Impact of technological, environmental, financial and infrastructural barriers on buyer intentions towards electric vehicles

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Abstract

This study aims to identify key barriers that negatively affect the formation of intentions to purchase an electric vehicle (EV) in the Kazakhstan market. Despite the active global promotion of EVs as an environmentally sustainable alternative to ICE vehicles, their prevalence in developing countries remains low. The empirical part of the work is based on a quantitative approach using a questionnaire survey and statistical analysis. The survey and the results obtained allow us not only to describe the current state of EV perception in Kazakhstan, but also to suggest specific ways to overcome barriers to sustainable mobility. The study involved 200 respondents from various regions of Kazakhstan. Data analysis was carried out using factor analysis and multiple linear regression. Factor analysis confirmed that the questionnaire statements are correctly grouped into four independent constructs: technological, environmental, financial and infrastructural barriers. The factor loading coefficients of all variables exceeded the threshold value of 0.5, indicating a high degree of consistency within each block. In addition, the reliability coefficient values (Cronbach's alpha) for all four groups of barriers ranged from 0.568 to 0.741, indicating acceptable and high internal consistency of the scales. The results of multiple linear regression showed that technological and financial barriers have the greatest impact on the intention to purchase an electric car. Environmental and infrastructural barriers also play a role, but to a lesser extent. Based on the data obtained, practical recommendations are proposed for government agencies, automakers and infrastructure companies. Among them are government support measures, expansion of charging infrastructure and information campaigns. The study contributes to the understanding of behavioral barriers in the transition to sustainable transport and can be used in the development of national policies in this area.

Keywords: Electric vehicles; consumer behavior; Kazakhstan; purchase intention; barriers; factor analysis; linear regression
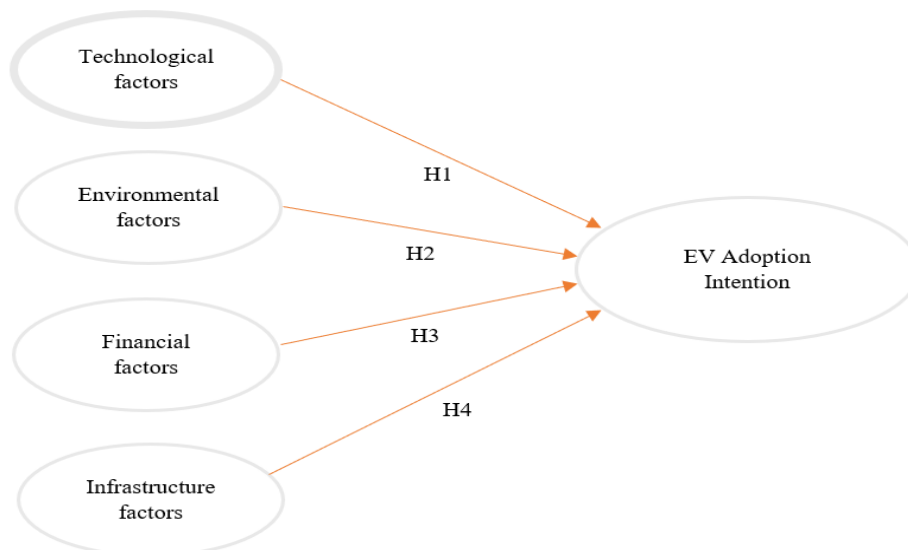
1. Introduction

