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Advancing Sustainable Development in Jordan: A Business and Economic Analysis of Electric Vehicle Adoption in the Transportation Sector

Ghazi A. Samawi [1,*], Omar M. Bwaliez [1,2], Mohannad Jreissat [3] and Abdallah Kandas [4]

[1] Management Sciences Department, Business School, German Jordanian University, Amman 11180, Jordan; omar.bwaliez@gju.edu.jo
[2] Business and Management Research Institute, University of Bedfordshire, Luton LU1 3JU, UK
[3] Industrial Engineering Department, School of Engineering, The University of Jordan, Amman 11942, Jordan; m.jreissat@ju.edu.jo
[4] Service Engineer, Electric Vehicle Department, Abu Khader Automotive—BMW Group Importer, Amman 11118, Jordan
* Correspondence: ghazi.samawi@gju.edu.jo

Abstract: This study explores electric vehicle (EV) adoption in Jordan, focusing on key transitional factors. It examines government policies, market dynamics, technological advancements, and infrastructure development through semi-structured interviews with key stakeholders, including government officials, industry experts, and consumers. The study provides insights into the economic prospects, infrastructure requirements, and regulatory measures necessary for widespread EV adoption. Government incentives, such as tax exemptions and reduced registration fees, are crucial, but challenges like insufficient charging infrastructure, high initial costs, and limited public awareness persist. Collaborative efforts between the public and private sectors are essential to develop resilient infrastructure, enhance consumer education, and foster technological innovation. The findings underscore the importance of government incentives and coordinated efforts to develop charging infrastructure and raise public awareness. Future research should focus on quantitative methods to validate these findings and explore additional strategies to overcome identified barriers.

Keywords: electric vehicles; sustainable development; sustainable transportation; government incentives; Jordan

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1. Introduction

The global transition toward sustainable development has placed electric vehicles (EVs) at the forefront of efforts to reduce carbon emissions and enhance energy security [1]. In Jordan, the transportation sector is a major contributor to greenhouse gas (GHG) emissions [2,3], making the adoption of EVs a critical component of the country's environmental and economic strategies [4]. The shift from internal combustion engines to electric-powered vehicles promises to address some of Jordan's most pressing challenges, including its reliance on fossil fuels and the environmental impact of its transportation sector [5,6]. However, despite the recognized benefits of EVs, their adoption in Jordan faces significant barriers, including insufficient infrastructure, high costs, and low public awareness [4]. These challenges underscore a critical research gap. While the potential for EVs to transform Jordan's transportation sector is evident, there is a lack of comprehensive studies that examine the multifaceted factors influencing this transition [7–9]. This study seeks to

fill this gap by exploring the economic, infrastructural, and technological challenges and opportunities associated with EV adoption in Jordan. The guiding research questions for this study are as follows:

- What are the key barriers to EV adoption in Jordan?
- How can these barriers be effectively addressed through policy, infrastructure development, and technological innovation?
- What role do government incentives and public–private partnerships (PPPs) play in facilitating this transition?

To address these questions, the study employs a qualitative approach, utilizing semi-structured interviews with a diverse group of stakeholders, including government officials, industry experts, infrastructure providers, consumers, environmental groups, and academics. This strategy allows for a comprehensive analysis of the current landscape of EV adoption in Jordan, providing insights into the economic and environmental implications of this transition and offering practical recommendations for policymakers and industry stakeholders. The findings of this study contribute to the broader discourse on sustainable transportation by highlighting the importance of coordinated efforts across multiple sectors to overcome the challenges of EV adoption. By addressing the identified research gaps, this study aims to provide a roadmap for Jordan to enhance its energy security, promote economic growth, and achieve its sustainability goals through the widespread adoption of EVs.

The remainder of this paper is organized as follows: Section 2 reviews the prior literature concerning various pertinent dimensions of EVs, including market potential, economic considerations, prerequisite infrastructure, technological advancements, consumer perceptions, government policy and regulation, and the conceptual framework of this research and EV adoption in Jordan. Section 3 explains the materials and methods, while Section 4 presents the results, which are discussed in Section 5 with regard to government policies, incentives, market demand and economic considerations, infrastructure, technology, consumer perceptions, environmental impacts, and stakeholder collaboration and long-term implications. Section 6 concludes the study, identifying its main outcomes, theoretical and practical implications, limitations, and future research directions.

2. Literature Review

The promotion of EVs is crucial for reducing GHGs and fostering sustainable development. This review examines the policies, incentives, and challenges associated with EV adoption, globally and in Jordan. The insights are based on recent research findings and provide a comprehensive understanding of the current landscape.

2.1. Market Potential

The global EV market is undergoing significant growth, driven by advancements in technology and robust government support. Enhanced battery performance and the expansion of charging infrastructure are pivotal factors contributing to EV penetration in many markets [10]. Financial incentives, such as purchase rebates, play a crucial role in boosting EV sales. Research studies have shown that direct all-EV discounts can increase new registrations by approximately 8 percent per USD 1000 offered [11]. As shown in Figure 1, the global EV market was valued at USD 255.54 billion in 2023, and is expected to surge to around USD 2108.80 billion by 2033, with an impressive compound annual growth rate (CAGR) of 23.42% from 2024 to 2033. This projected growth is supported by recent sales figures, which rose from 6.77 million units in 2021 to 10.52 million units in 2022 [12–14].

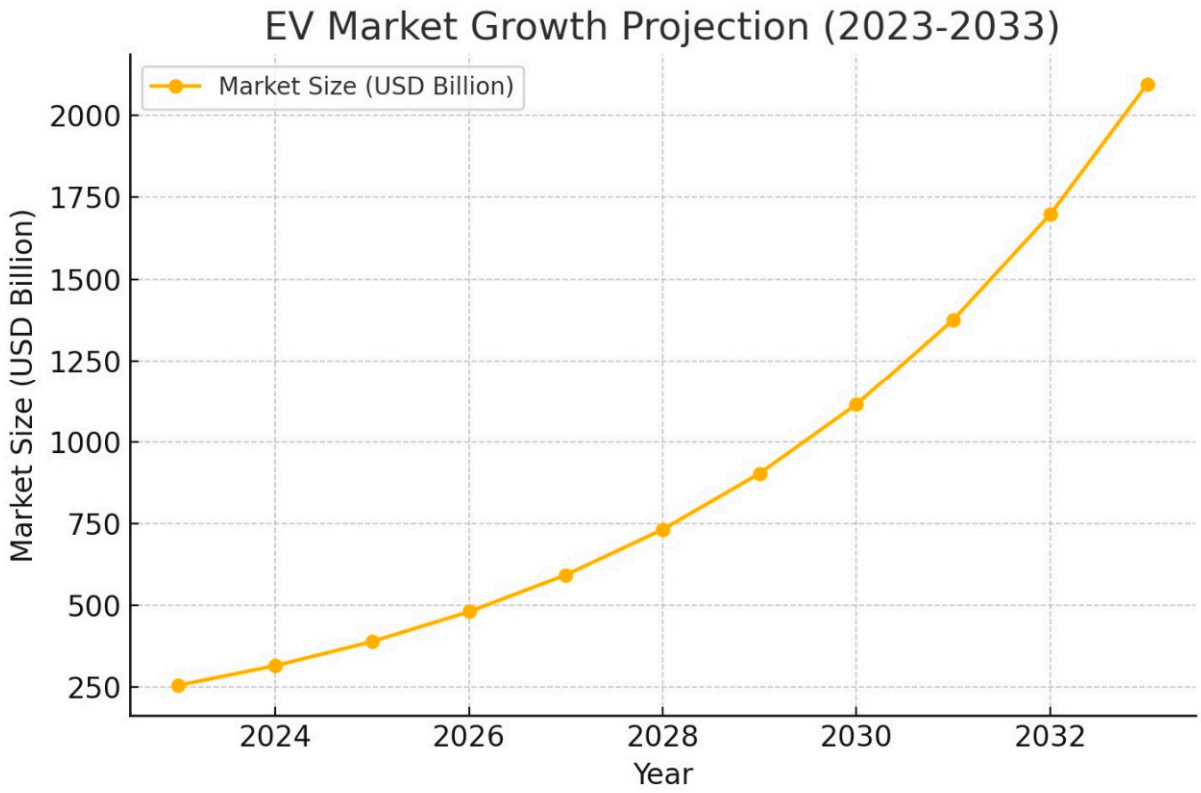

Figure 1. (EV market growth projection): EV market growth projection (2023–2033), data source from Ref. [14].

The adoption of EVs is strongly influenced by financial incentives, specifically those that provide consumers with substantial benefits. Although practical limitations associated with charging infrastructure remain a crucial factor inhibiting EV penetration, long-term financial considerations often tip the balance in favor of adoption [15]. The rapid growth of the EV market is particularly evident in Asia, where China has emerged as the leading market due to significant government intervention and infrastructure investments. China's dominance is further reinforced by stringent regulations, subsidies, and mandates requiring automakers to produce a certain percentage of EVs, establishing it as the largest market for EVs globally [16]. Notably, Chinese automakers such as BYD, GAC Aion, SGMW, and Li Auto lead global EV sales, as depicted in Figure 2.

Recently, the Asia–Pacific region led the global EV market, with China at the forefront, followed by India and Japan (see Figure 3). In 2024, China accounted for approximately 70% of global EV sales [18]. Countries like Japan, South Korea, and India are also emerging as key players in the market, with significant government investments in EV startups aimed at promoting manufacturing and sales. In Europe and North America, the EV market is witnessing substantial growth, driven by increasing demand particularly in the U.S., Norway, France, and Germany. Germany and Norway lead demand in the European market, with a CAGR of nearly 40%. Norway is at the forefront of electric mobility adoption in Europe, while the U.S. dominates the North American market, largely due to the rising demand for EVs [19].

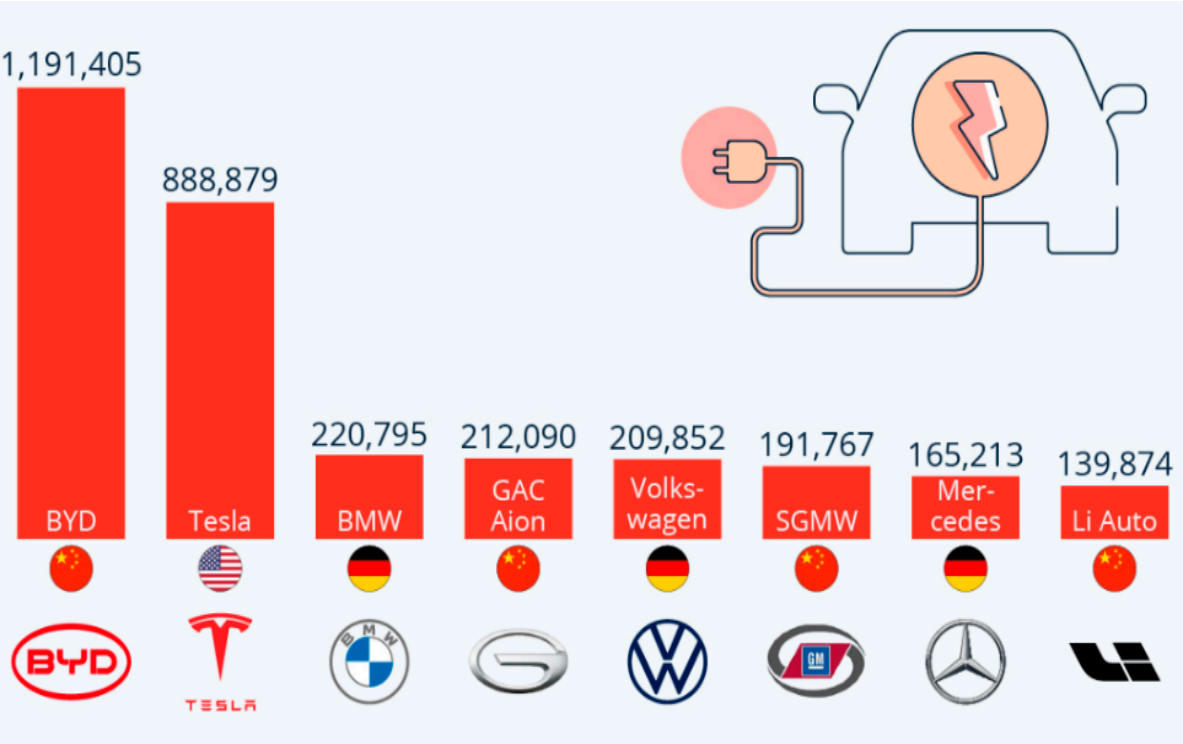

Figure 2. Estimated global sales of battery electric and plug-in hybrid EVs in the first half of 2023, by brand, reprinted from Ref. [17].

