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Role of Electric Mobility Projects on Urban Transport Efficiency: A Case of Key E-mobility Interventions in Nyarugenge District, Rwanda

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Abstract: *This study examined the role of Electric Mobility Projects on Urban Transport Efficiency in Nyarugenge District, Rwanda. Specifically, the study assessed the role of Electric Two-Wheeler Initiatives in Urban Transport Efficiency. The study adopted a descriptive and explanatory research design using a mixed-methods approach. The target population comprised 1,966 respondents, from which a sample size of 333 respondents was selected. Data were collected using structured questionnaires and semi-structured interviews and analyzed using SPSS. Descriptive statistics, Pearson correlation analysis, and simple linear regression analysis were used to examine the relationship and influence of Electric Two-Wheeler Initiatives on Urban Transport Efficiency. The findings showed that electric motorcycles were widely available, frequently used for daily commuting, reliable, and accessible, while also reducing commuter waiting time and travel time. Correlation analysis indicated a strong positive relationship between Electric Two-Wheeler Initiatives and Urban Transport Efficiency ($r = .766$, $p < .001$). Regression analysis further showed that Electric Two-Wheeler Initiatives significantly influenced Urban Transport Efficiency, explaining 60.2% of its variation. The study concluded that Electric Two-Wheeler Initiatives play an important role in improving Urban Transport Efficiency. The study recommends increasing the availability and accessibility of electric motorcycles, strengthening their reliability and continuous operation, and supporting their wider adoption through appropriate policies and stakeholder interventions.*

Keywords: *Electric Two-Wheeler Initiatives; Urban Transport Efficiency; Electric Mobility; Electric Motorcycles; Nyarugenge District; Rwanda*

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1. Introduction

Electric mobility (e-mobility) is increasingly recognized as a transformative solution for improving the efficiency, sustainability, and environmental performance of urban transportation systems. E-mobility refers to the use of electric-powered vehicles, including electric cars, buses, motorcycles, and bicycles, as alternatives to conventional internal combustion engine vehicles (Samson, 2023). These systems contribute significantly to reducing greenhouse gas emissions, improving air quality, and minimizing noise pollution in urban areas (Smith & Elahi, 2021). Furthermore, e-mobility enhances urban transport efficiency by integrating with smart transport systems and digital platforms that optimize mobility patterns. Although transitioning to electric mobility requires significant investments in infrastructure such as charging stations and grid upgrades, the long-term environmental and economic benefits are substantial (Wellas, 2024) .

Globally, the adoption of electric mobility has accelerated in recent years due to increased climate commitments, technological innovations, and the declining cost of lithium-ion batteries (Heller & Taylor, 2023). Countries such as China, Norway, and Germany have emerged as global leaders in the deployment of electric vehicles across both public and private transportation systems. According to the International Energy Agency (IEA, 2023), over 18 million electric vehicles were sold worldwide in 2022, demonstrating rapid market expansion. This global shift toward decarbonization and net-zero emission targets has stimulated significant investments in e-mobility infrastructure and fostered international collaborations in research, financing, and policy development (Kumar et al., 2022) .

In developed countries, e-mobility initiatives are closely aligned with broader smart city and climate resilience strategies. Nations such as Sweden, the Netherlands, and the United Kingdom have introduced ambitious policies aimed at phasing out internal combustion engine vehicles within specific timelines (Walker & Jensen, 2022). These efforts are supported by strong institutional frameworks, financial incentives, and consumer subsidies that encourage the adoption of electric vehicles. Additionally, advanced infrastructure such as widespread charging networks and integrated multimodal transport systems enables seamless mobility. Technologies such as real-time route optimization and predictive maintenance further improve operational efficiency and user experience (Leopold, 2024) .

In contrast, Sub-Saharan Africa faces unique challenges in adopting electric mobility, including unreliable electricity supply, high upfront costs of electric vehicles, and underdeveloped transport infrastructure (Kiote & Oguru, 2024). Despite these challenges, there is growing interest in e-mobility across the region, with several countries launching pilot projects to electrify urban transport systems such as buses, motorcycles, and taxis (Nduta & Moyo, 2023). Informal transport systems, particularly minibuses, dominate urban mobility in many African cities, presenting both challenges and opportunities for electrification. Transitioning to electric two- and three-wheelers offers significant potential for reducing fuel costs, improving environmental sustainability, and enhancing urban transport efficiency (Tadesse et al., 2023) .

East Africa has emerged as a promising hub for e-mobility development, driven by rapid urbanization, supportive government policies, and the need to reduce dependence on fossil fuels (Mwajuma, 2024). Countries such as Kenya, Uganda, Tanzania, and Ethiopia are actively piloting electric mobility initiatives and expanding related infrastructure. For example, Kenya has introduced electric buses in Nairobi, while Uganda is promoting electric motorcycle startups and integrating green transport policies into national development plans. The widespread use of mobile technologies and ride-hailing applications has further accelerated the adoption of electric mobility solutions, improving efficiency in both formal and informal transport sectors (Mutebi & Karanja, 2024) .