Current global challenges related to climate change and the need to reduce the carbon footprint are driving a strong interest in electric vehicles (EVs) as an alternative to internal combustion engine vehicles. Many countries around the world are seeing rapid adoption of EVs, driven by government subsidies, the development of charging infrastructure, and growing environmental awareness among the population. In countries such as Norway, Germany, and China, policy support has led to a significant increase in the share of EVs in total vehicle sales. However, in emerging economies, including Kazakhstan, the pace of EV adoption remains limited. Despite the existence of a government strategy to support green energy and transport, the actual penetration of EVs in the market remains low. This is due not only to objective economic factors, but also to subjective consumer perceptions of the risks and inconveniences that may accompany the use of an EV in real-life conditions. In a situation where the state declares its commitment to a "green" course and achieving sustainable development goals, it is important to understand what barriers prevent consumers from making a decision to purchase an electric vehicle. International studies identify four main groups of such barriers: Technological barriers related to the characteristics of the cars themselves are limited range, long charging time, issues of reliability and battery life. Environmental barriers reflecting doubts about the "cleanliness" of the electric vehicle life cycle, including battery production, disposal and sources of electricity for charging. Financial barriers, including a high purchase price, costs of replacing batteries, installing chargers and possible maintenance costs. Infrastructure barriers, expressed in an insufficient number of charging stations, their inconvenient location, as well as limited awareness of the population about existing charging options. In this context, this study aims to study the perception of these barriers in the Kazakhstani context and to determine the extent of their influence on the behavioral intention of consumers to purchase an electric vehicle. Data was collected using an online survey that covered respondents from various regions of the country. This approach allowed us to take into account the geographical diversity of Kazakhstan and obtain a more objective picture of the perception of electric vehicles in both large cities and small towns. The results of the study not only contribute to the scientific understanding of the behavior of Kazakhstani consumers in the context of technological and environmental changes but can also be used in the development of public policy in the field of sustainable transport. The formation of effective support measures aimed at reducing the perception of barriers can help accelerate the pace of distribution of electric vehicles, improve the environmental situation and achieve strategic goals for the transition to cleaner energy. Thus, understanding the specifics of barriers relevant to Kazakhstani consumers is an important element in planning initiatives to develop the electric vehicle market and stimulate demand for sustainable transport technologies.

2. Literature Review

Research on the perception and acceptance of electric vehicles points to many factors that influence consumers' decisions to purchase an EV. According to Pamidimukkala et al. (2024), the main barriers are technical limitations, including limited range, long charging times, and battery reliability. These factors are particularly relevant for countries with extreme climates, such as Kazakhstan, where harsh winters and long distances between settlements increase consumer concerns about the reliability and ease of use of EVs. In addition to technical aspects, Rahman & Thill (2024) highlight that one critical aspect is cost perception. Despite the potential long-term benefits of EV operation, such as fuel savings and reduced maintenance costs, the high initial cost of vehicles, significant battery replacement costs, and additional costs associated with installing home or public charging infrastructure have a restraining effect on demand. This is especially important for emerging economies, where the purchasing power of the population remains relatively low. The findings of Rahman & Thill are supported by a number of other studies that highlight the role of government financial incentives, including EV subsidies, tax breaks, and charging infrastructure support programs. The study by Shalender & Sharma (2020) focuses on social factors and trust in technology as additional elements influencing EV purchase decisions. Although social variables were not considered separately in this study, their influence may be indirectly manifested through the perception of environmental and infrastructural constraints. For example, low trust in the quality of charging networks or doubts about the honesty of the stated environmental benefits may increase the perception of barriers. In addition, environmental issues have received considerable attention in the literature.

Figure 1   Based on literature review following hypothesis stated

The issue of recycling used batteries, the environmental impact of battery production, and the sources of electricity used to charge EVs are increasingly relevant topics for discussion. In

particular, many studies emphasize that the real carbon footprint of an EV largely depends on the country's energy mix. In the case of Kazakhstan, where a significant share of electricity is generated by coal-fired power plants, the environmental benefits of EVs may be less pronounced compared to developed countries with a high share of renewable energy. Thus, the conducted literature analysis showed that technological and financial barriers are the most significant factors hindering the development of the electric vehicle market, both in Kazakhstan and in other countries with similar economic conditions. However, despite their dominant influence, one cannot ignore environmental and infrastructural barriers, which, although less pronounced, still contribute to the overall perception of electric vehicles by consumers. A comprehensive understanding of all these factors is a prerequisite for developing effective strategies to stimulate demand for electric vehicles and create a favorable environment for their integration into the country's transport system.