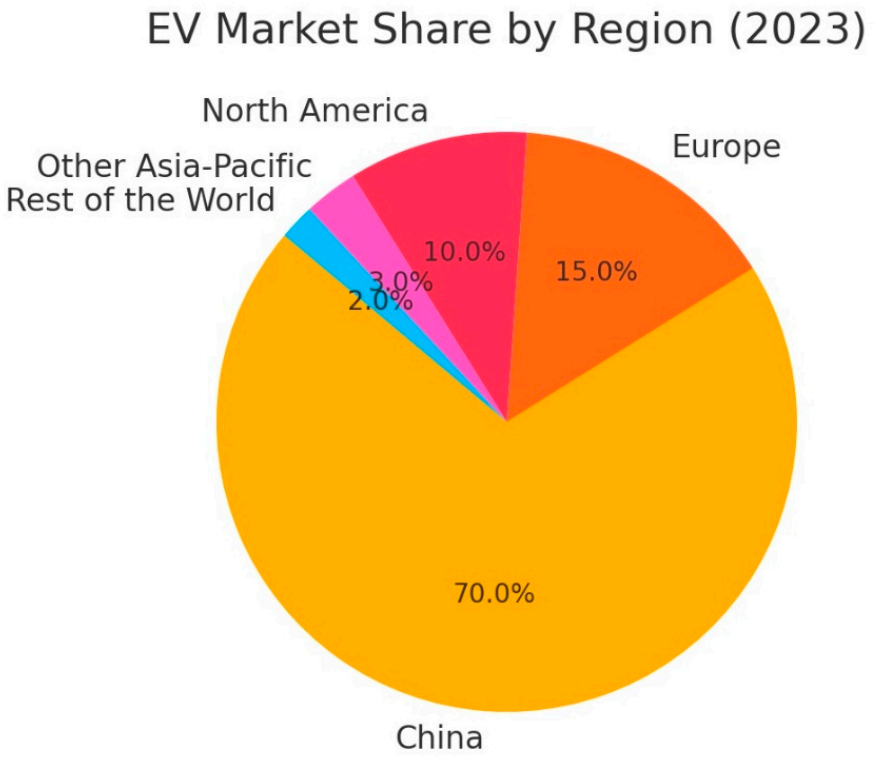

Figure 3. (EV market share by region): EV market share by region (2023), data source from Ref. [14].

2.2. Economic Benefits and Costs

Economic considerations are among the most significant barriers to the widespread adoption of EV technologies. The high upfront costs of EVs, coupled with lingering doubts about the broader benefits of ownership, continue to pose substantial challenges. Financial

constraints, vehicle performance issues, and the insufficient availability of charging stations have been identified as critical obstacles preventing consumers from fully embracing EV technology, which is necessary for achieving economies of scale and long-term market growth [20]. A major impediment to EV adoption is the initial cost. Although battery prices have been decreasing, the upfront expense of purchasing an EV remains higher compared to traditional internal combustion engine vehicles. This cost disparity is particularly pronounced in regions with lower average incomes, where potential buyers are often deterred by the higher initial investment required for an EV [21]. These economic barriers highlight the need for targeted policy interventions and continued advancements in technology to make EVs more financially accessible and attractive to a broader range of consumers.

2.3. EV Infrastructure Development

The development and availability of charging infrastructure are crucial factors influencing the adoption of EVs. To enable the widespread use of EVs, it is essential to build both public and private charging networks, including fast-charging stations, and to integrate these with renewable energy sources [16]. Additionally, advancements in battery design and smart grid technologies are vital in supporting the broader implementation of EVs [10]. As illustrated in Figure 4, South Korea currently leads in the installation of EV charging infrastructure relative to the number of EVs on its roads.

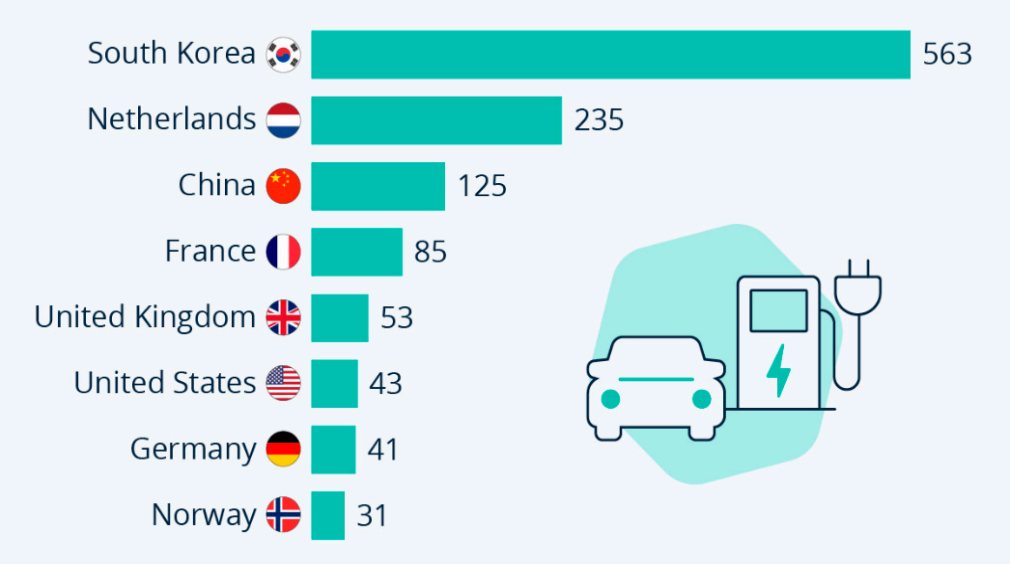

Figure 4. Number of public charging stations per 1000 plug-in electric passenger cars in 2022, reprinted from Ref. [22].

However, the development of this necessary infrastructure is capital intensive. The high costs associated with installing public and private charging stations, upgrading the electrical grid, and ensuring proper maintenance can be particularly challenging for developing countries [16]. Strategic placement of EV charging stations is crucial to accommodate the growing number of EVs while avoiding overloading regional electrical distribution grids. Well-planned infrastructure can help manage this balance effectively [23]. Studies, such as those conducted by Planners Ink in New York, have addressed urban demand and distribution challenges for charging stations [24].

Despite these efforts, the lack of standardized charging infrastructure and variations in load settings across different regions continue to hinder market growth. Diverse standards for EV charging exist in regions such as China, Europe, the U.S., Japan, and Korea. Some

manufacturers, like Tesla Inc., are actively working towards the global standardization of charging infrastructure to address these challenges [14].

2.4. Technological Advancements

Technological advancements have significantly enhanced the benefits of EVs, notably in terms of driving ranges and overall performance. However, concerns about range anxiety and battery life continue to be among the top issues for consumers [25]. Addressing these concerns, improvements in battery efficiency and cost reduction have become crucial for the broader adoption of EVs. Enhanced battery performance has alleviated some of the primary consumer anxieties, such as range limitations and long charging times, thereby making EVs more accessible to a wider audience [26]. Table 1 provides a clear comparison of the different types of vehicle batteries, highlighting their respective advantages, disadvantages, and applications.

Table 1. Comparative analysis of different types of vehicle batteries.

Battery Type	Advantages	Disadvantages	Applications
Lithium-ion (Li-Ion)	High energy density, long cycle life, low self-discharge, lightweight, superior performance	Higher cost, sensitivity to high temperatures, safety concerns (thermal runaway)	Widely used in modern EVs
Nickel-metal hydride (NiMH)	Good energy density, longer lifespan than lead-acid, environmentally friendly	Higher self-discharge rate, lower energy density than Li-Ion, heavier and bulkier	Commonly used in hybrid EVs (HEVs)
Lead-acid	Low cost, high availability, robust, reliable, well-established recycling infrastructure	Low energy density, heavy, shorter lifespan, high maintenance, environmental concerns	Older EV models, auxiliary power in modern EVs
Solid-state	Higher energy density, improved safety	Still in development, higher cost	Future EV applications
Lithium iron phosphate (LFP)	Safety, long cycle life, cost-effective	Lower energy density	Gaining popularity due to stability and cost-effectiveness

Despite these improvements, battery-related concerns, including range, charging time, and lifespan, remain significant for consumers. Technological progress in battery development is essential for overcoming these issues, making EVs more practical for everyday use [27]. Furthermore, the lack of standardized charging connectors and protocols poses compatibility challenges, complicating the charging process for users. Standardization is critical to ensuring a seamless charging experience and promoting the widespread adoption of EVs [28]. As the battery industry continues to grow, China is emerging as a dominant player, further driving the development of EV technology [14].

The future of the EV market is also likely to be positively influenced by the rising trend of self-driving vehicles. Major original equipment manufacturers, including Volvo, Daimler Vera, and Tesla, are actively developing autonomous EVs. The advancement of self-driving technology is expected to increase the demand for EVs over the long term, thanks to its numerous benefits, such as reduced accident risk, ease of use, and the inclusion of value-added features. This technology is anticipated to mature over the next five to six years, offering significant growth opportunities for the EV market in the foreseeable future [14].

2.5. Consumer Perceptions

Consumer perceptions and behavioral factors play a crucial role in the adoption of EVs. Research studies highlighted that environmental concerns, along with the perceived ease of use and usefulness of EVs, are key determinants influencing consumer intentions to embrace this technology. In particular, a deeper understanding and awareness of EVs can significantly boost consumer willingness to adopt them, especially in developing countries, where familiarity with related technologies might be lower [29]. Consumption attitudes also significantly impact consumer intentions, either directly or indirectly, through perceived behavioral control [30].

As consumers become more aware of the negative environmental and social impacts of traditional vehicles, they show a greater willingness to shift their purchasing patterns, moving from ownership models to shared usage of EVs [31]. This shift is also driven by the emergence of the green consumer, who prioritizes sustainability and environmental responsibility in their purchasing decisions [32]. Moreover, consumer behavior is often driven by positive attitudes toward the perceived benefits of EVs, which can be further influenced by societal factors such as peer pressure and the innovation seen in everyday experiences. This is particularly true when the ease of use is complemented by the public value associated with EV technology [33]. As illustrated in Figure 5, there is a growing share of respondents whose primary vehicle is a hybrid or battery EV, indicating a positive trend in consumer adoption in the context of the U.S. [34].

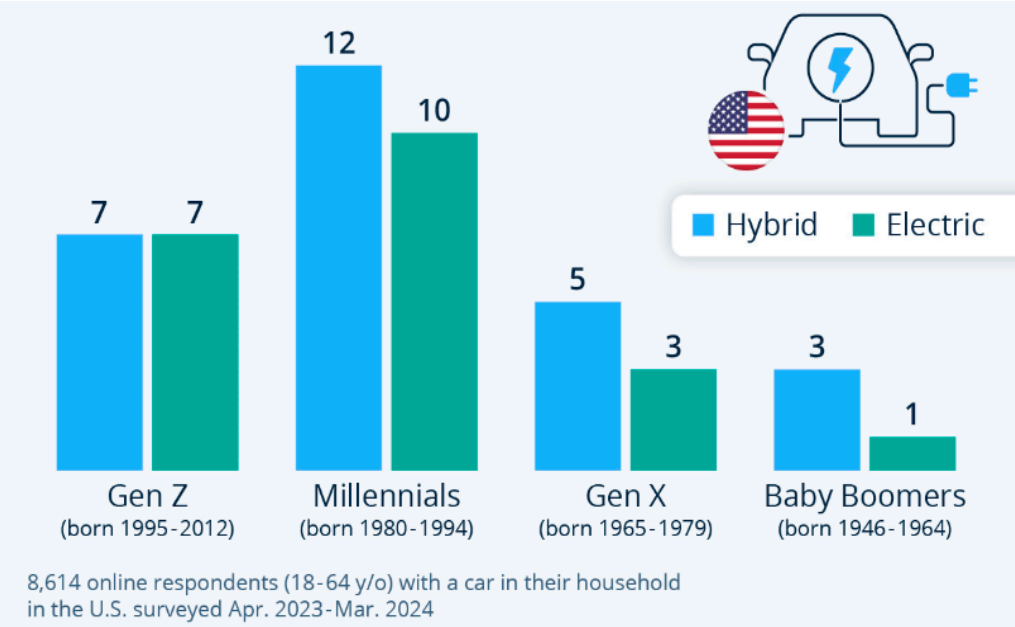

Figure 5. Percentage of respondents whose primary car is a hybrid/battery EV, reprinted form Ref. [34].

