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Adoption of Electromobility in Urban Transport in Poland – Cost-Benefit Trade-Offs and Decision-Making Challenges

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Abstract. Electromobility is increasingly recognized as a cornerstone of sustainable urban transport strategies. This paper presents an analysis of selected economic, environmental, and infrastructural implications of transitioning from internal combustion engine vehicles to electric vehicles (EVs) in urban settings. Through a cost-benefit analysis, the study compares the purchase and operating costs of EVs and conventional cars across mini, compact, and premium market segments, accounting for factors such as energy consumption, fuel and electricity prices, annual mileage, and carbon emissions. The development and expansion of charging infrastructure, along with the integration of smart grid solutions and energy storage capabilities, are examined in the context of meeting the growing demand from a rising fleet of EVs. Additionally, the paper analyzes changes in urban mobility behaviors, highlighting the shift toward shared mobility and ecomobility, and discusses how these trends can reshape urban transportation to improve quality of life and reduce environmental impacts. Drawing on current trends, national electromobility development plans in Poland, and international best practices, the study identifies challenges and enablers for policymakers and decision-makers in the transportation and energy sectors, highlighting the need for coordinated planning and policy support to ensure the long-term viability and sustainability of electromobility in urban environments.

Keywords: electromobility, urban transport, electric vehicles, cost-benefit analysis, sustainable mobility, charging infrastructure, energy systems, infrastructure planning, environmental impact, transport policy, strategic management

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1. INTRODUCTION

Transport is a crucial pillar of economic competitiveness, social development, and global integration. It not only delivers high mobility, efficiency, comfort, and safety but also provides robust logistical support across supply, production, and distribution networks. However, transport systems generate significant external costs – including traffic accidents, congestion, fossil fuel dependence, air and noise pollution, extensive land consumption, and contributions to climate change – that have attracted growing scrutiny from researchers and policymakers in today's globalized landscape.

Since the 1990s, the surge in private car usage across European cities has introduced complex challenges that cut across environmental, climate, energy, and spatial planning policies. Urban mobility and infrastructure have thus emerged as central issues in the development of sustainable transport strategies, as the effects of motorization reverberate economically, socially, and ecologically. At the same time, the automotive industry has come under increasingly strict regulations, especially concerning safety and environmental impact. Consequently, addressing urban congestion and pollution requires innovative mobility concepts that are firmly aligned with the Sustainable Development Goals. Recent shifts in the vehicle market – fueled by the rising popularity of electric vehicles (EVs), evolving legislative frameworks, and targeted environmental initiatives – are accelerating the transition toward electromobility. This transformation is poised to reshape urban development and the energy sector by necessitating new infrastructure and distribution networks, while also opening up opportunities for enhanced energy storage. Furthermore, the anticipated increase in electricity demand is expected to drive improvements in the efficiency, reliability, and cost-effectiveness of energy production and supply (Wiśniowski, 2018).

This study examines how the rise of EVs is transforming urban mobility, with a particular focus on assessing the impacts of electromobility and the evolving travel behaviors in Poland. The paper is organized as follows: the first section discusses the current state of the electromobility sector in Poland; the second assesses the development of charging infrastructure; the third presents a cost comparison between electric and combustion vehicles based on empirical data; the fourth section analyzes emerging trends in urban mobility within the context of this paradigm shift; concluding remarks are presented in the final section.

2. THE ELECTROMOBILITY SECTOR IN POLAND

The electrification of transportation in Poland reflects not only technological and policy trends, but also a series of interdependent decisions made by various stakeholders. For policymakers, the challenge lies in balancing industrial development goals with environmental sustainability. For firms, it is a matter of cost competitiveness and regulatory compliance. For consumers, it depends on affordability, infrastructure availability, and perceived value (Sipiński & Bolesta, 2017).