Rwanda is rapidly emerging as a leader in electric mobility in Africa, driven by its commitment to reducing reliance on imported fossil fuels, addressing urban congestion, and mitigating environmental pollution, particularly in Kigali. The government's strategy is anchored in the Strategic Paper on E-Mobility (Ministry of Infrastructure, 2021) and the Rwanda Urban Mobility Improvement (RUMI) Project, a \$204 million initiative supported by the World Bank (World Bank, 2023). These initiatives aim to modernize Kigali's transport system through the introduction of electric buses, dedicated bus lanes, and improved non-motorized transport infrastructure. A major focus is the electrification of motorcycles, with plans to phase out petrol motorcycles and increase the share of electric motorcycles in the national fleet (Ministry of Infrastructure, 2024).

Several flagship projects highlight the implementation of e-mobility in Rwanda. The Ampersand project has introduced battery-swapping technology for electric motorcycles, reducing operational costs and increasing efficiency for moto-taxi drivers. The IZI Electric project has implemented an "E-Mobility-as-a-Service" model that provides vehicles, infrastructure, and maintenance through leasing arrangements, thereby reducing upfront costs. Similarly, the BasiGo project has introduced electric buses using a pay-as-you-drive model, facilitating the gradual transition to electric public transport systems (Ministry of Infrastructure, 2023; Rwanda Sustainable Mobility Report, 2024; African Transport Futures, 2025). These e-mobility initiatives are aligned with national goals related to climate change mitigation, energy security, and socio-economic development (Munyakazi, 2023). They contribute to reducing greenhouse gas emissions, decreasing dependence on imported fossil fuels, and promoting inclusive urban mobility. Infrastructure development, including charging stations and battery-swapping facilities, alongside public–private partnerships such as the RUMI project, has further strengthened the sector (Rwanda Energy Transition Plan, 2025)

1.2 Statement of the Problem

Urban transport efficiency is a critical component of sustainable urban development, as it facilitates the movement of people and goods in a reliable, affordable, and environmentally sustainable manner. Globally, electric mobility (e-mobility) has emerged as a key solution for addressing urban transport challenges such as traffic congestion, air pollution, and dependence on fossil fuels. According to the International Energy Agency (IEA, 2024), global electric vehicle sales exceeded 17 million units in 2024, accounting for approximately 20% of all vehicle sales worldwide. Countries that have successfully integrated electric mobility into their transport systems have reported improvements in transport efficiency, reductions in greenhouse gas emissions, and lower operational costs. Consequently, governments and development partners increasingly promote electric mobility projects as a strategy for achieving sustainable urban transport systems.

In Rwanda, the government has demonstrated a strong commitment to promoting electric mobility through initiatives such as the National E-Mobility Strategy, tax exemptions on electric vehicles, the Rwanda Urban Mobility Improvement (RUMI) Project, and partnerships with private operators such as Ampersand, BasiGo, and IZI Electric. As of 2024, Rwanda had over 5,000 electric motorcycles operating in Kigali and other urban areas, while several electric buses and charging stations had been introduced to support sustainable transport (MININFRA, 2024). Despite these efforts, urban transport challenges persist, particularly in Kigali City, including Nyarugenge District. Reports indicate that traffic congestion continues to increase due to rapid urbanization, with Kigali's population growth exceeding transport infrastructure expansion. Furthermore, transport operators continue to face high operational costs, while air pollution and carbon emissions from the transport sector remain significant concerns (RURA, 2024).

Although electric mobility projects have been implemented to address these challenges, their actual contribution to urban transport efficiency remains insufficiently documented. Existing studies in Rwanda have largely focused on policy implementation, environmental benefits, and the technical feasibility of electric vehicles. However, limited empirical evidence exists regarding how specific e-mobility interventions such as electric two-wheelers, charging infrastructure development, and electric four-wheeler adoption influence urban transport efficiency indicators including travel time, accessibility, service reliability, and cost efficiency. Moreover, most previous studies have examined these interventions independently rather than assessing their combined contribution to urban transport efficiency within a single analytical framework. This creates a knowledge gap regarding the effectiveness of electric mobility projects in improving urban transport efficiency, particularly in Nyarugenge District where e-mobility initiatives are rapidly expanding. Therefore, this study seeks to fill this gap by assessing the role of electric mobility projects on urban transport efficiency through an examination of key e-mobility interventions in Nyarugenge District, Rwanda.

