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Assessing Barriers to Electrical Vehicles and Its Impact On Public Acceptability in Rwanda: A Case Study of Kigali City

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Abstract

Despite global advancements in electric vehicles (EVs) adoption, Rwanda has struggled to meet its goal of importing 20,000 EVs annually due to barriers such as limited awareness, inadequate infrastructure, high costs, and unreliable electricity, particularly outside Kigali. While research on EVs adoption has focused on developed regions, there is a gap in studies addressing Rwanda's unique challenges. This study aimed to identify obstacles, assess policies, and propose strategies to accelerate EVs adoption to support Rwanda's climate goals. The main objective was to evaluate public acceptability by identifying economic, social, and infrastructural challenges affecting EVs adoption. Specific objectives include identifying key barriers, assessing public perceptions, evaluating policies and infrastructure, and proposing solutions to increase EVs uptake in Rwanda. The study aimed to provide insights beneficial to police makers, investors, and stakeholders in the transport and energy sectors. Findings offered Evidence-based recommendations to overcome barriers, enhance EVs adoption, and improve Rwanda's transition towards sustainable mobility while addressing infrastructural and economic constraints. In conclusion, the study highlights that while there is growing interest in electric vehicle (EV) adoption in Rwanda. In conclusion, the study highlights that while there is growing interest in electric vehicle (EV) adoption in Rwanda, significant barriers remain primarily the high upfront cost, limited charging infrastructure, and low public awareness.

Keywords: *Barriers, Electrical, Vehicles, Public and Acceptability*
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1. Introduction

Electric vehicles (EVs) are emerging as a sustainable alternative to traditional fuel-powered vehicles, offering significant benefits in the fight against climate change and environmental degradation. EV adoption is on the rise due to their ability to reduce greenhouse gas emissions, lower air pollution, and decrease dependence on fossil fuels (Onwuegbuzie, 2005). When powered by renewable energy sources, EVs produce minimal emissions, making them an ideal option for environmentally conscious transportation. In Rwanda, where the government has committed to green growth through its Vision 2050 and other climate action strategies, EVs present a promising solution to improving urban mobility while advancing environmental sustainability (Axsen, 2016).

However, despite these environmental advantages, the adoption of EVs in Rwanda faces several notable barriers. High upfront costs, limited charging infrastructure, lack of technical knowledge, and low public awareness continue to hinder widespread acceptance. Many people remain skeptical about EV performance, battery lifespan, and maintenance availability. These barriers significantly affect public perception and willingness to transition to EVs. Addressing these challenges through policy incentives, infrastructure development, and awareness campaigns is essential to increase public acceptability and support Rwanda's shift toward a cleaner, more sustainable transport system (Morton, 2016).

1.2. Background Information

An Electric Vehicle (EV) is a type of automobile powered by electricity rather than traditional fossil fuels such as petrol or diesel. EVs use electric motors and rechargeable batteries, most commonly lithium-ion batteries, to operate. There are different categories of EVs, including Battery Electric Vehicles (BEVs), which rely solely on electric power, and Plug-in Hybrid Electric Vehicles (PHEVs), which combine electric propulsion with internal combustion engines (Jones, 2019). EVs offer numerous environmental and economic benefits, including zero tailpipe emissions, reduced greenhouse gas emissions, lower maintenance costs, and better fuel efficiency with rising concerns over climate change and fossil fuel dependency, EVs have become a central focus of sustainable transportation efforts worldwide (Onat, 2019).

Historically, the global shift towards electric vehicles began gaining momentum in the early 2000s due to growing environmental concerns, technological innovation, and increasing fossil fuel prices. Milestone developments, such as the launch of the Tesla Roadster (2008) and Nissan Leaf (2010), helped shape the modern EV industry. Countries like Norway led early adoption through strong incentives and infrastructure, achieving nearly 89% EV market share by 2024. China, meanwhile, became the largest EV market, driven by aggressive industrial policies and local manufacturing support (Krishnan, 2021).

In Africa, EV interest has surged more recently, as countries aim to reduce fuel import dependency and carbon emissions. However, structural challenges like weak energy infrastructure, high vehicle costs, and limited consumer awareness have slowed progress.