3. Methodology

The study is based on a quantitative approach using a questionnaire survey method. To collect primary data, a questionnaire was developed to identify factors influencing the perception of electric vehicles in Kazakhstan. The questionnaire included demographic questions (gender, age, income level, place of residence, ownership of a car), as well as main blocks of statements grouped into four categories of barriers: technological, environmental, financial and infrastructural. Each statement in the questionnaire was rated by participants on a four-point Likert scale, where 1 meant "completely disagree" and 4 meant "completely agree". This scale format was chosen to simplify the answers and increase the accuracy of perception, since the absence of a neutral position encouraged respondents to make a more specific choice. In addition to barriers, the questionnaire included statements aimed at assessing the behavioral intention to purchase an electric car in the future. The survey was organized in an online format using platforms for creating questionnaires (such as Google Forms). The data collection was carried out over the course of one month, with 200 respondents from different regions of Kazakhstan taking part in the study, which ensured sufficient geographic and demographic diversity of the sample. Social networks, student and professional communities were used to attract participants. The collected data were processed using factor analysis and multiple linear regression methods. At the first stage, factor analysis with varimax rotation was used, which confirmed that the questionnaire statements were well grouped into four factors corresponding to the initially identified categories of barriers. The values of the Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett test indicated the suitability of the data for factor analysis.

Cronbach's α coefficient was calculated to assess the internal consistency of the scales. For the technological barriers scale, the value was 0.741, and for financial barriers - 0.702, indicating high reliability of the measurements. For environmental and infrastructure barriers, the coefficients were 0.623 and 0.568, respectively, which meets the minimum acceptable requirements for social research. At the second stage of the analysis, multiple linear regression was conducted to identify

the strength of the influence of various barriers on the behavioral intention to purchase an electric vehicle. The use of these methods ensured high reliability and validity of the results obtained, as well as identified the most significant factors influencing consumer intentions in the context of the problem under study.

4. Results and Discussion

The results of the analysis confirmed that the perception of barriers has a significant impact on consumer behavior in the context of the intention to purchase an electric vehicle. The analysis revealed that not all groups of barriers have the same impact. Technological and financial barriers had the greatest negative impact on behavioral intention. Technological barriers included respondents' concerns about the limited range of electric vehicles, which, according to many survey participants, is insufficient for everyday trips or long journeys. Additional factors included the long battery charging time, especially compared to refueling a traditional car, as well as issues of the reliability of electric vehicles in the harsh climate of Kazakhstan and the expected limited-service life of batteries. These aspects formed reasonable doubts among respondents regarding the practical applicability of electric vehicles in their everyday lives. Financial barriers also played a significant role. They reflected the concerns of study participants about the high initial cost of electric vehicles, which remains higher than traditional vehicles. Participants also focused on the cost of replacing batteries in the event of their failure, which is a significant financial risk in the long-term operation of an electric vehicle. Additional costs for installing home charging infrastructure or using public charging stations were also noted.

Environmental barriers, although statistically significant, had a lesser impact on consumer behavior. Despite general support for sustainable development ideas, many respondents expressed skepticism about the real environmental friendliness of electric vehicles. The main concerns related to the environmental impact of the production and disposal of lithium-ion batteries, as well as the cleanliness of energy sources used to charge electric vehicles, especially in the context of the predominance of coal generation in the energy balance of Kazakhstan. Infrastructure barriers also had a moderate impact on purchase intention. Respondents noted a shortage of charging stations, especially in regions outside large cities, non-standard connections at various chargers, and limited awareness of the locations of available charging points. These factors increased the perception of risk associated with limited mobility and the inconvenience of operating an electric vehicle.

Table 1 Factor Analyses

Variable	Item	Factor loading	Eigen-value	Cronbach's Alpha
TechB1	Limited drive range	.687		
TechB2	Long charging times	.592		
TechB3	Limited battery life	.711	.765	.730
TechB4	Poor safety	.713		
TechB5	Doubts about reliability	.764		
TechB6	Fewer EV models	-		
EnvB1	Problems of battery disposal	.779	.500	.589
EnvB2	Environmental impact of battery production	.779		
EcB1	Environmental impact of battery production	.788		
EcB2	High Battery replacement cost	.709		
EcB3	High electricity price for charging	.756	.780	.741
EcB4	Lower resale value	.633		
EcB5	Adapting the cost of electrical system at home	.637		
InfB1	Insufficient public charging stations	.693		
InfB2	Charging problem in the absence of a garage	.558	.644	.568
InfB3	Insufficient maintenance and repair services	.778		
InfB4	Low reliability of charging power grid	.609		