This research was guided by the following study objectives:

i. To assess the role of electric two-wheeler initiatives in enhancing urban transport efficiency under the key e-mobility interventions in Nyarugenge District.

2.1 Literature Review

This section reviews literature related to Electric Two-Wheeler Initiatives and Urban Transport Efficiency. It examines the concepts and empirical evidence concerning electric mobility projects, electric two-wheeler initiatives, and urban transport efficiency, with particular attention to their relevance to the urban transport context of Nyarugenge District, Rwanda.

2.1.1 Electric Mobility Projects

Electric mobility projects refer to organized initiatives that promote the use of electric-powered vehicles and associated infrastructure to replace conventional fossil fuel-based transport. (Green Mobility Africa, 2024). These projects often involve a combination of electric two-wheelers, electric four-wheelers, and public transport solutions such as electric buses. Electric mobility projects also include the development of charging stations, battery management systems, and supportive policy and financial incentives aimed at encouraging adoption. They are generally implemented by governments, private companies, or public–private partnerships to promote sustainable transportation, reduce environmental pollution, and improve energy efficiency in urban areas (Rwanda Ministry of Infrastructure, 2023).

Electric mobility projects contribute directly to urban transport efficiency by reducing travel time, congestion, and operational costs (African Transport Review, 2024). Electric vehicles, especially in densely populated cities, produce lower emissions and can operate more efficiently in stop-and-go traffic compared to conventional vehicles. The integration of electric mobility projects into urban transport systems can enhance the reliability of public transit services and facilitate smoother traffic flows. Additionally, projects that incorporate innovative models such as battery-swapping stations and pay-as-you-drive systems help minimize downtime for vehicles, ensuring continuous mobility and more efficient urban transport networks (The Magazine Today, 2023).

In the context of this study, electric mobility projects in Nyarugenge District represent a growing and critical component of Kigali's urban transport system. Key interventions include initiatives involving electric two-wheelers, electric four-wheelers, and the expansion of charging infrastructure. These projects are designed to improve the efficiency and sustainability of urban transport while providing affordable and accessible mobility options for commuters and transport operators. By examining these projects, this study seeks to understand how such initiatives influence urban transport efficiency and contribute to Rwanda's broader sustainable development goals.

2.1.2 Electric Two-Wheeler Initiatives

Electric two-wheeler initiatives are organized projects that aim to introduce and promote electric motorcycles and scooters as sustainable alternatives to conventional gasoline-powered two-wheelers (Rwanda Transport Authority, 2023). These initiatives often involve collaborations between government agencies, private companies, and international development partners. Key components include the provision of electric motorcycles, battery-swapping stations, leasing schemes, and financial incentives for riders. The initiatives are designed to reduce operating costs, minimize greenhouse gas emissions, and increase mobility efficiency in urban areas (Green Mobility Africa, 2024).

These initiatives contribute significantly to urban transport efficiency by reducing congestion, lowering fuel consumption, and providing reliable last-mile transportation. Electric two-wheelers can operate effectively in dense traffic areas, and their reduced maintenance and energy costs improve overall service reliability for riders. Battery-swapping stations and other infrastructure innovations minimize downtime, enabling riders to maintain continuous operations and enhancing overall system efficiency (Kigali Urban Mobility Report, 2024).

In the context of Nyarugenge District, Kigali, electric two-wheeler initiatives have been actively implemented to promote cleaner and more efficient urban transport. Programs led by private companies such as Ampersand, in partnership with the government, have established battery-swapping networks and provided incentives for moto-taxi operators to transition to electric motorcycles. These interventions are expected to improve the efficiency, affordability, and sustainability of urban transport, while supporting Rwanda's broader climate and development objectives (Rwanda Ministry of Infrastructure, 2024).

2.1.3 Urban Transport Efficiency

Urban transport efficiency is defined as the ability of a city's transport system to move people and goods reliably, affordably, and sustainably, while minimizing congestion and environmental impacts (World Bank, 2024). Efficiency is measured by factors such as travel time, traffic flow, vehicle operating costs, and commuter satisfaction. An efficient transport system supports economic productivity, social inclusion, and environmental sustainability, particularly in rapidly urbanizing cities (Rwanda Transport Authority, 2023).

The integration of electric mobility projects, including electric two-wheelers and four-wheelers, along with charging infrastructure, directly improves urban transport efficiency. Electric vehicles lower operating costs, reduce emissions, and increase reliability of transport services. Infrastructure innovations such as battery-swapping stations, digital fleet monitoring, and optimized charging networks reduce downtime and enhance route planning for operators (Green Mobility Africa, 2024). This ensures smoother traffic flow, faster service delivery, and better urban mobility overall.

