фактора, резултати две примењене методе додатно наглашавају значај прихода домаћинства, позитивну друштвену перцепцију ових возила и уверење да електрична и хибридна возила доприносе смањењу загађења. Будући да се старост, место становања, образовање и величина домаћинства не појављују као значајни фактори који утичу на намеру испитаника да купе електрична и хибридна возила, фокус треба усмерити на претходно поменуте факторе. Овако добијени резултати пружају основу за дефинисање политика за промовисање усвајања електричних и хибридних возила у Србији.

Кључне речи: електрична возила, хибридна возила, одрживи развој, транспорт, животна средина, друштвени утицај

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