Understanding these behavioral dynamics is essential for promoting EV adoption, as they highlight the importance of aligning technological advancements with consumer expectations and societal influences.

2.6. Policy and Regulatory Measures

Governments worldwide are implementing a range of initiatives, such as tax rebates, subsidies, grants, and other non-financial benefits like reduced car registration fees and access to carpool lanes, all of which are expected to drive EV sales in the coming years. For instance, in November 2019, German car manufacturers increased their cash incentives

for electric cars to support the transition from combustion engines to battery-powered engines, aiming to reduce harmful emissions [35]. Countries like the U.S., China, and various European nations have seen significant growth in EV sales over the past few decades, which is expected to continue contributing to market growth [36]. Chinese manufacturers, including CATL and BYD, have expanded their global market shares, thanks to the government's extensive investments and supportive regulations [14].

Government policies and regulatory measures are pivotal in accelerating EV adoption. Effective policy frameworks need to address both economic and infrastructural barriers to enhance market penetration. Financial incentives and infrastructure development are critical components of these policy measures [37]. Globally, subsidies and financial incentives have played a crucial role in promoting EV adoption. In countries like China and several European nations, substantial financial subsidies have been implemented to lower the purchase price of EVs, making them more competitive with traditional internal combustion engine vehicles. Such incentives have led to a marked increase in EV adoption rates [38]. However, the gradual reduction in these subsidies in recent years presents a challenge to maintaining this growth trajectory [28].

In addition to financial incentives, non-financial measures such as road privileges, free parking, and access to high-occupancy vehicle lanes have proven effective in encouraging EV adoption. These policies address convenience factors, enhancing the attractiveness of EVs compared to conventional vehicles [39]. In China, for example, policies that eliminate purchase and driving restrictions have significantly bolstered EV market penetration [38].

A successful policy framework typically combines financial and non-financial incentives. Norway's comprehensive policy approach, which includes high purchase taxes on fossil fuel vehicles and exemptions for EVs, has resulted in one of the highest EV adoption rates globally [40]. Such frameworks must be adaptable to evolving market conditions and technological advancements to remain effective. Regions like Europe and North America have seen the strongest EV uptake, driven by robust policy support and consumer incentives. Research indicates that higher installations of EV infrastructure occur in countries where there are strong policy and financial incentives. For instance, in Norway, substantial subsidies and tax incentives have significantly closed the price gap between EVs and conventional cars, leading to high adoption rates [41,42].

Figure 6 illustrates the top 20 countries for EV sales as a percentage of overall car sales in 2021, and Figure 7 shows the increase in consumer and government spending on electric cars between 2015 and 2020. During this period, both consumer and government spending on electric cars saw significant increases, driven by growing environmental awareness and the introduction of various incentives and subsidies for EV purchases. As a result, the market for electric cars expanded rapidly, with more models becoming available and technological advancements making them more appealing to consumers. The most common mechanisms for administering these incentives include rebates, with New Zealand being one of the latest countries to offer cash rebates for switching to EVs [42].

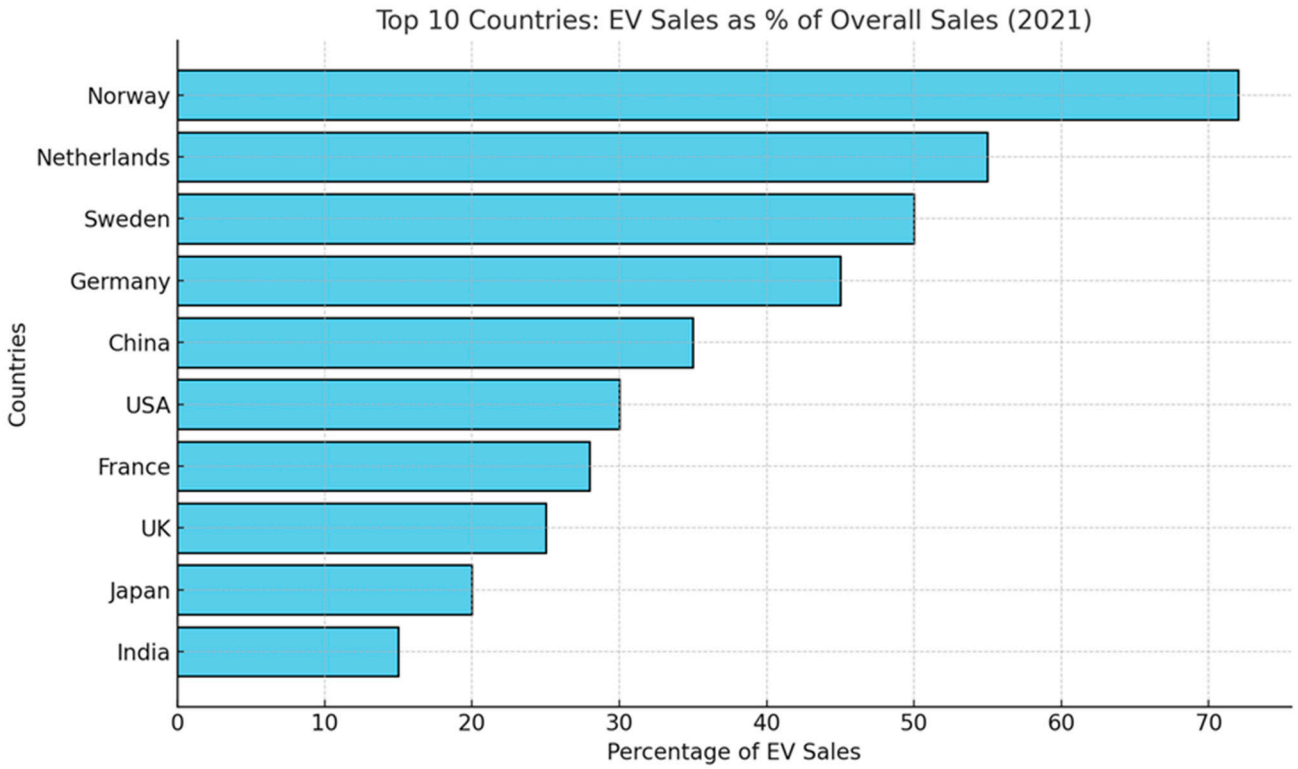

Figure 6. (Top 10 countries for EV sales): Top 10 countries for EV sales as a percentage of overall sales in 2021, data source from Ref. [13].

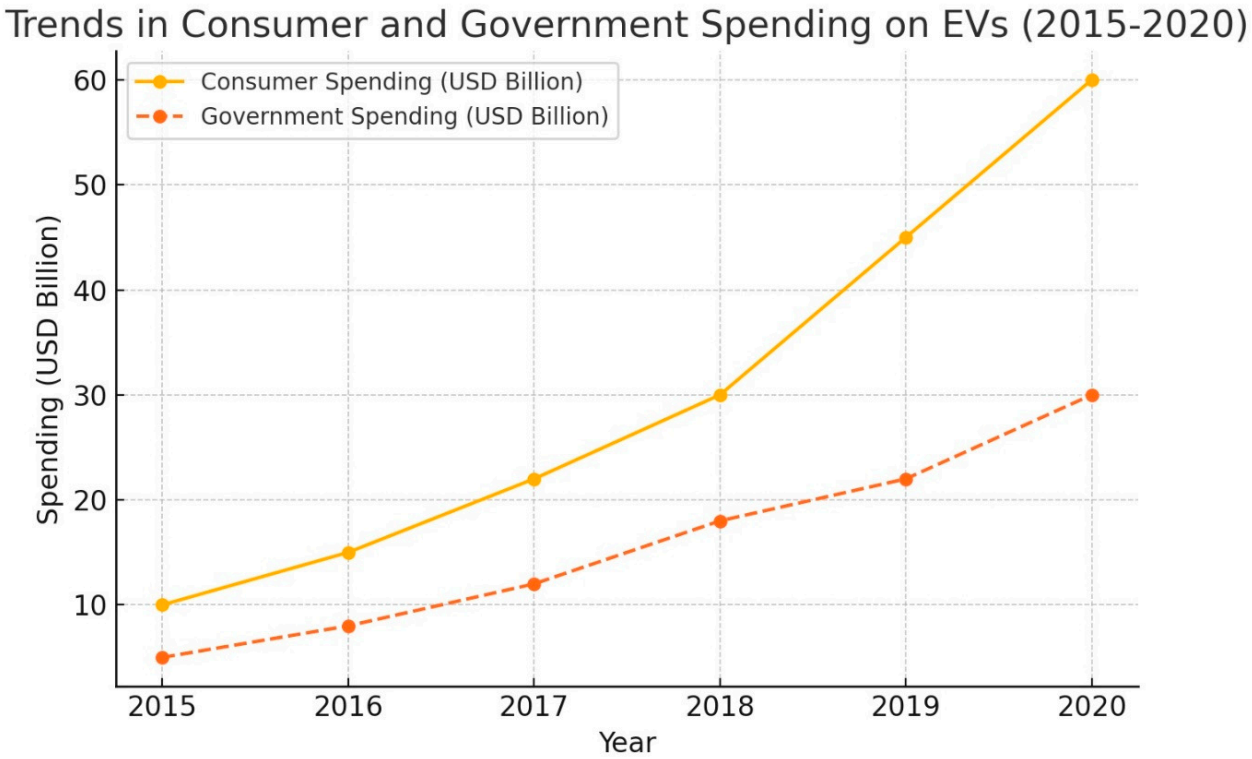

Figure 7. (Consumer and government spending): Trends in consumer and government spending on EVs (2015–2020), data source from Ref. [42].

2.7. Factors Influencing EV Adoption in Jordan

Based on the literature reviewed above, this study developed a conceptual framework for understanding the adoption of EVs in Jordan that integrates various dimensions that

influence this transition. The framework is structured around six key factors: market potential, economic benefits and costs, infrastructure development, technological advancements, consumer perceptions, and policy and regulatory measures. Each factor is interconnected, creating a comprehensive understanding of the elements driving and hindering EV adoption as shown in Figure 8.

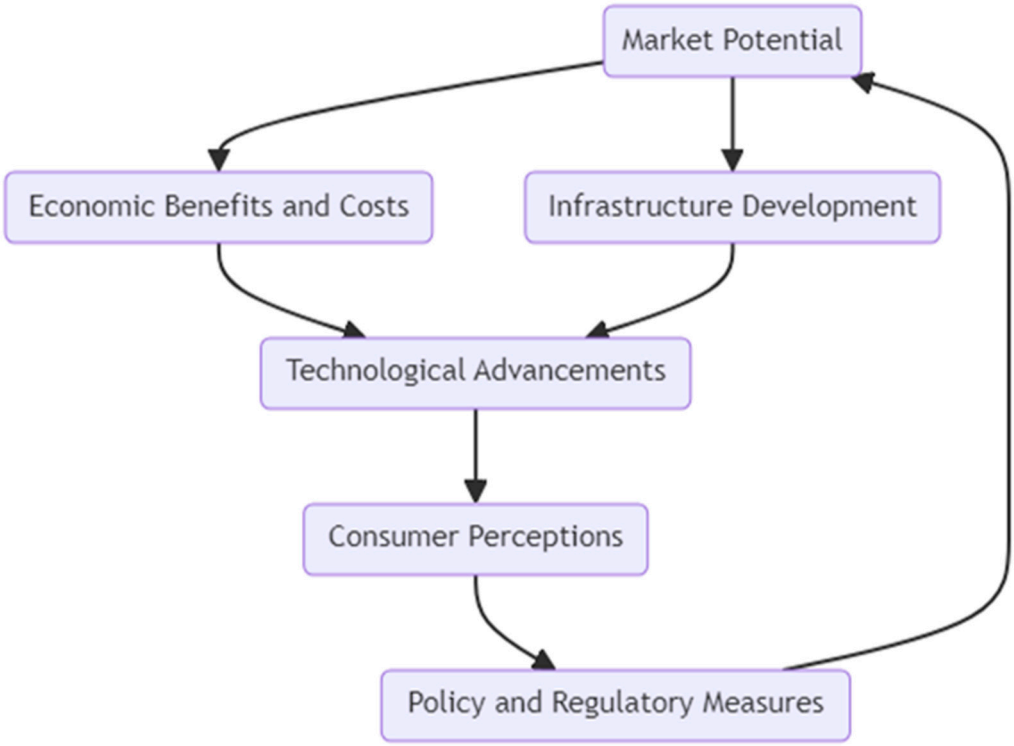

Figure 8. Factors influencing EV adoption in Jordan.