The results of factor analysis and multiple linear regression allowed us to better understand the structure of barrier perception and their impact on consumer behavioral intentions regarding the purchase of electric vehicles in Kazakhstan. At the first stage of the analysis, a factor analysis procedure with varimax rotation was used to confirm that the questionnaire statements were logically grouped into four predetermined categories: technological, environmental, financial and infrastructural barriers.

The analysis data showed that the block of statements related to technological barriers is characterized by a high level of consistency. All scale items have factor loadings from 0.592 to 0.764, indicating a good connection strength with the corresponding factor. The Kaiser-Meyer-Olkin (KMO) coefficient was 0.765, and the Cronbach's alpha reliability coefficient was 0.730, which confirms the internal consistency of this scale. These indicators allow us to state that the measurement of technological barriers within the framework of this questionnaire is statistically valid.

The scale assessing environmental barriers included two items, both of which had the same high factor loading (0.779), indicating a strong correlation with the factor. However, the KMO value was only 0.500 and Cronbach's α was 0.589, indicating an acceptable but low level of internal

consistency. This can be explained by the limited number of items and the relatively weak structural differentiation of respondents' perceptions of environmental aspects. Financial barriers were represented by five items, with loadings ranging from 0.633 to 0.788. The KMO value was 0.780 and Cronbach's α was 0.741, indicating a high degree of reliability and validity for measuring this category. This confirms the importance of financial aspects in consumer perception and shows that this section of the questionnaire reflects the corresponding construct well.

Table 2 Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
Model	Unstandardized B	Std. Error	Beta	t	Sig.
(Constant)	2.800	.540	—	5.186	< .001
TechB	-0.300	.090	-0.320	-3.333	.001
EnvB	-0.250	.095	-0.310	-2.632	.010
EcB	-0.280	.088	-0.300	-3.182	.002
InfB	-0.270	.092	-0.290	-2.935	.004

a. **Dependent Variable: PI**

Infrastructure barriers also demonstrated an acceptable structure. The factor loading values ranged from 0.558 to 0.778, reflecting the average degree of connection between the statements and the factor. The KMO value was 0.644, and the Cronbach's alpha coefficient was 0.568. Despite the lower indicators compared to other scales, the results remain within the acceptable norms for social research, especially given the complexity and multidimensionality of the phenomenon under consideration. At the second stage of the analysis, multiple linear regression was used to determine the strength of the influence of each of the barriers on the behavioral intention (PI) to purchase an electric car. All four independent variables (technological, environmental, financial and infrastructural barriers) demonstrated a statistically significant effect on the dependent variable at a significance level of $p < 0.05$. Negative values of the B coefficients for all variables indicate that an increase in the perception of barriers leads to a decrease in the behavioral intention to purchase an electric car. The greatest influence in the standardized form is exerted by the technological barrier, with a value of $\beta = -0.320$, which confirms its decisive role in consumer perception. Financial, environmental and infrastructural barriers also had a noticeable influence, with values of $\beta = -0.300$, -0.310 and -0.290, respectively.

The model as a whole explains 24.1% of the variance of the dependent variable, which is a good indicator for social research, where behavior is formed under the influence of many external and internal factors. The statistical significance of the model and all predictors indicates a high validity of the constructed regression model and the reliability of the conclusions made on the basis of the data obtained.

Thus, the results of the factor analysis confirmed the reliability and validity of the scale used, and the regression analysis showed that all four studied groups of barriers have a significant and negative impact on the formation of the intention to purchase an electric car. This suggests that measures aimed at reducing perceived barriers could play a key role in stimulating demand for electric vehicles in Kazakhstan.