Modern transport must address its negative environmental and climatic impacts – challenges that are especially evident in road transport's heavy reliance on petroleum-based fuels (Chłopek, 2002; Wasiak et al., 2014). Reducing emissions, lowering energy consumption, and increasing energy efficiency are now global priorities outlined in international frameworks, such as the 2015 Paris Agreement (United Nations Climate Change, 2015). In this context, the development of electromobility is central to many environmental, climate, and energy programs. Transitioning to electric vehicles (EVs) requires both continued technological innovation and heightened public awareness of their benefits. As electric drivetrains gradually replace traditional internal combustion engines, the automotive landscape is poised for significant transformation, opening opportunities for new market entrants who can first target niche segments before expanding more broadly (Flasza, 2017). Currently, electromobility is one of the fastest-growing sectors, with approximately 500,000 EVs sold globally each year and projections indicating that by 2040, nearly 40 million electric vehicles will be on the road – meaning one in every four cars could be electric (Krawiec & Krawiec, 2017).

The electrification of road transport is a key economic priority for the Polish government. In 2017, the publication of two strategic documents to support electromobility was followed by the 2018 Act on Electromobility and Alternative Fuels (*Ustawa z dnia 11 stycznia 2018 r. o elektromobilności i paliwach alternatywnych*, 2018). These initiatives aim to mitigate the environmental impact of Poland's transport sector – a major contributor to air pollution and related health concerns. Electric vehicles offer a promising emissions advantage, as their overall CO_2 output (when accounting for both energy production and consumption) is generally lower than that of combustion vehicles. Although Poland's current energy mix remains heavily reliant on coal, gradual shifts toward renewable energy and cleaner technologies are expected to reduce emissions further. Moreover, integrating EVs with renewable energy sources could further reduce emissions, potentially approaching near-zero levels (Denis & Kuczyński, 2017; Kucharska & Ruszel, 2016). The Act on Electromobility and Alternative Fuels also introduced mandatory shares of electric vehicles in the fleets of local government units. This requirement creates a direct compliance obligation for municipalities, influencing their procurement decisions and positioning them as essential actors in shaping the diffusion of electromobility (*Ustawa z dnia 11 stycznia 2018 r. o elektromobilności i paliwach alternatywnych*, 2018).

Placing Poland's electromobility development in a regional perspective helps identify transferable solutions and contextualize national challenges. Poland's situation can be better understood by comparing it with neighboring countries that share a similar fossil-dominated energy mix. In the Czech Republic and Hungary, coal and natural gas still dominate power generation, limiting the immediate emissions benefits of EV adoption. At the same time, both countries are pursuing gradual RES expansion and have introduced incentive schemes for EV uptake, including subsidies and preferential registration fees (European Alternative Fuels Observatory, 2020). Such regional parallels underline that Poland's challenges are not unique and that solutions – such as regional grid integration and harmonized infrastructure standards – may be scalable within Central and Eastern Europe.

Poland's efforts in this field are guided by the "Plan for Electromobility Development," which outlines goals such as improving air quality, enhancing energy security, and promoting technological and industrial growth. This plan is structured in three phases (Flasza & Matuszczyk, 2018):

1) 2016–2018– Pilot programs aimed at raising public awareness and stimulating interest in EVs;
2) 2019–2020 – Infrastructure development, notably the installation of charging stations and the initiation of short-run vehicle production;
3) 2020–2025 – Transition to mass production, integration with the national energy grid, and expansion of the public EV fleet (including government vehicles).

Despite these forward-thinking initiatives, challenges remain. Securing adequate funding for infrastructure, addressing public skepticism about EV benefits, expanding the underdeveloped charging network, and reducing high vehicle costs are significant issues. Additional barriers include limited vehicle range, longer charging times, and prevailing perceptions that EVs are costly or unproven. Nevertheless, driven by industrial readiness and technological improvements, the adoption of EVs is expected to surge between 2021 and 2024.