Still, countries such as Kenya, Ghana, and Tanzania have started building momentum by supporting local startups and importing affordable EV models. In Africa, and particularly in Rwanda, the adoption of EVs is gradually taking shape (Muhizi, 2023).

Rwanda has implemented forward-looking policies such as tax incentives and import duty reductions to encourage electric mobility. The government has also partnered with companies like Volkswagen and Siemens to pilot electric vehicle projects, marking a significant step toward sustainability. Despite these initiatives, the EV market in Rwanda remains nascent, facing several constraints (Krishnan, 2021). Key challenges include the high upfront cost of EVs, a lack of widespread charging infrastructure, and limited access to reliable electricity in rural areas, and low public awareness. These factors make it difficult for the average Rwandan consumer to transition from traditional fuel-powered vehicles to electric ones, despite long-term savings and environmental benefits (GoR , 2020a).

Nevertheless, EVs present significant potential benefits for Rwanda and the broader African continent. They contribute to reduced air pollution and health risks in urban areas, cut transportation costs, and open doors for green jobs and local innovation through assembly and battery recycling industries. Rwanda's commitment to electric mobility positions it as a potential leader in the region (Venkatesh, 2000). To achieve greater adoption, however, there is a need for increased investment in infrastructure, consumer education to dispel misconceptions about EV reliability and maintenance, and stronger policy support for private vehicle ownership. With the right strategies, Rwanda can align with global electric mobility trends and build a sustainable transport system that benefits both its people and the environment (Hardman et .al, 2018).

Rwanda’s push for EV adoption is rooted in its broader Vision 2050 strategy for green growth and sustainability. The 2019 partnership between Volkswagen and Siemens marked the country’s entry into electric mobility, with initial pilot projects deployed in Kigali. Since then, the government has introduced import duty exemptions, tax breaks, and investment incentives to stimulate EV uptake. Despite these efforts, constraints such as inadequate charging infrastructure, limited vehicle availability, and low public knowledge continue to hinder widespread adoption. However, with continued policy development and regional collaboration, Rwanda is well positioned to become a leader in Africa’s EV transition.

2. Material and Methods

2.1. Description of the study area

The City of Kigali is the capital of Rwanda and is located at Rwanda’s geographical heart. Occupying an area of 730km. The City of Kigali is composed of three Districts namely Gasabo, Kicukiro and Nyarugenge. Gasabo is the largest district by geographical area at 429.3km2, followed by Kicukiro (166.7km2) and Nyarugenge (134km2). The figure 1 below describes the location of Kigali capital city of Rwanda.

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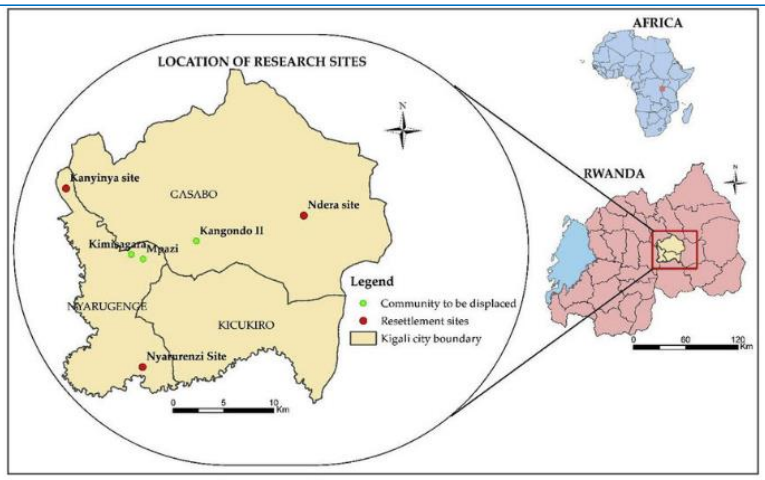

Figure 3. Capital city of Rwanda, Atlas Map (2020).

2.2 Methodology

This study employed a cross-sectional mixed-methods design to capture both quantitative and qualitative insights into electric vehicle (EV) adoption in Rwanda. A sample size of 384 respondents was determined using Cochran's formula (1977) and selected through random sampling to ensure diverse representation of EV users, potential buyers, transport operators, and energy stakeholders. Data collection combined structured questionnaires, semi-structured interviews, focus group discussions (FGDs), documentary reviews, and field observations. Questionnaires, administered physically and online, gathered demographic, economic, social, and policy-related data, while six FGDs (6–10 participants each) enabled in-depth exploration of perceptions. Documentary reviews covered national policies, strategies, and incentive reports, and structured observations at charging stations provided real-time behavioral insights.