Market potential assesses the likelihood of EVs penetrating the market based on current trends, consumer interest, and economic viability [43]. The growing interest in sustainable transportation solutions and governmental support significantly boost the market potential in Jordan [44]. The economic dimension evaluates the financial implications for both consumers and the economy. This includes the initial costs of purchasing EVs, the long-term savings on fuel and maintenance, and the economic incentives provided by the government to encourage EV adoption. Infrastructure is another critical factor that includes the availability and accessibility of charging stations, the capacity of the electrical grid to support increased EV usage, and the development of maintenance and support services. Advancements in battery technology, vehicle performance, and charging solutions play a crucial role in making EVs more attractive to consumers.

Improved battery life, reduced charging times, and enhanced vehicle features can significantly influence adoption rates. Consumer perceptions, including attitudes towards EVs, environmental consciousness, perceived reliability, and the overall appeal of EVs compared to traditional vehicles, are also important. Public awareness campaigns and education initiatives can help improve consumer perceptions. Finally, government policies and regulatory measures provide the framework for promoting EV adoption. This includes financial incentives, tax breaks, and regulations that support infrastructure development and ensure the standardization of EV technologies.

By addressing these six factors comprehensively, Jordan can create a conducive environment for EV adoption, thus contributing to sustainable development and reducing GHGs. Promoting EV adoption requires a multifaceted approach, combining financial

incentives, policy frameworks, and technological advancements. Addressing economic and technological barriers is essential for accelerating the transition to electric mobility. For Jordan, enhancing infrastructure, increasing public awareness, and maintaining supportive government policies will be crucial to fostering sustainable development in the transportation sector.

EV adoption is crucial for advancing sustainable development in Jordan, addressing both environmental and economic challenges. The transportation sector, a major contributor to carbon emissions and energy consumption, stands to benefit significantly from the shift to EVs. These vehicles offer a substantial reduction in GHGs and reduce reliance on fossil fuels, making them a viable alternative to traditional internal combustion engine vehicles. Gahlaut et al. [1] have highlighted the significant environmental benefits of decarbonizing the transportation sector through the adoption of EVs.

The transportation sector is vital to Jordan's socio-economic development, though it is also one of the most costly for local companies, due to high fuel prices and limited natural resources. Despite these challenges, the sector remains essential to national growth and energy security [45]. The EV market in Jordan has gained momentum thanks to government incentives such as tax breaks and reduced registration fees. However, challenges such as a lack of infrastructure, high initial costs, and limited public awareness persist [46].

Adopting EVs is essential for achieving sustainable transportation in Jordan. A tailored theoretical framework provides an overview of the factors driving EV adoption in the country, offering a qualitative assessment of the market potential, economic impacts, infrastructure needs, technological advancements, consumer perceptions, and policy measures.

Jordan has witnessed a significant increase in EV adoption, spurred by government initiatives like tax exemptions and lower registration fees. However, for the market to continue developing, infrastructure and consumer awareness issues must be addressed [2]. Economic factors, such as the higher fuel efficiency and lower operating costs of EVs compared to internal combustion vehicles, play a significant role in the growing adoption rates in Jordan, further driving the regional market potential for EVs [47,48], and helping Jordan achieve energy sustainability [49].

Promoting the uptake of EVs in Jordan could substantially reduce the country's carbon footprint, enhance energy security, and support economic development, aligning with global sustainability goals [50]. The Jordanian government has implemented policies to support EV adoption, including financial incentives and regulatory measures aimed at standardizing charging infrastructure. Nonetheless, challenges such as public awareness and the availability of charging stations, especially in rural areas, remain significant hurdles [23].

Addressing these challenges involves examining the market opportunities for EVs in Jordan, analyzing their economic impacts on a large scale, and identifying the infrastructure requirements necessary for widespread adoption. Technological advancements, such as improved range and faster charging times, are also critical to increasing EV adoption. As these innovations become more widely adopted, they will help overcome existing barriers, ensuring that Jordan's transportation sector can meet long-term sustainability goals. Effective policy measures and strategic planning will be essential in overcoming these challenges and promoting the integration of EVs into Jordan's transportation landscape.

The primary challenges to EV adoption in Jordan include high initial installation and investment costs, limited charging infrastructure, and concerns related to battery life and maintenance. Additionally, improving public awareness of the benefits and functionality of EVs is essential to driving higher adoption rates [50].

3. Materials and Methods

3.1. Qualitative Approach Using Semi-Structured Interviews

This study employs a qualitative approach, using semi-structured interviews to explore the perspectives and experiences of various stakeholders involved in or impacted by the adoption of EVs in Jordan. This approach allows for an in-depth understanding and flexibility in probing specific areas of interest [3].

3.2. Selection Criteria for Interview Participants

To ensure a comprehensive understanding of the factors influencing EV adoption in Jordan, interviews were conducted with a diverse range of stakeholders comprising 31 interviewees. The selection criteria for participants are explained in Table 2.

Table 2. Selection criteria for interview participants.

Role	Type of Organization	No. Interviewees	Rationale for Selection
Government officials	Government	5	Policymakers and regulators responsible for transportation, energy, and environmental policies.
Industry experts	Automotive industry	7	Professionals with expertise in manufacturing, distribution, and market dynamics of EVs.
Infrastructure providers	Charging station companies	4	Companies involved in the development and maintenance of EV charging infrastructure.
Consumers	General public (EV users)	8	Current and potential EV users representing diverse demographic backgrounds.
Environmental groups	Environmental NGOs and advocacy	3	Representatives focused on promoting sustainable practices and environmental benefits of EVs.
Academics and researchers	Universities and research centers	4	Experts in sustainable transportation, energy systems, and technological advancements in EVs.

To strengthen the credibility of using expert input from 31 participants in this study, the approach is supported by similar methodologies employed in the recent literature. Expert interviews are widely recognized as a robust method for gathering nuanced insights, particularly in fields requiring specialized knowledge, such as sustainable transportation and EV adoption. Recent studies have validated the use of expert opinions in exploring complex socio-technical transitions and assessing barriers in emerging markets [51], as applied in European rail-road transport in Europe [52] and tourism behavior modeling [53]. This approach aligns with established qualitative research practices and ensures a comprehensive understanding of the multifaceted factors influencing EV adoption.

3.3. Data Collection and Analysis Methods

The primary method of data collection was semi-structured interviews with the selected participants. This method allows for flexibility in questioning, enabling the interviewer to probe deeper based on the responses provided [3]. The interview guide included open-ended questions tailored to each stakeholder group to elicit detailed responses on their perspectives and experiences regarding EV adoption. Table 3 outlines the key topics

and themes discussed during the semi-structured interviews, along with the main and follow-up questions used to gather comprehensive insights from the interviewees.

Table 3. Interview questions.

Topic/Theme	Discussed Questions	Follow-Up Questions
Government policies and incentives	What policies and incentives are currently in place to support the adoption of EVs in Jordan?	How effective do you think these policies and incentives have been in promoting EV adoption? Are there any new policies or incentives being considered to further support EV adoption?
Challenges in EV integration	What challenges does the government face in promoting EV integration?	How can these challenges be addressed effectively? What role can the private sector play in overcoming these challenges?
Infrastructure development	How is the government planning to enhance the necessary infrastructure for EVs?	What specific infrastructure developments are prioritized for the near future? How will these infrastructure enhancements be funded and managed?
Market demand	What is the current market demand for EVs in Jordan?	How has the market demand for EVs changed over the past few years? What factors do you believe are driving this demand?
Barriers to entry	What are the main barriers to entry for EV manufacturers in the Jordanian market?	How can these barriers be mitigated or overcome? Are there any specific regulatory or economic changes needed to reduce these barriers?
Competitive landscape	How do you see the competitive landscape for EVs evolving in the next five years?	What new brands or technologies do you expect to enter the market? How might this increased competition affect prices and consumer choices?
Infrastructure requirements	What are the key infrastructure requirements for supporting a large number of EVs in Jordan?	How do current infrastructure capacities compare to these requirements? What innovations or developments are needed to meet these requirements?
Challenges in charging infrastructure	What challenges do you face in developing and maintaining EV charging stations?	How can these challenges be addressed? What role can government incentives play in supporting charging infrastructure development?
Government-private sector collaboration	How can the government and private sector collaborate to improve the EV infrastructure?	Are there any successful models of such collaborations from other countries that Jordan can adopt? What specific areas should be prioritized in these collaborations?
Consumer considerations	What are your main considerations when deciding whether to purchase EV?	How do these considerations vary among different demographic groups? What information or incentives would help address these considerations?
Concerns about EV adoption	What concerns do you have about the adoption of EVs?	How significant are these concerns in your decision-making process? What measures could alleviate these concerns?

Table 3. *Cont.*

Topic/Theme	Discussed Questions	Follow-Up Questions
Perceived cost and benefits	How do you perceive the cost and benefits of owning an EV compared to a traditional vehicle?	Are there any financial incentives or savings that influence this perception? How do maintenance and operational costs compare between EVs and traditional vehicles?
Environmental impact	How do you assess the environmental impact of transitioning to EVs in Jordan?	What specific environmental benefits do you expect from increased EV adoption? Are there any potential negative environmental impacts associated with EVs?
Public awareness role	What role do you think public awareness plays in the adoption of EVs?	What strategies have been effective in raising public awareness about EVs? How can public awareness campaigns be improved or expanded?
Support from environmental groups	How can environmental groups support the integration of EVs?	What specific actions or campaigns have been successful in promoting EV adoption? How can environmental groups collaborate with other stakeholders to support EV adoption?
Technological advancements	What are the latest technological advancements in EVs that are relevant to the Jordanian market?	How do these advancements address current challenges in the EV market? What future technological trends do you anticipate will impact the EV market?
Academic support for policy development	How can academic research support the development of policies for EV integration?	Are there specific areas of research that should be prioritized to support policy development? How can academic findings be effectively communicated to policymakers and industry stakeholders?
Long-term implications	What are the long-term implications of widespread EV adoption for Jordan's economy and environment?	How can the economic benefits of EV adoption be maximized for Jordan? What strategies should be implemented to mitigate any potential negative impacts?

Interview transcripts were analyzed using thematic analysis to identify common themes and patterns. The analysis followed a manual, step-by-step approach to ensure rigor and reliability, including data familiarization, coding, theme development, validation, and interpretation. These steps are detailed below:

Data Familiarization: All interview transcripts were carefully reviewed multiple times to ensure a thorough understanding of the content. The key points and initial impressions were noted during this process.

Coding: Recurrent ideas and phrases were manually highlighted and assigned initial codes. This iterative process involved reviewing the transcripts line-by-line to capture key themes accurately.

Theme Development: The initial codes were grouped into broader themes that reflected the main issues discussed in the interviews. The themes were refined and reorganized to ensure they adequately represented the data.

Theme Validation: The developed themes were reviewed by the research team to ensure consistency and reliability. Discrepancies were discussed, and themes were adjusted as necessary to maintain coherence and alignment with the data.

Interpretation: The finalized themes were interpreted in the context of the research questions, drawing connections between stakeholder perspectives and the study objectives.

This systematic approach ensured a rigorous and reliable analysis of qualitative data while maintaining transparency and accuracy in the absence of analytical software. By following these steps, the themes generated were grounded in the data and aligned with the study objectives, providing robust insights into EV adoption in Jordan.

4. Results

4.1. Government Officials

The Jordanian government has implemented several policies and incentives to promote the adoption of EVs. These include tax exemptions and reductions in EV imports, significantly lowering customs duties and sales tax. Additionally, the government has reduced registration and licensing fees for EVs, further encouraging their adoption.

Despite these incentives, several challenges hinder the widespread integration of EVs in Jordan. The most significant barrier is the limited charging infrastructure, especially in rural areas. Moreover, there is a low level of public awareness regarding the benefits and functionality of EVs. Technological concerns, such as battery life, range, and maintenance issues, also pose challenges to EV adoption. This was supported by one of the government officials, who clarified with the following:

> "Tax exemptions and reduced registration fees are pivotal in promoting EV adoption in Jordan. However, limited charging infrastructure remains a significant hurdle".