Beyond improving environmental outcomes, the growth of electromobility represents a new economic branch that can boost electricity demand, reduce reliance on oil imports, and stimulate Polish industrial development while creating jobs. An increasing number of EVs will necessitate expanded charging infrastructure, broader distribution networks, and innovative energy storage solutions. The Ministry of Energy estimates that the additional electricity demand could range from 2.3 TWh to 4.3 TWh by 2025 – a demand that may be met through both new power plant initiatives and more efficient use of existing capacities (Sipiński & Bolesta, 2017). For environmental and energy security reasons, a significant portion of this extra capacity must come from renewable sources.

The expansion of electromobility also intensifies the demand for lithium, a key ingredient in advanced batteries. By 2020, the electric vehicle manufacturing industry was already responsible for at least half of the global lithium demand. With the production of 10 million EVs offering ranges of up to 500 km, annual requirements had climbed to 110,000–150,000 tons. As EV adoption increases, reduced oil consumption is expected to enhance Poland's energy independence. While Poland is self-sufficient in electricity production, approximately 97% of its oil is imported – placing a strain on the trade balance and exposing the economy to volatile oil prices, which in turn can reduce disposable income.

The widespread adoption of EVs in Poland could significantly improve urban quality of life by reducing harmful emissions and noise. Given that transportation is a significant source of air pollution, especially in cities, the shift to electromobility promises substantial public health benefits by reducing healthcare costs and mitigating environmental damage. However, for these benefits to materialize fully, a significant portion of the energy used to power EVs must be generated from renewable sources.

A significant obstacle to achieving these goals is the underdeveloped charging infrastructure. The scarcity of charging stations, paired with the relatively high cost of electric vehicles and limited state support, poses a significant barrier to broader EV adoption. Addressing these challenges will require comprehensive legal reforms, increased investments, and targeted financial incentives. In this context, Norway's successful approach – characterized by high consumer awareness, penalties on combustion-engine vehicles, robust financial incentives, and an extensive charging network – serves as a helpful model. For Poland to meet its ambitious electromobility goals, these elements must be implemented in tandem, as neglecting any one of them could undermine the overall strategy. By examining these facets, this section highlights both the immense opportunity presented by electromobility and the critical challenges that must be addressed to secure a sustainable future for urban transport in Poland.

3. CURRENT STATUS AND PROSPECTS FOR THE DEVELOPMENT OF ELECTRIC CAR CHARGING INFRASTRUCTURE

Charging infrastructure development is both a technical and strategic decision-making issue. Overinvestment risks financial inefficiency, while underinvestment risks deterring adoption. Governments must therefore decide on phased roll-out strategies, while municipalities consider optimal geographical placement, and firms evaluate opportunities for private-public partnerships.

In many advanced economies, a comprehensive electric vehicle charging network is already in place, highlighting that the full realization of EV technology hinges on an adequately developed charging infrastructure. In the early stages of EV market growth, it is essential to align charging facility expansion with rising user demand. An imbalance – whether from an overabundance of EVs without sufficient charging stations or vice versa – could either discourage prospective users or lead to economically unsustainable operations. According to the "Electromobility Development Plan for Poland" issued by the Ministry of Energy, primary emphasis is placed on developing charging infrastructure in major urban conglomerates and along trans-European transport corridors traversing Poland. This plan focuses on establishing numerous publicly accessible EV charging points to accommodate the anticipated growth in electric vehicle usage. Global trends, corroborated by statistical analyses of EV market growth and European Union air quality regulations, indicate that Poland is entering the era of automotive electrification. With most charging expected to occur during off-peak nighttime hours, the national energy system is well-positioned to absorb the additional load, making EVs a flexible and beneficial component of the electrical grid.