Quantitative data were analyzed using SPSS (Version 25) and Excel for descriptive statistics, chi-square tests, and binary logistic regression, while qualitative data from FGDs and interviews were transcribed, coded, and thematically analyzed using Ethnographic Content Analysis. Validity was ensured through expert consultation and pilot testing, while reliability was strengthened by split-half testing and peer debriefing. Ethical approval, informed consent, and confidentiality were strictly maintained.

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3. Results

Table 1: Demographic Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	182	45.9%
	Female	152	37.6%
	Prefer not to say	70	17.3%
Age	18–24	44	11%
	25–34	127	31%
	35–44	135	33%
	45–54	83	21%
	Above 55	15	4%
Education	No formal education	37	9%
	Primary education	101	25%
	Secondary education	132	33%
	Vocational training	55	14%
	University degree or higher	77	19%
	Less than 100,000 RWF	41	10%
Income Level (per month)	100,000 to 300,000 RWF	145	36%
	300,000 to 600,000 RWF	148	37%
	600,000 to 1,000,000 RWF	63	16%
	Over 1,000,000 RWF	7	2%
Status on Vehicle Ownership	Owns at least one vehicle	152	34.8%
	Does not own a vehicle	235	59.6%
	Prefer not to say	17	2%

The logistic regression reveals nuanced relationships between demographics and EV awareness. While age shows no significant effect (all $p>0.05$), the strong education effect (OR=0.64 for secondary education, $p=0.237$) suggests awareness campaigns should target less educated groups through appropriate channels. The striking income effect (OR=2.34 for >600k Rwf, though $p=0.122$) hints at an emerging "EV information divide" where wealthier individuals have greater access to EV knowledge. This has important equity implications - as Rwanda develops its EV policy, it must ensure information access doesn't become restricted to economic elites. The non-significance of age variables suggests EV awareness cuts across adult age groups equally in urban Rwanda.

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Table 2. Ordinal Regression Analysis of Barriers to EV Adoption in Rwanda

Predictor (Barrier)	β (Beta Coefficient)	SE (Standard Error)	p-value	OR (Odds Ratio)
High Initial Cost (EV Price)	0.68	0.19	<0.001	1.98
Limited Charging Infrastructure	0.57	0.21	0.007	1.77
Low Public Awareness	0.49	0.18	0.012	1.63
Inadequate Government Incentives	0.45	0.20	0.025	1.57
Lack of Skilled Technicians	0.38	0.17	0.031	1.46
Unstable Electricity Access	0.33	0.16	0.045	1.39

The ordinal regression analysis indicates that all identified barriers significantly affect the public acceptance of electric vehicles (EVs) in Rwanda, with p-values below the 0.05 threshold. Among the predictors, the high initial cost of EVs shows the strongest impact, with a β value of 0.68 and an odds ratio (OR) of 1.98, suggesting that respondents are nearly twice as likely to show lower acceptance of EVs due to their price. Limited charging infrastructure also significantly influences acceptance (β = 0.57, OR = 1.77), highlighting the importance of expanding charging stations. Similarly, low public awareness (β = 0.49, OR = 1.63) and inadequate government incentives (β = 0.45, OR = 1.57) further reduce willingness to adopt EVs. Other factors such as lack of skilled technicians and unstable electricity access show moderate but meaningful effects, suggesting that technical and infrastructural limitations also contribute to adoption reluctance

Table: 3. Logistic Regression Results on Public Willingness to Adopt EVs

Predictor	β (Beta Coefficient)	SE (Standard Error)	p-value	OR (Odds Ratio)
Awareness of EVs	1.325	0.218	0.000	3.76
Perceived Cost of EVs	-0.847	0.275	0.002	0.43
Environmental Concern	0.710	0.198	0.000	2.03
Charging Infrastructure Access	0.592	0.243	0.015	1.81
Government Incentives Awareness	0.385	0.190	0.042	1.47
Age Group (Young = ref)	-0.321	0.157	0.045	0.73
Income Level	0.468	0.212	0.028	1.60