To address these challenges, the government is developing legislation to govern investment in charging stations, strengthen the regulatory system, and establish new regulations for importing EVs that adhere to European and American standards for AC and DC charging ports. These steps aim to standardize and improve the EV infrastructure in Jordan. A government official declared the following:

> "We are developing legislation to enhance investment in charging stations and standardize regulations for EV imports".

4.2. Industry Experts

The market demand for EVs in Jordan has seen significant growth. Since 2010, nearly 120,000 EVs have been introduced on the roads, with a sharp increase in recent years from 50,000 before 2020 to at least 100,000 today. With a total of around 2 million cars in Jordan, EVs now constitute 5–7% of the total number of vehicles [53]. However, the market faces several barriers to entry. Jordan's auto market is relatively small compared to other regions, resulting in lower potential sales volume [54]. Additionally, consumer price sensitivity is a significant issue, as EVs are generally more expensive than traditional gasoline vehicles, which limits initial consumer adoption. An industry expert stated the following:

> "The market demand for EVs has grown significantly in Jordan, but the high initial costs and small market size pose barriers to further adoption".

Looking ahead, the competitive landscape for EVs in Jordan is expected to evolve with the arrival of new brands, models, and battery technologies. This increased competition is anticipated to lead to more affordable options in the next coming years. One of the industry experts foresaw the following:

> "We expect increased competition and more affordable EV options in the next five years".

4.3. Infrastructure Providers

The development of EV infrastructure in Jordan requires several key elements, including increasing the number of publicly accessible charging stations in urban areas, highways, and remote locations, and encouraging the installation of home charging units for EV owners. Fast and ultra-fast charging stations are also needed to reduce charging times and improve convenience. Additionally, standardized charging connectors and protocols are essential to ensure compatibility across different EV brands and models. Enhancing the capacity and resilience of the national grid and implementing smart grid technologies to manage demand, reduce peak loads, and optimize energy distribution are also critical. Lastly, increasing the share of renewable energy sources in the energy mix to power EVs sustainably is necessary. One of the infrastructure providers stated the following:

> "Developing a robust charging infrastructure is critical. We need more public charging stations and home charging units to support the growing EV fleet".

Despite these requirements, infrastructure providers face several challenges. High upfront costs for equipment, installation, land renting, and grid upgrades are significant barriers. Ensuring the electricity grid has sufficient capacity to handle the increased demand from EVs charging simultaneously is also challenging. The lack of universal standards for charging plugs and protocols, the need for regular maintenance and repairs, finding suitable locations for charging stations, and navigating the permitting process and complying with various regulations are additional challenges. An infrastructure provider said the following:

> "High upfront costs and grid capacity challenges are major obstacles we face".

Collaboration between the government and the private sector is essential to overcome these challenges. Financial incentives, such as government subsidies, tax breaks, and PPPs, can help fund and build charging infrastructure. Joint development of standards, streamlining permitting processes, and sharing anonymized data on EV usage patterns can further support long-term infrastructure planning.

4.4. Consumers

When deciding whether to purchase an EV, consumers consider factors such as car price, range, warranty, and the availability and price of spare parts. Consumers have several concerns about adopting EVs, including battery life, charging times, and the depreciation of the car's value. A consumer said the following:

> "Lower fuel and maintenance costs make EVs attractive, but concerns about battery life and charging times still exist".

Despite these concerns, consumers recognize the advantages of EVs, including lower fuel and maintenance costs compared with traditional gasoline cars. An EV owner stated the following:

> "Public awareness campaigns can help address misconceptions and promote EV adoption".

4.5. Environmental Groups

Environmental groups highlight the positive environmental impact of transitioning to EVs. EVs produce zero tailpipe emissions, leading to cleaner air in cities and reduced respiratory problems. Despite the emissions from electricity generation, EVs generally have lower lifecycle emissions compared to gasoline vehicles. Additionally, transitioning to EVs would reduce Jordan's reliance on imported oil, boosting energy security and potentially lowering costs in the long run. An environmental group manager explained as follows:

"EVs can significantly reduce air pollution and emissions, contributing to a cleaner environment".

Public awareness plays a critical role in EV adoption. Education about EV range, charging options, and real-world capabilities can alleviate popular anxieties and erroneous beliefs. Highlighting the environmental benefits and addressing misconceptions about high costs, long charging times, and limited availability can motivate people to choose EVs. Campaigns showcasing the reliability, safety, and positive user experience of EVs can build trust and shift social norms towards EVs as the preferred choice. A top manager in an environmental group asserted the following:

"Public awareness is crucial. Campaigns showcasing the benefits and addressing misconceptions can shift norms towards EVs".

Environmental groups can support EV integration by organizing educational campaigns, partnering with media outlets to spread positive messages, highlighting success stories, working with local communities to promote EV benefits, advocating for charging infrastructure projects, and supporting training programs for technicians and educators.

4.6. Academics and Researchers

Academics and researchers emphasize the importance of technological advancements, particularly in increasing battery power and energy capacity for longer-term distances. A professor in automotive engineering observed the following:

"Technological advancements in battery performance are essential for addressing range anxiety and improving EV appeal".

Practical research can provide evidence of EV performance success in various conditions, supporting policy development. Research maximizing the positive environmental impact of reducing CO_2 emissions is also crucial. A professor in electrical engineering argued the following:

"Research supporting policy development can maximize the environmental benefits of EV adoption".

4.7. Key Insights

The widespread adoption of EVs in Jordan has several long-term implications. It can lower fossil fuel consumption in the transportation sector, reduce operational and maintenance costs, and mitigate harmful environmental impacts and CO_2 emissions. Effective management of EV batteries at the end of their lifecycle can minimize environmental impacts, contributing to global temperature rise mitigation. Jordan's experiences as it moves towards widespread EV adoption involve comprehensive strategies across various sectors. Government incentives, infrastructure development, public awareness, and technological advancements all play crucial roles. Addressing the identified challenges and leveraging opportunities will position Jordan as a leader in EV adoption within the region. The main findings, challenges, and future prospects/plans for each stakeholder group involved in the adoption of EVs in Jordan are presented in Table 4.

Table 4. The main findings, challenges, and future prospects/plans for each stakeholder group.

Stakeholder Group	Key Findings	Challenges	Future Prospects/Plans
Government officials	Policies and incentives: tax exemptions, reductions, and lower registration fees	Challenges: limited charging infrastructure, low public awareness, technological concerns	Plans for enhancement: legislation updates, standardized regulations for charging ports

Table 4. *Cont.*

Stakeholder Group	Key Findings	Challenges	Future Prospects/Plans
Industry experts	Market demand: significant growth in EV adoption	Barriers to entry: small market size, high consumer price sensitivity	Competitive landscape: increased competition, more affordable options in the next five years
Infrastructure providers	Infrastructure requirements: public charging stations, home charging solutions, fast charging networks, standardization, grid upgrades, smart grid technologies, renewable energy integration	Challenges: high costs, grid capacity, lack of standards, maintenance needs, finding locations, regulatory compliance	Government–private sector collaboration: financial incentives, standardization, data sharing
Consumers	Considerations for purchase: price, range, warranty, spare parts availability	Concerns: battery life, charging times, car depreciation	Perceived benefits: lower fuel and maintenance costs
Environmental groups	Environmental impact: reduced air pollution, lower GHGs, reduced dependence on fossil fuels	Public awareness role: overcoming range anxiety, highlighting benefits, addressing misconceptions, building trust, shifting norms	Support strategies: educational campaigns, media partnerships, success stories, community partnerships, charging infrastructure projects, training programs
Academics and researchers	Technological advancements: improved battery power and energy capacity	Support for policy development: practical research, maximizing environmental impact	Long-term implications: reduced fossil fuel consumption, operational cost reduction, environmental benefits, climate change mitigation, battery lifecycle management

5. Discussion

This study aimed to explore the adoption of EVs in Jordan, focusing on the business and economic implications within the transportation sector. The research was conducted through semi-structured interviews with various stakeholders, including government officials, industry experts, infrastructure providers, consumers, environmental groups, and academics. This section discusses the findings in relation to the study's objectives, compares them with the existing literature, and highlights the implications for policy and practice.

5.1. Government Policies and Incentives

The adoption of EVs in Jordan has been significantly influenced by government policies and incentives, such as tax exemptions and reduced registration fees, which have made EVs more accessible and attractive to consumers, aligning with global trends that emphasize the importance of financial incentives in accelerating EV adoption. Studies confirm that such incentives are pivotal in reducing the financial burden of EV ownership [38,40]. However, despite these encouraging developments, several challenges persist, including limited charging infrastructure and low public awareness. These barriers mirror those identified in other regions [16,21]. To enhance the effectiveness of its policies, the Jordanian government must address these challenges through strategic investments in public education campaigns and infrastructure development, as recommended by previous researchers [20,39].

One of the most effective strategies for promoting EV adoption is enhancing financial incentives. While Jordan has already implemented tax exemptions and reduced registration fees, extending these incentives further could address the high upfront costs associated with EVs. Additional measures, such as providing direct subsidies for EV purchases and offering reduced interest rates on EV loans, could make EV ownership more feasible for middle- and low-income households. Similar initiatives in Norway, where EVs are exempt from purchase tax and VAT, have resulted in some of the highest EV adoption rates globally [40]. Jordan can replicate these successes by tailoring its policies to the local context, ensuring that financial incentives are accessible to a broader segment of the population.

Beyond financial incentives, the government can introduce non-financial benefits to encourage EV adoption further. Policies such as offering free parking for EVs, granting access to bus lanes, and waiving road tolls have proven successful in countries like Germany and the United States [39]. Implementing these measures in Jordan would not only incentivize EV ownership but also address practical concerns related to convenience and operational costs. For example, granting EVs access to bus lanes could reduce travel times in congested urban areas, enhancing the appeal of switching to electric transportation. Similarly, creating "green zones" in major cities, where only EVs are permitted to operate, could improve air quality while promoting sustainable mobility.

Addressing the challenges of limited charging infrastructure and low public awareness is equally crucial for the widespread adoption of EVs in Jordan. The development of a comprehensive charging station network is an urgent priority. This network should include fast-charging options at key transit points and popular destinations, ensuring that EV owners can travel across the country without concerns about range anxiety. PPPs can play a vital role in financing and deploying this infrastructure. In addition, the government should launch targeted public education campaigns to raise awareness about the economic and environmental benefits of EVs. These campaigns can showcase successful global case studies, emphasizing the cost savings and environmental impact of transitioning to EVs. Partnering with automakers and non-governmental organizations to host exhibitions and offer test drives could further demystify EV technology and encourage adoption.

In comparison to global leaders in EV adoption, Jordan's journey reflects both opportunities and challenges. Countries like Norway and China provide valuable lessons in policy innovation and infrastructure investment. While Norway's focus on financial incentives has led to impressive adoption rates, China's emphasis on infrastructure development has made EVs a practical choice for millions. Jordan must adopt a hybrid approach, combining financial incentives, infrastructure enhancements, and public education to overcome its unique barriers and accelerate EV adoption.

Government policies and incentives have been instrumental in promoting EV adoption in Jordan. However, addressing the challenges of limited infrastructure and public awareness is essential for sustaining this momentum. By enhancing financial and non-financial incentives, investing in charging networks, and educating the public, Jordan can position itself as a regional leader in sustainable transportation. Such measures can support the country's environmental goals, and align with global sustainability trends, contributing to a cleaner and more resilient future.

5.2. Market Demand and Economic Impact

The market demand for EVs in Jordan has shown significant growth, supported by government incentives and increasing consumer interest. This growth is consistent with global patterns where financial and policy support has led to higher EV adoption rates [10,41]. The economic benefits of EVs, such as lower fuel and maintenance costs, were also highlighted by the respondents, echoing findings from studies in other regions [55,56].

Despite these advantages, the high initial cost of EVs remains a significant barrier. This aligns with the literature, which points to the need for substantial subsidies and financing options to overcome cost barriers [28,57].

5.3. Infrastructure Development

The development of an accessible charging infrastructure is critical to achieving widespread adoption of EVs in Jordan. One of the major challenges identified in the study is the lack of public charging stations, particularly in rural areas, compounded by the high costs associated with infrastructure development. This finding aligns with global research that highlights the central role of accessible and affordable charging networks in driving EV adoption [15,23]. Addressing these challenges requires a collaborative approach, leveraging PPPs to pool resources and share costs, as evidenced by successful international models [24].