According to the Polish Alternative Fuels Association (Polskie Stowarzyszenie Nowej Mobilności, 2021), at the end of November 2021, there were 1,784 publicly accessible charging stations in Poland, providing a total of 3,541 charging points. Of these, 1,102 were AC stations with 2,106 connectors, and 682 were DC fast-charging stations with 1,435 connectors. It is therefore necessary to distinguish between charging stations, understood as physical locations, and charging points, which refer to individual connectors available for use. The infrastructure remains concentrated in major urban centers such as Warsaw, Kraków, Katowice, Gdańsk, and Poznań, but expansion into medium-sized cities has also accelerated in recent years. While early deployments often provided free access, most operators now apply differentiated tariffs based on the charger's power rating and speed. National policy documents still anticipate substantial growth, with targets of several thousand additional charging points, accompanied by the development of centralized registration and monitoring systems to ensure interoperability and data exchange.

The plan further envisions that by 2025, the power grid will be upgraded to sufficiently support energy supplies for one million electric vehicles, with these EVs integrated as active regulatory elements of the system. However, two primary challenges have emerged in this developmental phase. The first concerns the optimal spatial and temporal distribution of charging stations. Overconcentration in a single area may overburden the local grid and prevent simultaneous full-power charging, while infrastructure limitations in certain regions may preclude installing additional units. The second challenge involves accommodating the growing electricity demand driven by an increasing EV population. Fast-charging facilities, for example, require high-capacity grid connections, despite their relatively low overall energy consumption. It is estimated that servicing one million EVs could nearly double the grid's maximum connection capacity, even as total annual electricity consumption rises by only about 1.5–3%. This disparity suggests that EV users should ultimately not only share the cost of the electricity they consume (per kilowatt-hour, kWh) and its distribution, but also contribute to the costs of grid connection and charging-station construction.

While the development of EV charging infrastructure is undoubtedly complex and capital-intensive, a phased, well-coordinated approach offers a sustainable path forward. Spreading the investment over time ensures that planning, preparation, and implementation are conducted in a manner that preserves energy system security and maintains manageable operating costs throughout the network.

Beyond the number and distribution of charging stations, the integration of EVs into the energy system also raises questions of grid stability and flexibility. A growing EV fleet will inevitably interact with the stability and security of Poland's electricity system. Increased charging demand may exacerbate peak load pressures, especially in urban centers where charging clusters are concentrated. At the same time, integrating EVs offers opportunities to enhance system flexibility. Vehicle-to-grid (V2G) technology, which enables bidirectional power flows, has been successfully tested in several European pilot projects as a tool to balance variable renewable energy sources and provide ancillary services (International Energy Agency, 2020). For decision-makers, the strategic challenge lies in aligning EV deployment with power system modernization and ensuring that charging infrastructure evolves alongside grid capacity and digital control mechanisms.

4. COST-EFFECTIVENESS ANALYSIS OF THE PURCHASE AND OPERATION OF AN ELECTRIC VEHICLE

The comparison of ICE and EV costs highlights both financial trade-offs and strategic decision points. Consumers evaluate affordability and long-term savings. Fleet managers assess the total cost of ownership and maintenance risks. Governments weigh fiscal incentives against budget constraints. This section provides structured evidence for these decision contexts, showing where EVs are already competitive and where barriers remain.

Electric vehicles have rapidly gained traction within the automotive industry. Today, most leading global manufacturers offer at least one electric-powered model, with many more in development. Although EVs have not yet emerged as full-scale competitors to internal combustion engine (ICE) vehicles worldwide, their rapid technological progress suggests that they will soon redefine market dynamics. Environmental concerns drive much of the growing interest in EVs. Urban areas, characterized by high traffic density and limited pollutant dispersion, often result in exceedances of air quality standards for particulate matter and nitrogen oxides, making them particularly vulnerable to the harmful effects of motor vehicle emissions. The shift to electric propulsion is seen as a promising strategy not only to mitigate these emissions but also to reduce dependence on dwindling non-renewable resources, such as crude oil. By eliminating tailpipe emissions and curbing reliance on petroleum-based fuels, EVs present a viable solution to these challenges. Today's automotive market is diverse, offering ICE, pure electric, and hybrid options. Each alternative has its unique advantages and drawbacks. EVs are noted for their low environmental emissions, lower operating costs on short trips, and a simpler mechanical design that reduces maintenance needs. In contrast, ICE vehicles incur higher fuel expenditures, emit significant pollutants, and generate more noise.