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Based on the provided logistic regression table, several factors significantly influence the likelihood of the outcome, which appears to be a decision related to electric vehicles (EVs). A strong positive relationship exists between Awareness of EVs and the outcome, with an odds ratio (OR) of 3.76, indicating that greater awareness substantially increases the odds. Similarly, Environmental Concern (OR = 2.03) and Income Level (OR = 1.60) are also significant positive predictors, suggesting that individuals who are more environmentally conscious or have higher incomes are more likely to make the decision. Additionally, Charging Infrastructure Access (OR = 1.81) and Government Incentives Awareness (OR = 1.47) are both significant positive factors, highlighting the importance of practical and financial support. Conversely, Perceived Cost of EVs has a significant negative relationship, with an OR of 0.43, meaning that a higher perceived cost substantially decreases the odds of the outcome. Finally, the Age Group variable indicates that the group represented is less likely to engage in the outcome compared to the young reference group, with an OR of 0.73. All these predictors have p-values below 0.05, confirming their statistical significance.

Table 4. Logistic Regression Output – Effectiveness of Government Support for EV Uptake.

Predictor	β (Beta Coefficient)	SE (Standard Error)	p-value	OR (Odds Ratio)
Awareness of government incentives	0.84	0.26	0.001	2.31
Accessibility of charging infrastructure	1.15	0.29	<0.001	3.16
Policy consistency	0.63	0.20	0.002	1.88
Institutional support	0.71	0.23	0.003	2.03
Availability of technical expertise	0.57	0.22	0.009	1.77
Perception of infrastructure adequacy	0.41	0.20	0.039	1.51

The logistic regression results demonstrate that all proposed solutions have a statistically significant and positive impact on enhancing public acceptance of electric vehicles (EVs). Among them, the introduction of financial subsidies shows the strongest effect (OR = 3.39), indicating that offering direct economic incentives is the most effective strategy to boost adoption. This is followed by the expansion of charging infrastructure (OR = 2.95) and public awareness campaigns (OR = 2.56), both of which significantly improve the odds of EV uptake by addressing practical access and informational gaps. Tax exemptions for EV imports (OR = 2.41) and the inclusion of EVs in national transport policy (OR = 2.20) also play key roles by reducing costs and integrating EVs into long-term planning frameworks. Finally, local training for EV maintenance (OR = 1.93) contributes positively by ensuring that technical support is available, thus enhancing consumer confidence in the sustainability and reliability of EV ownership.

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Table 5. Logistic Regression Output Recommended Solutions to Enhance Public Acceptance of EVs.

Predictor (Proposed Action)	β (Beta Coefficient)	SE (Standard Error)	p-value	OR (Odds Ratio)
Introduction of financial subsidies	1.22	0.31	<0.001	3.39
Expansion of charging infrastructure	1.08	0.28	<0.001	2.95
Public awareness campaigns	0.94	0.27	0.001	2.56
Inclusion of EVs in national transport policy	0.79	0.25	0.003	2.20
Local training for EV maintenance	0.66	0.23	0.005	1.93
Tax exemptions for EV imports	0.88	0.26	0.001	2.41

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4.2. Discussion

4.2. Identify and classify key barriers limiting the adoption of electric vehicles in Rwanda and evaluate how these barriers influence public acceptance.

The study identifies several barriers hindering the adoption of electric vehicles (EVs) in Rwanda, grouped into economic, infrastructural, and policy-informational categories. Economic barriers: High upfront costs of purchasing EVs remain the most significant deterrent to adoption. Despite long-term operational savings, many Rwandan consumers still perceive the initial purchase cost as prohibitive (GIZ, 2021). Infrastructural barriers: Limited charging infrastructure: As of 2024, Rwanda had only around 24 public charging stations, 4 direct motorcycle chargers, and 49 battery-swapping stations mostly concentrated in Kigali, leaving rural areas underserved (Mbaraga, 2024; Africa Press,

2024). Unreliable electricity supply: National electricity capacity stands at just 225 MW, with only about 53% of the population connected to the grid (Vuka, 2023). This raises concerns about reliability, particularly in charging infrastructure and remote areas.