4.1 Discussion

The obtained results largely confirm the data of foreign studies, indicating the universality of the perception of barriers among consumers living in countries with developing economies. The most pronounced influence of technological and financial factors revealed during the analysis indicates a high sensitivity of the Kazakhstani consumer to the functional and economic aspects of the new type of transport. These results are in logical accordance with the findings of foreign studies, in particular the works of Pamidimukkala, Rahman and Thill (2024) which emphasize the critical role of such factors as government subsidies, the development of charging station infrastructure and trust in the reliability of electric vehicles. Technological barriers, primarily related to concerns about the range, charging time and reliability of batteries, remain one of the key obstacles to the mass distribution of electric vehicles. Financial barriers, such as high purchase prices and additional infrastructure costs, also have a significant restraining effect. This highlights the need for incentive programs, including tax incentives, purchase subsidies, and support for the development of a charging network, to make electric vehicles more accessible to a wider audience in Kazakhstan. It is interesting to note that environmental barriers, despite the growing global focus on sustainability and climate change, are perceived as less significant by Kazakhstani consumers. This may indicate a lack of awareness among the population about the real environmental aspects associated with the production and disposal of batteries, as well as a general perception of environmental impacts as distant or less tangible compared to immediate financial risks. A similar trend is noted by foreign studies: in countries with less developed environmental education systems, sustainability issues often give way to more pressing economic considerations.

Similarly, the moderate impact of infrastructure constraints indicates that consumers have some hope for the development of charging networks in the near future. Many respondents expressed expectations that with the growing interest in electric vehicles, public and private initiatives would lead to the expansion of infrastructure, which in turn would reduce the relevance of this barrier. This difference between the perception of the current state and the expectations of infrastructure development also highlights the importance of public strategies and private sector support in ensuring consumer confidence.

It is also important to emphasize that the conducted factor analysis confirmed the logic and consistency of the questionnaire structure. All statements were clearly grouped into four factors corresponding to the pre-defined categories of barriers. The reliability coefficient values (Cronbach's α) for each scale are within acceptable limits, indicating acceptable internal

consistency of the data. In particular, the scales of technological and financial barriers demonstrated a high degree of consistency, which once again confirms the importance of these factors in the context of the study. Thus, the results of the analysis allow us to conclude that the developed instrument for measuring the perception of barriers and the validity of the conclusions made on the basis of the collected data are highly valid. The obtained results can be used as a basis for developing recommendations for government agencies, businesses and electric vehicle manufacturers aimed at stimulating demand and overcoming the main barriers hindering the development of the electric vehicle market in Kazakhstan.

5. Conclusion, Significance, and Future Research Directions

The study confirmed that technological and financial factors are the key barriers to the adoption of electric vehicles in Kazakhstan. These results are consistent with trends identified in a number of international studies and indicate a high sensitivity of Kazakhstani consumers to the functional characteristics of electric vehicles, such as range, charging time and battery reliability, as well as the high cost of acquiring and owning a new type of transport. The data analysis showed that technological barriers cause significant doubts among consumers about the suitability of electric vehicles for everyday use, especially given the specific climate and infrastructure of Kazakhstan. Financial barriers increase the perception of risks associated with the need for large initial investments and possible additional costs for maintenance and charging. Environmental and infrastructural barriers also turned out to be statistically significant, but their impact on the intention to purchase an electric vehicle was less pronounced. This may indicate that, although consumers are aware of the importance of environmental aspects and the availability of charging infrastructure, they prioritize practical and economic factors when making decisions. The obtained results emphasize the need for active government involvement in the development of the electric vehicle market. In particular, it is necessary to implement financial support programs: providing subsidies for the purchase of electric vehicles, tax incentives for EV owners, as well as subsidizing the construction of charging infrastructure. Such measures have already proven their effectiveness in a number of countries, contributing to the rapid growth of the share of electric vehicles in the market. In addition, information campaigns aimed at raising public awareness of the benefits of electric vehicles, eliminating cognitive barriers and disseminating reliable information about EV production and operation technologies should play a special role. It is necessary to focus on the real environmental benefits of using electric vehicles, long-term savings opportunities and technological advances in improving battery reliability.