In Poland, the shift toward electromobility is an inevitable development for the domestic automotive industry. Although the initial purchase price of an EV is typically higher than that of a conventional vehicle, the reduced operating costs over time are frequently emphasized as a key benefit. To assess the overall cost-effectiveness, this analysis adopts three criteria: purchase costs, operating costs, and CO_2 emissions. Using these criteria, the profitability of owning and operating ICE vehicles versus EVs is evaluated across three market segments – mini, compact, and premium. The comparison is based on specific assumptions summarized in Table 1: vehicle purchase price (catalog prices); fuel consumption for ICE vehicles (4.2–9.5 l/100 km), electricity consumption for EVs (13–18 kWh/100 km), annual mileage of 30,000 km, fuel price (5.10 PLN/l), electricity price (0.55 PLN/kWh), and CO_2 emission factor for electricity production (614 g/kWh). The comparison of environmental impacts in this study was limited to CO_2 emissions due to data availability and the need for a standardized metric across vehicle categories. Nevertheless, it should be noted that particulate matter (PM) and nitrogen oxides (NO_x) frequently exceed permitted levels in Polish cities (Wasiak et al., 2014), and thus remain critical considerations for decision-makers in urban transport policy. The electricity price of 0.55 PLN/kWh reflects the assumption of home charging at household tariffs. In practice, using public charging infrastructure would entail higher costs, potentially eroding EVs' financial advantage in specific usage scenarios (Sipiński & Bolesta, 2017).

The selection of the Tesla Model S and Audi A8 as representatives of the premium segment warrants clarification. Although the Tesla is closer in market positioning to models such as the Audi A6, BMW 5 Series, or Mercedes E-Class, it was included here due to its comparable performance parameters and to reflect the growing role of

EVs in the upper market tier (Flasza, 2017). This choice does not imply full equivalence in prestige or pricing.

Table 1. *Technical parameters: fuel and electricity consumption, annual distance, fuel and electricity prices*

Vehicle model	Purchase price [PLN]	Fuel consumption [l/100 km]	Electricity consumption [kWh/100 km]
Mini Cooper	82,100	4.2	–
Nissan Note	67,800	6.1	–
Audi A8	429,000	9.5	–
BMW i3	162,100	–	13
Nissan Leaf	133,000	–	15
Tesla S	440,000	–	18

The first criterion – vehicle purchase price – reveals a significant disparity between EVs and ICE vehicles, particularly in the mini and compact segments, where EVs can be roughly twice as expensive as their combustion-engine counterparts. In the premium segment, however, price differences are minimal, suggesting a more competitive stance for EVs. The second criterion addresses operating costs. Estimates for covering 30,000 km annually, based on manufacturer data and standard assumptions, are summarized in Table 2. EVs have substantially lower operating costs than ICE vehicles. This cost efficiency primarily results from the simpler, more efficient construction of electric motors, which entail fewer components subject to wear or failure. Operating cost calculations exclude insurance and service costs, which vary widely depending on provider, vehicle segment, and user profile. Their omission reflects data limitations, but the relative differences in energy and fuel expenditures remain the dominant factors shaping cost-effectiveness (Wiśniowski, 2018).