Urban rural divide and cost: Establishing new charging stations remains costly, ranging from about $21,000 for AC stations to $200,000+ for DC fast-charging units (Mobility Rising, 2023). Policy and informational barriers: • Awareness and range anxiety: Many consumers lack clear information about EV benefits and remain uncertain about range and charger compatibility (GIZ, 2021; Automag Rwanda, 2025a). Emerging incentives: The Rwandan government has introduced promising incentives such as zero VAT and exemptions on import and excise duties, rent-free land for charging stations, and reduced electricity tariffs to promote EV adoption and charging infrastructure development (Mujyambere, 2023). Gaps in incentive visibility: Despite these efforts, knowledge of incentive schemes remains limited among the public, dampening confidence and slowing uptake (Automag Rwanda, 2025b). Influence on public acceptance: These combined barriers reinforce public skepticism EVs are viewed as expensive, inconvenient, and uncertain. Without progress across all three domains economic, infrastructural, and policy/informational public confidence remains fragile. A comprehensive strategy that addresses upfront costs through incentives, expands reliable charging infrastructure, and educates the public is essential for increasing acceptance.

4.2.2 Assess public attitudes toward electric vehicles in Rwanda, focusing on factors that shape willingness to adopt Public willingness to adopt

EVs in Rwanda are shaped by multiple intertwined factors: Awareness and environmental consciousness: Individuals who are better informed about EV benefits particularly environmental advantages are more open to adoption. Global behavioral studies confirm that higher awareness and eco-friendly attitudes correlate with stronger adoption intent (Jones, (2019) . Perceived cost benefits: While the initial purchase cost remains a concern, drivers using EV systems especially battery-swapping models are already realizing economic gains. For example, Ampersand drivers experience about a 35% increase in net income and annual savings of around $700 on fuel and maintenance (Krishnan, 2019). Infrastructure confidence: Persistent concerns about the availability, reliability, and distribution of charging infrastructure particularly beyond Kigali dampen adoption willingness. Potential buyers fear being stranded or limited in travel, which undermines confidence in EV practicality (Johnson, 2021). Overall, targeted education and awareness campaigns, alongside greater visibility of incentive programs and infrastructure improvements, can strengthen public confidence and help transform favorable attitudes into actual EV adoption.

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4.2.3: Critically assess the effectiveness of existing government policies, incentives, and infrastructure supporting EV uptake.

Although Rwanda has introduced supportive policies and incentives, their effectiveness is limited by inadequate infrastructure development, lack of coordination among institutions, and low public engagement. The study suggests that more strategic, inclusive, and better-funded implementation is necessary to make these policies impactful, including stronger institutional collaboration and public involvement in decision-making.

4.2.4: Recommend solutions to address identified challenges and enhance public acceptance.

The findings support a multi-faceted strategy to increase EV acceptance, emphasizing financial subsidies, infrastructure expansion, and educational initiatives. Tax exemptions, public awareness campaigns, integration into national transport strategies, and local capacity building are key recommendations. These measures, validated through stakeholder consultations, collectively offer a roadmap to overcoming barriers and accelerating the transition to electric mobility in Rwanda.

5. Conclusion

The study highlights that while there is growing interest in electric vehicle (EV) adoption in Rwanda, significant barriers remain primarily the high upfront cost, limited charging infrastructure, and low public awareness. However, the analysis demonstrates that strategic government support through financial subsidies, expanded infrastructure, consistent policies, and targeted awareness campaigns can substantially improve public willingness to adopt EVs. Furthermore, socio-demographic factors such as age, income, and education play a critical role in shaping attitudes toward EV adoption. The findings emphasize the need for a coordinated and inclusive approach involving public institutions, private stakeholders, and local communities to ensure the successful integration of EVs into Rwanda's transportation landscape

5. Recommendations

- Partner with private companies through tax incentives to expand fast-charging corridors along major highways.
- Future researchers should Track adoption rates post-policy interventions (e.g., after subsidy introductions) through longitudinal surveys.
- Future researchers should Compare Rwanda's EV barriers
- with those in peer cities (e.g., Nairobi, Kampala) to identify transferable solutions.
- Future researchers should investigate battery recycling and second-life applications, a growing concern as EV fleets expands.

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