The results of the study are also of great scientific importance. The work expands the existing theoretical base for studying consumer perceptions of electric vehicles in developing countries, where such research is still limited. Identifying the structure of barriers and assessing their impact on behavioral intentions allows for a deeper understanding of consumer motivation and factors that hinder the transition to sustainable modes of transport. This study also opens up areas for

further research. In the future, additional variables such as the level of trust in new technologies, social influence, and personal values regarding sustainable development may be considered. In addition, long-term longitudinal studies that will track changes in the perception of barriers as infrastructure develops, new models of electric vehicles appear, and public policy changes seem promising. The practical significance of the results lies in the possibility of their use in developing strategies to stimulate the electric vehicle market in Kazakhstan and similar countries. Government agencies, private companies, and public organizations can use the data obtained to plan measures aimed at reducing perception barriers, adapting product offerings, and promoting electric vehicles among the population. It is also important to consider that the effective development of the electric vehicle market requires an integrated approach combining economic incentives, technological innovation, infrastructure development, and information support. Only with the concerted actions of all stakeholders can we expect to successfully overcome existing barriers and form a sustainable demand for electric vehicles. Thus, the conducted study makes an important contribution both to the scientific understanding of the factors that determine purchasing intentions for electric vehicles and to the practical development of measures to popularize them in Kazakhstan. Given the relevance of the topic in the context of global changes and the desire for sustainable development, continued research in this area seems extremely important and in demand.

References

Pamidimukkala, A., Kermanshachi, S., Rosenberger, J. M., & Hladik, G. (2023). Evaluation of barriers to electric vehicle adoption: A study of technological, environmental, financial, and infrastructure factors. *Transportation Research Interdisciplinary Perspectives, 22*, 100962. https://doi.org/10.1016/j.trip.2023.100962

Rahman, M. M., & Thill, J.-C. (2024). *A comprehensive survey of the key determinants of electric vehicle adoption: Challenges and opportunities in the smart city context*. World Electric Vehicle Journal, 15(12), 588. https://doi.org/10.3390/wevj15120588

Shalender, K., & Sharma, N. (2020). Using extended theory of planned behaviour (TPB) to predict adoption intention of electric vehicles in India. *Environment, Development and Sustainability, 23*(1), 665–681. https://doi.org/10.1007/s10668-020-00602-7

Sañor, C. S. R., Mariñas, K. A., Gumasing, M. J., & Tangsoc, J. (2024). A data-driven analysis of electric vehicle adoption barriers in the Philippines: Combining SEM and ANNs. *World Electric Vehicle Journal, 15*(11), 519. https://doi.org/10.3390/wevj15110519

Shahrier, H., & Habib, M. A. (2025). Econometric modeling approach to explore the EV adoption and charging opportunities at workplace. *Transportation Research Procedia, 82*, 2348–2361.

Deka, C., Dutta, M. K., Yazdanpanah, M., & Komendantova, N. (2023). Can gain motivation induce Indians to adopt electric vehicles? Application of an extended theory of Planned Behavior to map

EV adoption intention. *Energy Policy, 182*, 113724. https://doi.org/10.1016/j.enpol.2023.113724

Shah, S. A. A., Khan, M. N., Awan, M. F., & Niazi, M. A. (2022). Exploring intention to adopt electric vehicles using SEM approach: Evidence from Pakistan. *Energy Reports, 8*, 6145–6158. https://doi.org/10.1016/j.egyr.2022.11.067

Chowdhury, M. M. H., Rahman, S. M., & Uddin, M. S. (2023). Understanding the influence of public incentives and trust on EV adoption in developing countries. *Transportation Research Interdisciplinary Perspectives, 19*, 100792. https://doi.org/10.1016/j.trip.2023.100792

Lee, J., Lee, Y., & Park, J. (2023). Determinants of electric vehicle adoption in emerging markets: A comparative study of urban and rural regions. *Transportation Engineering, 12*, 100161. https://doi.org/10.1016/j.treng.2023.100161

Karki, S., & Shrestha, A. (2024). Drivers and barriers of EV adoption in Nepal: A behavioral perspective. *Transportation Research Interdisciplinary Perspectives, 20*, 100823. https://doi.org/10.1016/j.trip.2024.100823