Table 2. *Annual costs of fuel and electricity consumption for 30,000 km*

Vehicle model	Annual fuel cost [PLN]	Annual electricity cost [PLN]
Mini Cooper	6,426	–
Nissan Note	9,333	–
Audi A8	14,535	–
BMW i3	–	2,145
Nissan Leaf	–	2,475
Tesla S	–	2,970

Another vital operating cost driver for EVs is battery degradation and, in some cases, eventual replacement. Capacity fade is accelerated by temperature extremes, with both laboratory and review studies showing faster aging at elevated temperatures and performance loss in cold operation (Edge et al., 2021; Jaguemont et al., 2016). Field evidence from Scandinavia indicates that winter conditions materially reduce usable range: Norwegian Automobile Federation (NAF) and Motor magazine winter tests in 2020–2021 reported average shortfalls versus WLTP range in cold weather, with individual models showing reductions on the order of ~20–30% depending on conditions (Motor/NAF, 2021; NAF, 2020). In climates with marked seasonal swings – such as Poland – these thermal effects can both reduce effective driving range in winter and accelerate long-term capacity loss if thermal management is inadequate. Consequently, lifecycle evaluations should explicitly account for the risk of battery performance degradation and potential refurbishment/replacement costs.

Table 3. *Battery replacement costs for selected EV models*

Vehicle model	Estimated battery cost [PLN]	Battery capacity [kWh]
BMW i3	18,000	22
Nissan Leaf	25,000	30
Tesla S	40,000	55

Source: own elaboration based on secondary data from industry reports, service provider estimates, and press releases (not direct manufacturer list prices)

Original Equipment Manufacturers do not officially publish the exact costs of battery replacements. The estimates in Table 3 are compiled from secondary sources, including reports by Bloomberg New Energy Finance (2017), the International Energy Agency (2017), Frankel and Wagner (2017), and scientific analysis by Flasza (2017). Values were standardized to Polish zlotys [PLN] using the average exchange rates for 2017–2018.

The third evaluation criterion involves CO_2 emissions. Although EVs are often labeled 'zero-emission,' this holds only if the electricity used for charging is entirely renewable. In Poland, the renewable share in electricity production was already markedly higher than 10%: analyses for 2020 show coal's share fell below 70% and renewables increased, reflecting a significant – although still in the minority – contribution of RES to the power mix (Forum Energii, 2021). System statistics published for 2018–2020 likewise document the evolving fuel structure of production (Polskie Sieci Elektroenergetyczne, 2021). Given that fossil sources continued to dominate through 2020, indirect CO_2 emissions from EV charging remain non-negligible. Tables 4 and 5 present comparative emissions profiles for the selected ICE and EV models under these conditions. While the analysis is based on a single operational year, extending the horizon to a standard vehicle lifecycle (8–10 years) would provide a fuller picture of cost-effectiveness. Over extended periods, the lower operating costs of EVs tend to outweigh their higher purchase prices, reinforcing their attractiveness to decision-makers (Wiśniowski, 2018).

Table 4. *CO_2 emissions for selected ICE vehicles*

Vehicle model	Fuel consumption [l/100 km]	CO_2 emissions [kg/100 km]
Mini Cooper	4.2	11.8
Nissan Note	6.1	17.7
Audi A8	9.5	26.6

Source: own elaboration based on manufacturer fuel consumption data and standard CO_2 emission factors for gasoline (≈2.31 kg CO_2 per liter) (European Environment Agency, 2019)

Table 5. *CO_2 emissions for selected EV models (based on Poland's energy mix)*

Vehicle model	Electricity consumption [kWh/100 km]	CO_2 emissions [kg/100 km]
BMW i3	13	9.36
Nissan Leaf	15	10.80
Tesla S	18	12.96

Source: own elaboration based on electricity consumption data and the national grid emission factor (0.72 kg CO_2/kWh) reported by Polskie Sieci Elektroenergetyczne (2021)