Expanding the EV charging network is essential to reducing range anxiety and encouraging more consumers to transition to EVs. This expansion should prioritize urban centers, highways, and rural regions, ensuring comprehensive coverage that caters to the diverse mobility needs of the population. A strategic focus on renewable energy sources, such as solar and wind, for powering charging stations would further enhance the sustainability of this infrastructure. By integrating renewable energy into the charging network, Jordan can align its efforts with global environmental goals while reducing dependence on fossil fuels.

Globally, countries with extensive charging infrastructure have seen significant success in EV adoption. South Korea, for example, has established the highest number of public charging stations relative to the number of EVs, effectively mitigating range anxiety among drivers [25]. This achievement underscores the importance of accessible charging facilities in fostering consumer confidence and promoting EV usage. Jordan can draw lessons from such examples, adapting best practices to fit its unique geographic and economic context.

To address the financial barriers associated with infrastructure development, the Jordanian government should actively foster PPPs. These partnerships can distribute the costs of infrastructure deployment between the government and private sector stakeholders, reducing the financial burden on any single entity. Additionally, PPPs encourage innovation and efficiency by involving private companies with expertise in energy, technology, and logistics. For example, governments in Europe and North America have successfully collaborated with private companies to establish charging networks, benefiting from shared investment and expertise.

Moreover, offering incentives to private investors can further accelerate infrastructure development. These incentives could include tax breaks, subsidies, and streamlined regulatory processes for businesses that invest in EV charging facilities. Local businesses, especially those in hospitality and retail sectors, can also play a role by hosting charging stations, creating a mutually beneficial arrangement that attracts customers while supporting EV infrastructure expansion.

The development of an EV charging network is pivotal for overcoming one of the most significant barriers to EV adoption in Jordan. By targeting key areas for infrastructure expansion, integrating renewable energy sources, and fostering PPPs, Jordan can address the challenges of limited charging access and high development costs. Learning from global examples such as South Korea and leveraging local resources will enable Jordan to create a sustainable and accessible charging network, paving the way for a greener transportation future.

5.4. Technological Advancements and Consumer Perceptions

Technological advancements in battery performance and charging solutions are pivotal in addressing key consumer concerns, such as range anxiety and charging times, which significantly influence the adoption of EVs. The findings of this study align with existing literature, underscoring the importance of continuous improvements in battery technology to make EVs more appealing [11,26]. In addition, consumer perceptions of EVs, shaped by factors such as environmental awareness and perceived reliability, play a critical role in determining adoption rates [29,33]. To address these concerns, Jordan must focus on both advancing battery technology and improving public awareness and education regarding EV benefits.

One of the primary recommendations to enhance EV adoption in Jordan is investing in research and development (R&D) for battery technologies. Improving battery range and charging speeds will directly address consumer concerns, making EVs more competitive with traditional vehicles. Furthermore, regulations for battery recycling and lifecycle management should be established to minimize environmental impacts, ensuring that the growth of EV adoption does not lead to unforeseen ecological challenges. The integration of sustainable practices in battery production and recycling can position Jordan as a regional leader in green technology.

China offers a compelling example of how investment in battery innovation can drive both technological advancement and EV adoption. Significant government funding for R&D has enabled China to become a global leader in battery technology, fostering innovations that have reduced costs and improved performance [28]. Jordan can learn from China's approach by allocating resources to support local startups, universities, and research institutions working on advanced battery technologies and lifecycle management solutions. Offering grants and financial incentives to these entities can spur innovation and build a local ecosystem for EV-related technological advancements.

In addition to technological investments, public awareness campaigns and education initiatives are critical for improving consumer perceptions of EVs. Many consumers remain unaware of the long-term cost savings, environmental benefits, and advancements in EV reliability and performance. Educational programs should focus on dispelling misconceptions and emphasizing the advantages of EV ownership. Partnerships with automakers, environmental organizations, and media outlets can amplify the reach and impact of these campaigns. Test drive events, informational workshops, and online resources can further engage potential buyers and address their concerns.

Moreover, integrating EV education into school and university curricula can create a new generation of environmentally conscious consumers who are more likely to embrace EVs. Promoting environmental responsibility and showcasing the role of EVs in reducing carbon emissions can align consumer values with sustainable transportation choices. These efforts can be supported by government-led initiatives, such as subsidized EV advertisements and endorsements by influential figures.

Addressing technological and perceptual barriers is essential for accelerating EV adoption in Jordan. By investing in R&D for battery technology, creating regulations for sustainable battery practices, and implementing comprehensive public awareness campaigns, Jordan can enhance consumer confidence and drive EV adoption. Learning from global leaders like China while tailoring strategies to the local context will enable Jordan to build a sustainable and technologically advanced EV market. These measures can boost the appeal of EVs and contribute to the nation's environmental and economic sustainability goals.

5.5. Environmental Impacts

EVs offer significant environmental benefits, including reduced GHG emissions and improved air quality, making them a vital component of sustainable transportation strategies. This study reinforces findings from the existing literature, which demonstrate that EVs emit substantially less carbon compared to traditional vehicles powered by internal combustion engines [25,55]. Beyond reducing emissions, EVs contribute to energy security by decreasing reliance on imported fossil fuels—a critical consideration for Jordan, which heavily depends on energy imports.

One of the most immediate environmental benefits of EV adoption is the improvement in localized air quality. Major cities in Jordan, such as Amman, face high population densities and significant pollution from traditional vehicles. Transitioning to EVs can reduce particulate matter and nitrogen oxide emissions, leading to cleaner air and better public health outcomes. This shift aligns with global trends that emphasize the dual advantages of reducing carbon emissions and enhancing urban livability [55].

In addition to addressing localized pollution, EVs can play a pivotal role in mitigating Jordan's carbon footprint. Transportation accounts for a significant share of global GHG emissions, and widespread EV adoption offers a pathway to achieve national climate goals. Moreover, reducing dependency on imported fossil fuels enhances Jordan's energy security, providing economic and strategic advantages. By transitioning to domestically sourced or renewable electricity for EV charging, Jordan can further reduce its vulnerability to global energy price fluctuations.

Despite these benefits, the environmental impact of EV batteries presents a critical challenge. The production and disposal of EV batteries involve significant resource use and emissions. If not managed properly, these processes could offset some of the environmental gains associated with EVs. Policies promoting battery recycling and reuse are essential to address these concerns. Recycling programs can recover valuable materials such as lithium, cobalt, and nickel, reducing the need for new resource extraction and minimizing waste. Establishing a regulatory framework for battery lifecycle management will enhance the overall sustainability of EV adoption in Jordan.

Countries leading in EV adoption provide valuable lessons on managing these challenges. For instance, the European Union has implemented stringent regulations requiring manufacturers to ensure the recyclability of EV batteries. Similar policies in Jordan could incentivize the development of a circular economy for EV batteries, fostering innovation and reducing environmental impacts.

In addition to recycling policies, PPPs can play a crucial role in developing battery reuse and recycling infrastructure. Collaborations between the government, private sector, and research institutions can accelerate the implementation of sustainable battery management solutions. Encouraging local startups and universities to focus on battery recycling technologies could also create new economic opportunities while addressing environmental concerns.

In conclusion, EV adoption in Jordan offers dual opportunities: reducing emissions and enhancing energy security. By improving air quality and decreasing reliance on imported fuels, EVs align with Jordan's environmental and economic priorities. However, to fully realize these benefits, it is essential to address the environmental challenges associated with battery production and disposal. Implementing policies focused on lifecycle emissions, battery recycling, and reuse will optimize the sustainability of EVs and ensure their long-term viability. With the right strategies in place, Jordan can position itself as a regional leader in sustainable transportation while achieving its environmental and energy security goals.

5.6. Collaboration and Long-Term Implications

The successful adoption of EVs in Jordan depends heavily on the collaboration of multiple stakeholders, including government agencies, industry leaders, infrastructure providers, and environmental organizations. This study emphasizes the importance of such partnerships in addressing the complex challenges of EV adoption and formulating integrated strategies that combine financial incentives, infrastructure development, and public education. These collaborative efforts are crucial for ensuring a smooth and sustainable transition to electric mobility, which promises significant economic and environmental benefits.

Collaboration is particularly important for overcoming the multifaceted barriers to EV adoption. Government agencies play a key role in designing and implementing policies that provide financial incentives, such as tax exemptions and subsidies, to make EVs more affordable for consumers. Industry experts and manufacturers contribute by improving vehicle affordability, expanding model availability, and advancing technologies, such as battery performance and charging solutions. Infrastructure providers are essential for building the charging networks that alleviate range anxiety, while environmental organizations help advocate for sustainable practices, such as battery recycling and public education campaigns. When these stakeholders work together, they can create a comprehensive ecosystem that supports EV adoption.

The long-term benefits of widespread EV adoption in Jordan are substantial [49], aligning with findings from global research [37,57]. One of the most significant economic benefits is the reduction in fossil fuel consumption. As a country heavily reliant on imported energy, Jordan can enhance its energy security and reduce its economic vulnerability by transitioning to domestically generated electricity to power EVs. Additionally, EVs offer lower operational and maintenance costs compared to traditional vehicles, providing long-term savings for consumers and businesses alike.

The environmental benefits are equally compelling. Widespread EV adoption would lead to significant reductions in greenhouse gas emissions and improvements in air quality, particularly in densely populated cities like Amman. Cleaner air has direct public health benefits, reducing respiratory and cardiovascular illnesses caused by vehicle emissions. This, in turn, can lower healthcare costs and improve the overall quality of life for citizens.

To achieve the many benefits of EVs, the study underscores the need for a collaborative approach in strategy development and implementation. PPPs offer a proven framework for pooling resources and expertise. For example, the government can partner with private companies to co-invest in charging infrastructure, while NGOs can play a role in raising public awareness and advocating for policy improvements. Collaborative initiatives that combine financial incentives, infrastructure development, and educational campaigns can address the diverse challenges of EV adoption holistically.

In conclusion, collaboration among key stakeholders is essential for the successful adoption of EVs in Jordan. By working together, government agencies, industry leaders, infrastructure providers, and environmental groups can create a sustainable and supportive ecosystem for electric mobility. The long-term economic and environmental benefits, including reduced fossil fuel consumption, lower operational costs, and improved public health, make EV adoption a vital component of Jordan's sustainable development strategy. By fostering collaboration and leveraging the strengths of diverse stakeholders, Jordan can position itself as a regional leader in the transition to cleaner and more efficient transportation systems.

5.7. Variations in Expert Perspectives

The perspectives gathered from different stakeholder groups highlight significant variations based on their roles and priorities in the adoption of EVs. Table 5 provides a

comparative summary of the key focus areas, challenges, and recommendations identified for each group, emphasizing the diversity of insights that inform a multi-stakeholder approach to EV adoption in Jordan.

As shown in Table 5, each stakeholder group has unique priorities and challenges, underscoring the importance of integrating these perspectives into a comprehensive, collaborative strategy for EV adoption. Addressing these variations cohesively is critical to overcoming barriers and fostering sustainable transportation solutions in Jordan.

Table 5. Variations in expert perspectives.

Stakeholder Group	Key Focus Areas	Challenges Identified	Future Recommendations
Government officials	- Policy frameworks (e.g., tax exemptions, fee reductions)	- Limited rural charging infrastructure - Low public awareness	- Strengthen rural infrastructure investment - Launch public awareness campaigns
Industry experts	- Economic viability - Competitive landscape	- High consumer price sensitivity - Small market size	- Encourage competition to lower costs - Support R&D for cost-effective EVs
Infrastructure providers	- Development of charging networks - Integration of renewable energy	- High upfront costs - Grid capacity limitations - Lack of standardized protocols	- Promote PPPs - Standardize charging ports and protocols
Environmental groups	- Environmental benefits (e.g., reduced GHG emissions, improved air quality) - Public education	- Misconceptions about EV cost and range - Limited awareness of environmental impact	- Organize educational campaigns - Advocate for renewable energy in charging infrastructure
Academics and researchers	- Technological advancements (e.g., batteries, charging efficiency) - Alignment with sustainability goals	- Gaps in battery performance - Lack of integration between research and policy	- Enhance funding for battery research - Develop frameworks for research–policy collaboration

5.8. Summary

This study explores the adoption of EVs in Jordan, focusing on the economic, environmental, and technological implications within the transportation sector. The findings, derived from semi-structured interviews with various stakeholders, align with global research and underscore the critical factors influencing EV adoption in Jordan.