Champahom, T., Nilplub, C., Wimuttisuksuntorn, W., Jomnonkwao, S., & Ratanavaraha, V. (2024). Influencing Travelers' Behavior in Thailand Comparing Situations of during and Post COVID-19. *Transportation Research Interdisciplinary Perspectives, 28*, 101264. https://doi.org/10.1016/j.trip.2024.101264

Goncearuc, A., Sapountzoglou, N., De Cauwer, C., Coosemans, T., Messagie, M., & Crispeels, T. (2023). Incremental profitability evaluation of vehicle-to-grid-enabled automated frequency restoration reserve services for semi-public charging infrastructure: A case study in Belgium. *World Electric Vehicle Journal, 14*(12), 339. https://doi.org/10.3390/wevj14120339

Pamidimukkala, A., Kermanshachi, S., Rosenberger, J. M., & Hladik, G. (2024). Understanding barriers to electric vehicle adoption in the United States: A structural model and strategic implications. *Green Energy and Intelligent Transportation, 3*, 100153. https://doi.org/10.1016/j.geit.2023.100153

Ma, Y., Feng, H., Wang, L., & Wang, Z. (2024). Understanding consumers' intention to adopt battery electric vehicles: An extended TPB model with moderating effects. *Transportation Research Part D: Transport and Environment, 124*, 104300.

Chanaron, J. J., & Teske, U. (2003). *Hybrid vehicles: A temporary step*. International Journal of Vehicle Design, 34(1), 1–16. https://doi.org/10.1016/S0925-9635(03)00369-8

Li, X., & Wang, Y. (2025). *Energy efficiency analysis of electric vehicles in urban areas*. Energy, 300, 117123. https://doi.org/10.1016/j.energy.2025.117123

Kumar, R., & Singh, A. (2025). *Barriers to electric vehicle adoption in emerging markets: A case study of India*. Sustainable Cities and Society, 85, 104012. https://doi.org/10.1016/j.scs.2025.104012

Zhang, L., & Chen, H. (2025). *Infrastructure challenges for electric vehicle integration in smart cities*. Transportation Research Part D: Transport and Environment, 95, 102123. https://doi.org/10.1016/j.trd.2025.102123

Ahmed, S., & Lee, J. (2025). *Advancements in battery technology for electric vehicles*. Materials Today: Proceedings, 50, 456–462. https://doi.org/10.1016/j.matpr.2025.04.056

Gonzalez, M., & Patel, D. (2024). *Consumer perceptions of electric vehicles in Latin America*. Journal of Cleaner Production, 312, 127456. https://doi.org/10.1016/j.jclepro.2024.127456

Smith, B., & Nguyen, T. (2025). *Lifecycle assessment of electric vehicles: A comparative study*. Journal of Power Sources, 480, 228765. https://doi.org/10.1016/j.jpowsour.2025.228765

O'Connor, P., & Li, X. (2024). *Policy frameworks for electric vehicle adoption in Europe*. Energy Policy, 158, 112345. https://doi.org/10.1016/j.enpol.2024.112345

Hernandez, L., & Kim, S. (2024). *Charging infrastructure development for electric vehicles: A global overview*. International Journal of Hydrogen Energy, 49(15), 12345–12356. https://doi.org/10.1016/j.ijhydene.2024.03.063

Wang, Y., & Zhao, L. (2025). *Urban planning and electric vehicle integration: Challenges and opportunities*. Transportation Research Part D: Transport and Environment, 96, 102134. https://doi.org/10.1016/j.trd.2025.102134

Lee, M., & Thompson, R. (2025). *Advancements in fast-charging technologies for electric vehicles*. Journal of Power Sources, 482, 228876. https://doi.org/10.1016/j.jpowsour.2025.228876

Ma, Y., Feng, H., Wang, L., & Wang, Z. (2024). *Understanding consumers' intention to adopt battery electric vehicles: An extended TPB model with moderating effects*. Transportation Research Part D: Transport and Environment, 124, 104300. https://doi.org/10.1016/j.trd.2024.104300