Thus, although EVs emit less CO_2 per 100 km compared to ICE vehicles, they are not entirely emission-free under Poland's current energy conditions. Unlocking the full environmental potential of electromobility will require a broader shift toward renewable energy sources for electricity generation. Overall, the analysis – grounded in purchase costs, operating expenses, and CO_2 emissions – offers a nuanced view of the economic and environmental trade-offs between ICE vehicles and EVs across the mini, compact, and premium segments. In the mini and compact markets, the considerably higher purchase prices of EVs make them less cost-effective at present, despite their lower operating costs. Conversely, in the premium segment, where purchase price differences are minimal, EVs' lower operating costs may make them cost-effective as early as the first year of ownership. While this analysis focuses on CO_2 emissions as a measurable and comparable indicator, it is essential to note that other pollutants – particularly particulate matter (PM) and nitrogen oxides (NO_x) – are also critical in urban transport contexts. Exceedances of PM and NO_x limits have been repeatedly documented in Polish cities; however, due to data gaps and methodological limitations, these were not included in the quantitative assessment. Nonetheless, they remain essential factors for decision-makers concerned with public health.

Looking further ahead, while the current calculations do not yield a definitive verdict on which vehicle type is universally more cost-effective, they do illuminate the circumstances where EVs offer clear advantages – and where improvements, such as an increased share of renewable energy in the national grid, could further enhance their appeal. This analysis lays a critical foundation for evaluating future shifts in market dynamics as technology and energy infrastructure evolve.

5. ANALYSIS OF URBAN MOBILITY CHANGES IN THE CONTEXT OF ELECTROMOBILITY DEVELOPMENT

Electromobility not only affects vehicles – it reshapes urban mobility behaviors. For decision-makers in municipalities, this creates opportunities and challenges in planning integrated mobility solutions. For consumers, it shifts preferences toward shared and ecological mobility models. For firms, it drives innovation in business models such as car-sharing, leasing, and fleet electrification.

Over the past two decades, Poland's urban landscape has undergone significant transformation, driven by the expansion of urban structures and evolving transportation behaviors (Gdowska, 2018). These changes have culminated in increased overall mobility, reflecting shifts in both lifestyles and travel patterns. Mobility itself is a multifaceted concept. In transportation economics, it encompasses all forms of individual movement toward a destination, regardless of motive or mode, even including walking. In urban logistics, it refers to the full spectrum of actions aimed at facilitating the movement of people within a given area (Gdowska et al., 2018). At its core, mobility is an expression of human activity, driven by two fundamental decisions: whether to travel and how to travel, including the choice of mode, timing, and route. These decisions are influenced by an interplay of external factors, such as infrastructure availability and economic considerations, as well as internal factors, including personal preferences, social influences, and psychological perceptions. Despite growing environmental awareness, the car remains a potent symbol of success and wealth; its cultural status frequently overshadows considerations of efficiency and sustainability. Such dynamics have fostered a car-centric mobility culture that not only exacerbates congestion – by inefficiently using limited road space – but also diminishes the attractiveness of alternative modes such as public transport.

The adverse effects of traditional, car-based mobility have prompted widespread public concern over worsening traffic conditions, inadequate safety, and declining urban quality of life due to increased noise, emissions, and spatial constraints. In response, cities are increasingly embracing a "new mobility culture" that seeks to reconcile economic growth with social well-being and environmental sustainability. This emerging paradigm emphasizes reducing private car use in favor of collective transport solutions and transitioning away from fossil-fuel-powered vehicles toward those powered by renewable energy or even human effort, as evidenced by initiatives such as Sustainable Urban Mobility Plans in Polish cities. The combined pressures of urbanization and advances in communication technologies have catalyzed new trends in urban mobility (Książek et al., 2021). Consumers are now more inclined toward services such as vehicle rentals, ride-sharing, and multimodal transportation, all of which have been facilitated by mobile applications. Although these trends initially took root in the United States and Western Europe, they are also rapidly gaining traction in Poland.