Government policies and financial incentives, such as tax exemptions and reduced registration fees, have played a pivotal role in promoting EV adoption. However, challenges like limited charging infrastructure and low public awareness persist, requiring strategic investments in infrastructure development and public education campaigns. Extending financial incentives and introducing non-financial benefits, such as free parking and bus lane access, can further enhance adoption rates, following successful global examples like Norway and Germany.

Market demand for EVs in Jordan is growing, driven by government support and increasing consumer interest. Despite the economic benefits of EVs, such as lower fuel and maintenance costs, high initial purchase costs remain a barrier. Addressing these cost challenges through subsidies and financing options is essential to sustaining market growth.

Charging infrastructure development is critical for widespread EV adoption. The lack of public charging stations, particularly in rural areas, highlights the need for an accessible and comprehensive network powered by renewable energy. PPPs offer a viable solution to share costs and expertise, drawing lessons from successful models in countries like South Korea.

Technological advancements in battery performance and lifecycle management are vital for addressing consumer concerns such as range anxiety and environmental sustainability. Investing in R&D for battery innovation, coupled with public education campaigns, can improve consumer perceptions and drive adoption. Jordan can learn from global leaders like China by supporting local startups and research institutions working on advanced battery technologies and recycling solutions.

The environmental benefits of EV adoption, including reduced greenhouse gas emissions and improved air quality, are significant. Transitioning to EVs can also enhance energy security by reducing dependency on imported fossil fuels. However, addressing the environmental challenges of battery production and disposal is crucial. Policies promoting battery recycling and reuse will optimize sustainability and mitigate ecological impacts.

Collaboration among stakeholders, including government agencies, industry experts, infrastructure providers, and environmental organizations, is essential to address the multifaceted challenges of EV adoption. PPPs can facilitate resource sharing and innovation, while integrated strategies combining financial incentives, infrastructure development, and public education are crucial for success. The long-term implications of EV adoption include reduced fossil fuel consumption, lower operational costs, and improved public health, positioning Jordan as a regional leader in sustainable transportation.

By fostering collaboration and leveraging best practices from global leaders, Jordan can overcome its unique barriers to EV adoption, achieving both economic and environmental benefits. The findings provide actionable insights for policymakers, industry stakeholders, and researchers aiming to advance sustainable transportation in the region. Table 6 summarizes the key points arising from this discussion, situating our empirical findings concerning Jordan in relation to global exemplars.

Table 6. Summary of key findings.

Section	Key Findings	Challenges Identified	Recommendations	Global Comparisons
Government policies and incentives	Government incentives (e.g., tax exemptions, reduced fees) have boosted EV adoption.	Limited charging infrastructure and low public awareness.	Extend financial incentives, provide subsidies, reduce EV loan interest rates, and introduce non-financial incentives (e.g., free parking, bus lane access).	Norway: Tax and VAT exemptions led to high EV adoption rates. Germany: Free parking and bus lane access for EVs.
Market demand and economic impact	Increasing market demand driven by government incentives and consumer interest; EVs reduce fuel and maintenance costs.	High initial purchase costs remain a significant barrier to adoption.	Offer substantial subsidies and affordable financing options to make EV ownership feasible for low- and middle-income households.	Global patterns show financial support is key to overcoming cost barriers (e.g., China and India).

Table 6. *Cont.*

Section	Key Findings	Challenges Identified	Recommendations	Global Comparisons
Infrastructure development	Accessible charging infrastructure is critical for EV adoption; prioritizing urban, highway, and rural coverage enhances accessibility.	Lack of public charging stations, especially in rural areas; high costs of infrastructure development.	Expand charging network with a focus on renewable energy; foster PPPs to share costs and expertise.	South Korea: Extensive charging infrastructure mitigated range anxiety. Europe/USA: PPPs effectively expanded charging networks.
Technological advancements and consumer perceptions	Technological progress in battery range and charging solutions is vital for addressing range anxiety; consumer perceptions are improving.	Range anxiety, misconceptions about EV reliability, and environmental concerns over battery production and disposal.	Invest in R&D for advanced battery technologies; implement battery recycling regulations; conduct public awareness campaigns and education initiatives.	China: Significant R&D investments foster battery innovation. EU: Stringent battery recycling regulations ensure sustainability.
Environmental impacts	EVs reduce greenhouse gas emissions, improve air quality, and enhance energy security by reducing reliance on fossil fuels.	Environmental concerns related to battery production and disposal.	Promote battery recycling and reuse policies; establish a regulatory framework for battery lifecycle management; use renewable energy for charging infrastructure.	EU: Policies incentivize battery recyclability; global leaders demonstrate the environmental benefits of EV adoption.
Collaboration and long-term implications	Collaboration among stakeholders (government, industry, infrastructure providers, and environmental groups) is essential for EV adoption.	Fragmented efforts among stakeholders hinder the creation of a cohesive EV ecosystem.	Foster collaboration through integrated strategies; encourage PPPs for resource pooling and innovation; develop comprehensive financial, infrastructure, and educational plans.	PPPs have accelerated adoption in many global regions (e.g., Europe and the USA).

6. Conclusions

6.1. Main Outcomes

Continued and enhanced government incentives are crucial to overcoming the economic barriers to EV adoption. These incentives can take various forms, such as tax breaks, rebates, and subsidies, which can make the initial cost of EVs more manageable for consumers. In addition, policies should focus on improving public awareness and developing the necessary infrastructure to support EV usage. By educating the public about the benefits of EVs and ensuring that a reliable charging network is in place, governments can create a more conducive environment for the transition to electric mobility. The EV market in Jordan is currently growing, yet further incentives and financing options are needed to make EVs more affordable for a broader segment of the population. Additional measures such as low-interest loans and leasing programs can lower the financial barriers associated with EV ownership. Furthermore, increasing competition within the market is likely to

drive down prices and expand consumer choices. As more manufacturers and models become available, consumers will benefit from greater variety and better pricing, making EVs a more attractive option.

Investment in charging infrastructure is vital for the widespread adoption of EVs. A comprehensive network of charging stations, especially in underserved areas, is essential to alleviate range anxiety and ensure the convenience of recharging. PPPs can play a significant role in addressing the high costs and standardization challenges associated with building this infrastructure. By collaborating, government entities and private companies can develop a more extensive and efficient charging network that meets the needs of all EV users.

Technological advancements in batteries and charging solutions are key to alleviating consumer concerns about EVs. Improvements in battery technology can lead to longer driving ranges and faster charging times, making EVs more practical for everyday use. Additionally, effective public awareness campaigns are essential for improving consumer perceptions of EVs. By highlighting the advantages and addressing common misconceptions, these campaigns can drive adoption and increase consumer confidence in the technology.

The adoption of EVs can lead to significant reductions in GHGs, contributing to improved public health and a cleaner environment. Beyond the immediate environmental benefits, the long-term advantages of EV adoption include reduced dependence on fossil fuels and lower operational costs. As EVs become more prevalent, these environmental and economic benefits will support broader sustainability goals and provide tangible advantages to both consumers and society as a whole.

6.2. Theoretical Implications

The study provides several theoretical implications that advance the understanding of EV adoption, particularly in the context of Jordan. The findings underscore the necessity of integrated strategies involving government incentives, infrastructure development, and technological advancements to promote EV uptake. This research contributes to the literature by highlighting the specific challenges and opportunities within developing countries, where economic, infrastructural, and public awareness barriers are more pronounced. The study's emphasis on multi-stakeholder collaboration aligns with existing theories on sustainable development and technological diffusion, reinforcing the idea that complex socio-technical transitions require coordinated efforts across different sectors. Additionally, the research extends theoretical frameworks related to consumer behavior and technology adoption by providing empirical evidence on the factors influencing EV acceptance in a Middle Eastern context. This not only broadens the geographical scope of current theories but also provides a foundation for comparative studies across different regions.

6.3. Practical Implications

To lower the initial costs of EVs and make them more accessible, it is crucial to implement additional financial incentives and subsidies. These measures could include tax breaks, rebates, and other financial benefits designed to reduce the economic barriers to EV ownership. Additionally, developing targeted public awareness campaigns is essential to educate consumers about the numerous benefits of EVs, such as their environmental impact, cost savings, and technological advancements. By increasing public knowledge and interest, these campaigns can significantly boost EV adoption rates.

Investing in the expansion of public charging infrastructure is vital for the widespread adoption of EVs. Particular attention should be given to rural areas, where charging stations are often scarce. This investment will help alleviate range anxiety and ensure that

all regions have the necessary infrastructure to support EV usage. Moreover, promoting the standardization of charging protocols and fostering collaboration with private sector stakeholders are important steps. Standardization will ensure compatibility across different charging networks, while private-sector collaboration can bring in additional resources and expertise for infrastructure development. Furthermore, charging infrastructure is significant not only for first-time EV adopters but also for repeat EV buyers. This highlights the importance of prioritizing these issues in countries that are in the early stages of EV adoption, to ensure a smoother transition and sustained growth in the EV market.

Encouraging R&D in battery technology is key to improving EV performance and reducing costs. Advancements in battery technology can lead to longer driving ranges, shorter charging times, and more efficient and cost-effective vehicles overall. Facilitating partnerships between academic institutions and industry is also crucial for driving technological advancements. Such collaborations can accelerate innovation by combining academic research capabilities with industry resources and practical applications, leading to rapid advancements in EV technology.

Strengthening collaboration between government, industry, and environmental groups is essential to address the various challenges associated with EV adoption. This multi-stakeholder approach can lead to the development of comprehensive strategies that integrate financial incentives, infrastructure development, and public education. By working together, these groups can create a cohesive plan that addresses the economic, technological, and social barriers to EV adoption, ensuring a smoother and more effective transition to electric mobility. Such collaboration will also facilitate the sharing of best practices and resources, further enhancing the overall success of EV initiatives.

6.4. Limitations and Future Research Directions

Despite its contributions, the study has several limitations that should be acknowledged. Firstly, the reliance on qualitative data from semi-structured interviews may introduce biases related to the perspectives of the selected stakeholders. Future research could benefit from incorporating quantitative methods (e.g., a Likert-type quantitative surveys of stakeholder attitudes) to validate and generalize the findings. Secondly, the study focuses on the current state and near-term prospects of EV adoption, potentially overlooking longer-term trends and emerging technologies that could impact the market. Longitudinal studies are recommended to capture the evolving dynamics of EV adoption over time. Thirdly, the research is geographically limited to Jordan, which may limit the applicability of the findings to other regions with different socio-economic and infrastructural conditions. Comparative studies involving multiple countries could provide a more comprehensive understanding of the factors driving EV adoption globally. Additionally, future research should explore the environmental lifecycle impacts of EVs, including battery production and disposal, to provide a more holistic assessment of their sustainability. It would also be worthwhile to explore the geostrategic and political implications of EV adoption (e.g., with Jordanian foreign policy and security experts), given the fragile international situation in the Middle East. Addressing these limitations could significantly enhance the robustness and generalizability of the research findings.