Two key concepts – the sharing economy and ecomobility – have become central to contemporary discussions on urban mobility. The sharing economy, with its emphasis on the on-demand use of resources rather than ownership, has deepened its influence in the transport sector. The availability of ride-hailing services (e.g., Uber or Lyft), carpooling platforms (e.g., BlaBlaCar, Zimride), and both public and private car-sharing systems demonstrates how shared mobility can optimize vehicle usage and alleviate congestion (Korcyl et al., 2016). In contrast, ecomobility represents a broader challenge to the automotive industry. It is not merely about eco-friendly transport; it is about rethinking mobility to offer fast, affordable, and reliable transportation while minimizing environmental impact.

In Poland, the drive toward ecomobility is supported by public innovation funds and targeted programs from institutions such as the National Fund for Environmental Protection, the National Centre for Research and Development, and the Polish Development Fund. These state-driven initiatives aim to establish the technical and organizational foundations that will make ecological transport options the natural choice for the public. Taken together, the evolution of urban mobility in Poland is marked by a gradual yet significant shift away from outdated, car-dependent paradigms toward a more balanced and sustainable system – one that integrates shared mobility and ecomobility to address the spatial, social, and economic challenges of modern cities.

Finally, the adoption of EVs is shaped not only by technology and policy but also by consumer perceptions and social acceptance. Beyond technical and economic considerations, the social dimension of electromobility adoption is critical. Consumer surveys highlight persistent barriers, including range anxiety, limited awareness of the total cost of ownership, and the perception that EVs are luxury products accessible only to wealthier households (Sierzchula et al., 2014; Sovacool et al., 2018). Addressing these concerns requires targeted educational campaigns, transparent communication of lifecycle costs, and visible municipal initiatives that promote the normalization of EV use in public fleets and shared mobility services. Such measures can enhance consumer confidence and accelerate the diffusion of EVs by reframing them as mainstream mobility solutions rather than niche alternatives.

6. CONCLUDING REMARKS

This study has demonstrated that adopting electromobility in Poland entails complex trade-offs among costs, infrastructure, and environmental outcomes. By explicitly framing these trade-offs as decision-making challenges, the paper contributes to the decision sciences in three ways: (1) it structures the electromobility adoption problem as a multi-stakeholder decision under uncertainty; (2) it highlights the role of policy, managerial, and consumer perspectives in shaping feasible strategies; and (3) it provides empirical cost-benefit and infrastructure analysis to support informed choices. The transition to sustainable transport is not merely technological, but decisional, requiring adaptive strategies across consumers, firms, and governments.

The rapid development of electromobility – both globally and in Poland – offers a vital response to the environmental challenges posed by combustion-engine transportation. Electric vehicles provide a sustainable alternative for public and private transportation, benefiting both society and the natural environment. Historically, the automotive and electric power sectors operated independently, with little overlap.

Today, EVs bridge that gap by not only enabling eco-friendly transportation but also providing the potential to store energy during periods of peak demand. As major manufacturers increasingly focus on electric and hybrid models, consumers can look forward to a broader range of options across various market segments.

EVs stand out for their low noise emissions, the near absence of harmful pollutants, and high torque levels that contribute to enhanced active safety. However, significant barriers to widespread adoption remain – namely, high upfront costs and an insufficiently developed charging infrastructure. In response, Poland introduced the "Electromobility Development Plan" in 2016, emphasizing improvements to charging infrastructure and a gradual reduction in vehicle costs. While EV sales in Poland have seen modest growth, many potential buyers still associate these vehicles with high technological sophistication and environmental consciousness, often overlooking the lower operating costs. Despite current high purchase and maintenance expenses, economies of scale and technological advances are expected to reduce production costs – especially in the compact and mini segments – making EVs increasingly accessible.

Looking ahead, the prospects for electromobility in Poland are promising. As production scales up and technological innovations continue, electric vehicles are poised to become a genuine alternative to combustion engine cars. These advancements will enhance affordability and broaden consumer appeal, ultimately leading to a cleaner, quieter, and more efficient urban mobility landscape.

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