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References

1. Gahlaut, T.; Dwivedi, G.; Dwivedi, A. Analyzing the blockades to electric vehicle mobility in an emerging economy: Toward a triple bottom line sustainable development. *Sustain. Dev.* **2023**, *32*, 902–916. [CrossRef]
2. Albatayneh, A. Electric cars in Jordan: Opportunities and challenges. *Int. J. Electr. Comput. Eng. Res.* **2024**, *4*, 8–12. [CrossRef]
3. Samawi, G.A.; Bwaliez, O.M.; Dmour, W.A.; Mdanat, M.F.; Ta'Amnha, M.A. Eco-smart economics: Revolutionizing Jordan's logistics with sustainable drone technology. *Int. J. Energy Econ. Policy.* **2024**, *14*, 49–61. [CrossRef]
4. Abudayyeh, D.; Almomani, M.; Almomani, O.; Jaber, D.; Alhelo, E. Examining the determinants of electric vehicle acceptance in Jordan: A PLS-SEM approach. *World Electr. Veh. J.* **2023**, *14*, 304. [CrossRef]
5. Bsisu, K.A.D.; Bahlawan, M.A. The socio-economic aspects of using electric vehicles in Jordan. *Jordan Eng. Assoc. J.* **2019**, 74–84. [CrossRef]
6. Albatayneh, A.; Juaidi, A.; Abdallah, R.; Jeguirim, M. Preparing for the EV revolution: Petrol stations profitability in Jordan. *Energy Sustain. Dev.* **2024**, *79*, 101412. [CrossRef]
7. Larson, P.D.; Viáfara, J.; Parsons, R.V.; Elias, A. Consumer attitudes about electric cars: Pricing analysis and policy implications. *Transp. Res. Part A Policy Pract.* **2014**, *69*, 299–314. [CrossRef]
8. Lee, H.; Clark, A. Charging the Future: Challenges and Opportunities for Electric Vehicle Adoption. Harvard Kennedy School Faculty Research Working Paper No. RWP18-026. Available online: https://www.hks.harvard.edu/publications/charging-future-challenges-and-opportunities-electric-vehicle-adoption (accessed on 15 December 2024).
9. Zaino, R.; Ahmed, V.; Alhammadi, A.M.; Alghoush, M. Electric vehicle adoption: A comprehensive systematic review of technological, environmental, organizational and policy impacts. *World Electr. Veh. J.* **2024**, *15*, 375. [CrossRef]
10. Forsythe, C.; Gillingham, K.; Michalek, J.; Whitefoot, K. Technology advancement is driving electric vehicle adoption. *Proc. Natl. Acad. Sci. USA* **2023**, *120*, e2219396120. [CrossRef]
11. Salgado, R.; Danzi, F.; Oliveira, J.; El-Azab, A.; Camanho, P.; Braga, M. The latest trends in electric vehicles batteries. *Molecules* **2021**, *26*, 3118. [CrossRef]
12. International Council on Clean Transportation. Annual Update on the Global Transition to Electric Vehicles. 2022. Available online: https://theicct.org/wp-content/uploads/2023/06/Global-EV-sales-2022_FINAL.pdf (accessed on 15 December 2024).
13. International Energy Agency (IEA). Global EV Outlook 2023. Available online: https://www.iea.org/reports/global-ev-outlook-2023 (accessed on 15 December 2024).
14. Precedence Research. Electric Vehicle Market Size, Share, and Trends. Available online: https://www.precedenceresearch.com/electric-vehicle-market (accessed on 2 January 2025).
15. Sierzchula, W.; Bakker, S.; Maat, K.; Wee, B. The influence of financial incentives and other socio-economic factors on electric vehicle adoption. *Energy Policy* **2014**, *68*, 183–194. [CrossRef]
16. V, S.K.; Michael, L.K.; Hungund, S.S.; Fernandes, M. Factors influencing adoption of electric vehicles—A case in India. *Cogent Eng.* **2022**, *9*, 2085375. [CrossRef]
17. Richter, F. BYD and Tesla Dominate Global EV Sales. Available online: https://www.statista.com/chart/30758/most-popular-plug-in-electric-car-brands/ (accessed on 10 August 2024).
18. Pappas, T. Global EV Sales Shatter Records in November Thanks to China's Unstoppable Growth. Available online: https://www.carscoops.com/2024/12/global-ev-sales-keep-a-steady-rise-mostly-driven-by-china/ (accessed on 10 August 2024).
19. McKinsey & Company. What Norway's Experience Reveals About the EV Charging Market. Available online: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/what-norways-experience-reveals-about-the-ev-charging-market (accessed on 10 August 2024).
20. Jaiswal, D.; Kaushal, V.; Kant, R.; Singh, P.K. Consumer adoption intention for electric vehicles: Insights and evidence from Indian sustainable transportation. *Technol. Forecast. Soc. Change* **2021**, *173*, 121089. [CrossRef]
21. Deshazo, J. Improving incentives for clean vehicle purchases in the United States: Challenges and opportunities. *Rev. Environ. Econ. Policy* **2016**, *10*, 149–165. [CrossRef]

22. Richter, F. EV Infrastructure: South Korea Leads the Charge. Available online: https://www.statista.com/chart/30897/countries-with-the-best-ev-charging-infrastructure/ (accessed on 15 August 2024).
23. Bashaireh, A.; Obeidat, D.; Almehizia, A.; Shalalfeh, L. Optimal placement of electric vehicle charging stations: A case study in Jordan. In Proceedings of the IEEE Texas Power Energy Conference, College Station, TX, USA, 13–14 February 2023; pp. 1–6. [CrossRef]
24. Al-Habarnih, F.; Imam, R. Optimal locations of charging stations for electric vehicles in Amman, Jordan. *Int. Rev. Civ. Eng.* **2020**, *11*, 206–213. [CrossRef]
25. Kim, S.; Lee, J.; Lee, C. Does driving range of electric vehicles influence electric vehicle adoption? *Sustainability* **2017**, *9*, 1783. [CrossRef]
26. Singh, V.; Singh, V.; Vaibhav, S. A review and simple meta-analysis of factors influencing adoption of electric vehicles. *Transp. Res. Part D Transp. Environ.* **2020**, *86*, 102436. [CrossRef]
27. Wang, Y.; Zhang, X.; Li, K.; Zhao, G.; Chen, Z. Perspectives and challenges for future lithium-ion battery control and management. *Etransportation* **2023**, *26*, 100260. [CrossRef]
28. Wu, Y.; Ng, A.; Ng, A.; Yu, Z.; Huang, J.; Meng, K.; Dong, Z. A review of evolutionary policy incentives for sustainable development of electric vehicles in China: Strategic implications. *Energy Policy* **2021**, *148*, 111983. [CrossRef]
29. Mathew, N.; Varaprasad, G. Technology advancement: Factors influencing the adoption of electric vehicles in India. In Proceedings of the 2020 International Conference on System, Computation, Automation and Networking (ICSCAN), Pondicherry, India, 3–4 July 2020; pp. 1–5. [CrossRef]
30. Stockkamp, C.; Schäfer, J.; Millemann, J.A.; Heidenreich, S. Identifying factors associated with consumers' adoption of e-mobility—A systematic literature review. *Sustainability* **2021**, *13*, 10975. [CrossRef]
31. Wang, N.; Yan, R. Research on consumers' use willingness and opinions of electric vehicle sharing: An empirical study in Shanghai. *Sustainability* **2015**, *8*, 7. [CrossRef]
32. Lv, H.; Li, D. Impacts of heterogeneous green consumers on green innovation in electric vehicle and charging pile firms. *Sustain. Prod. Consum.* **2021**, *28*, 1216–1231. [CrossRef]
33. Eneizan, B. The adoption of electric vehicles in Jordan based on theory of planned behavior. *Am. J. Econ. Bus. Manag.* **2019**, *2*, 1–12. [CrossRef]
34. Zandt, F. Who Owns Electric Cars? Available online: https://www.statista.com/chart/32255/share-of-respondents-whose-primarily-used-car-is-a-hybrid-or-battery-electric-vehicle-by-generation/ (accessed on 10 September 2024).
35. Rogers, I.; Bloomberg, A.D.; Germany Boosts Electric-Car Incentives to Stimulate Demand. Providence Journal. Available online: https://www.providencejournal.com/story/business/automotive/2019/11/09/germany-boosts-electric-car-incentives-to-stimulate-demand/2333327007/ (accessed on 15 December 2024).
36. Khaleel, M.; Nassar, Y.; El-Khozondar, H.J.; Elmnifi, M.; Rajab, Z.; Yaghoubi, E.; Yaghoubi, E. Electric vehicles in China, Europe, and the United States: Current trend and market comparison. *Int. J. Electr. Eng. Sustain. Dev.* **2024**, *2*, 1.
37. Coffman, M.; Bernstein, P.; Wee, S. Electric vehicles revisited: A review of factors that affect adoption. *Transp. Rev.* **2017**, *37*, 79–93. [CrossRef]
38. Li, W.; Long, R.; Chen, H.; Dou, B.; Chen, F.; Zheng, X.; He, Z. Public preference for electric vehicle incentive policies in China: A conjoint analysis. *Int. J. Environ. Res. Public Health.* **2020**, *17*, 318. [CrossRef]
39. Huang, X.; Ge, J. Electric vehicle development in Beijing: An analysis of consumer purchase intention. *J. Clean. Prod.* **2019**, *216*, 361–372. [CrossRef]
40. Rietmann, N.; Lieven, T. A comparison of policy measures promoting electric vehicles in 20 countries. In *Governance of Smart Transportation Systems*; Finger, M., Audouin, M., Eds.; Springer: Cham, Switzerland, 2019; pp. 125–145, ISBN 978–3-319–96525–3. [CrossRef]
41. Liu, X.; Sun, X.; Zheng, H.; Huang, D. Do policy incentives drive electric vehicle adoption? Evidence from China. *Transp. Res. Part A Policy Pract.* **2021**, *150*, 49–62. [CrossRef]
42. World Economic Forum. Electric Vehicles and Financial Incentives. Available online: https://www.weforum.org/stories/2021/06/electric-vehicles-financial-incentives/ (accessed on 2 January 2025).
43. Nasdaq. EV Market Forecast: Top Trends for EVs in 2025. 2024. Available online: https://www.nasdaq.com/articles/ev-market-forecast-top-trends-evs-2025 (accessed on 9 January 2025).
44. Mdanat, M.F.; Al Hur, M.; Bwaliez, O.M.; Samawi, G.A.; Khasawneh, R. Drivers of port competitiveness among low-, upper-, and high-income countries. *Sustainability* **2024**, *16*, 11198. [CrossRef]
45. Mazur, M.P. *Economic Growth and Development in Jordan*; Routledge: London, UK, 2023; ISBN 978–1-032–40880–4.
46. Kumar, P.S.; Shriram, R.G.; Rajesh, R.; Rammohan, A. Causal analysis of the challenges to electric vehicles' adoption using GINA: Implications to emerging economies. *Case Stud. Transp. Policy.* **2024**, *15*, 101160. [CrossRef]
47. Mahadin, B. Factors Affecting Customer Switching Behavior towards Hybrid Electrical Vehicles (HEV's) from a Customer Perspective in Jordan. *Eur J. Mark. Econ.* **2018**, *1*, 53–65. [CrossRef]

48. Jreige, M.; Abou-Zeid, M.; Kaysi, I. Consumer preferences for hybrid and electric vehicles and deployment of the charging infrastructure: A case study of Lebanon. *Case Stud. Transp. Policy.* **2021**, *9*, 466–476. [CrossRef]
49. Sandri, S.; Hussein, H.; Alshyab, N. Sustainability of the energy sector in Jordan: Challenges and opportunities. *Sustainability* **2020**, *12*, 10465. [CrossRef]
50. Shalaifeh, L.; AlShalalfeh, A.; Alkaradsheh, K.; Alhamarneh, M.; Bashaireh, A. Electric vehicles in Jordan: Challenges and limitations. *Sustainability* **2021**, *13*, 3199. [CrossRef]
51. Dua, R.; Guzman, A.F. A perspective on emerging energy policy and economic research agenda for enabling aviation climate action. *Ener. Res. Soc. Sci.* **2024**, *117*, 103725. [CrossRef]
52. Gleser, M.; Elbert, R. Combined rail-road transport in Europe—A practice-oriented research agenda. *Res. Transp. Bus. Manag.* **2024**, *53*, 101101. [CrossRef]
53. Mukattash, I.L.; Alghizzawi, M.; Abu Hmeidan, T.; Alrousan, M.K.; Al Khasawneh, M. Consumer perception towards electric cars, an inductive study with specific reference to the Jordanian market. *J. Infrastruct. Policy Dev.* **2024**, *8*, 4690. [CrossRef]
54. Al-Masa'fah, W.; Abushaikha, I.; Bwaliez, O.M. Exploring the role of additive manufacturing in the prosthetic supply chain: Qualitative evidence. *Total Qual. Manag. J.* **2024**, *36*, 9. [CrossRef]
55. Komiyama, R.; Fujii, Y. Assessment of energy saving and CO_2 mitigation potential of electric vehicles and plug-in hybrid vehicles under Japan's power generation mix. *Electr. Eng. Jpn.* **2015**, *192*, 1. [CrossRef]
56. Nanaki, E.; Xydis, G.; Koroneos, C. Electric vehicle deployment in urban areas. *Indoor Built Environ.* **2016**, *25*, 1065–1074. [CrossRef]
57. Kumar, R.; Alok, K. Adoption of electric vehicle: A literature review and prospects for sustainability. *J. Clean. Prod.* **2020**, *253*, 119911. [CrossRef]