In the context of Nyarugenge District, Kigali, e-mobility projects have a significant role in enhancing urban transport efficiency. The district's high population density and traffic congestion require solutions that reduce travel time and environmental impact. By examining electric two-wheeler and four-wheeler adoption, along with charging infrastructure, this study assessed how these projects improve operational efficiency, lower costs, and enhance commuter satisfaction. Insights from this study can inform scaling up of e-mobility initiatives in other urban districts of Rwanda (Rwanda Ministry of Infrastructure, 2024).

2.2 Theoretical Review

This section presents the theoretical foundation underpinning the study of electric mobility projects and urban transport efficiency. The study is guided by the Diffusion of Innovation Theory, developed by Everett M. Rogers in 1962 to explain how, why, and at what rate new ideas and technologies spread among members of a social system. The theory emphasizes the innovation itself, communication channels, time, the social system, and adopter categories, including innovators, early adopters, early majority, late majority, and laggards (Greenhalgh et al., 2024; Terrace, 2022). It provides a useful framework for understanding the process through which new technologies are introduced, communicated, accepted, and adopted by individuals and communities over time.

Diffusion of Innovation Theory identifies several characteristics that influence the adoption of an innovation, including relative advantage, compatibility, complexity, trialability, and observability (Valente, 2021). Relative advantage refers to the perceived benefits of an innovation compared with existing alternatives, while compatibility concerns its consistency with users' needs, values, and existing practices. Complexity relates to how difficult the innovation is perceived to understand or use, whereas trialability refers to the opportunity to test the innovation before full adoption. Observability concerns the extent to which the benefits of an innovation can be seen by others. These characteristics are relevant to electric mobility because users may consider factors such as lower operating costs, convenience, reliability, accessibility, and environmental benefits when deciding whether to adopt electric vehicles (Pamela, 2020).

The theory is particularly relevant to this study because electric mobility is an emerging technological innovation within Rwanda's urban transport system. The adoption of electric two-wheelers and four-wheelers may depend on users' awareness of the technology, perceptions of its benefits, ease of use, compatibility with existing transport practices, and observable improvements in transport services. The theory also explains the stages of adoption, including knowledge, persuasion, decision, implementation, and confirmation, which can help to understand how electric mobility initiatives become integrated into urban transport. Therefore, the Diffusion of Innovation Theory provides an appropriate theoretical lens for examining the role of electric mobility projects in improving urban transport efficiency in Nyarugenge District.

3. Methodology

This study adopted a systematic methodological approach to examine the role of electric two-wheeler initiatives on urban transport efficiency in Nyarugenge District, Rwanda. The methodology covered the research design, target population, sample size, sampling techniques, data collection methods, research instruments, validity and reliability of the instruments, data collection procedures, data analysis methods, and ethical considerations. These methodological procedures were used to collect and analyze relevant information concerning Electric Two-Wheeler Initiatives as the independent variable and Urban Transport Efficiency as the dependent variable.

The study adopted a descriptive and explanatory research design using a mixed-methods approach. The descriptive design was used to describe the existing electric two-wheeler initiatives and the level of urban transport efficiency in Nyarugenge District. It enabled the researcher to obtain information concerning the availability, accessibility, usage, reliability, and operational performance of electric two-wheelers. The explanatory design was used to determine whether Electric Two-Wheeler Initiatives influenced Urban Transport Efficiency and to establish the nature and strength of the relationship between the two variables. The combination of descriptive and explanatory designs was appropriate because the study sought both to describe existing electric two-wheeler initiatives and to explain their influence on Urban Transport Efficiency. The mixed-methods approach enabled the researcher to obtain quantitative information through questionnaires and qualitative information through interviews concerning users' experiences, implementation challenges, and opportunities associated with electric two-wheeler initiatives.

The target population comprised 1,966 respondents who were directly involved in or associated with electric mobility and urban transport activities in Nyarugenge District, Rwanda. The population included Electric Two-Wheeler Users, Electric Four-Wheeler Users, Charging Infrastructure Managers, Nyarugenge District Transport Staff, National Transport/Regulatory Employees, and E-Mobility Support Staff. These categories were selected because they had different forms of involvement in electric mobility projects and urban transport activities. Electric Two-Wheeler Users provided information concerning their experience and use of electric motorcycles, while the other stakeholder groups provided information concerning the implementation, management, regulation, and support of electric mobility initiatives. The target population consisted of 1,234 Electric Two-Wheeler Users, 557 Electric Four-Wheeler Users, 22 Charging Infrastructure Managers, 12 Nyarugenge District Transport Staff, 7 National Transport/Regulatory Employees, and 134 E-Mobility Support Staff, giving a total of 1,966 respondents.

A sample size of 333 respondents was selected from the target population using Yamane's formula. Structured questionnaires were administered to 303 respondents, while 30 key informants participated in interviews. The questionnaire respondents included Electric Two-Wheeler Users, Electric Four-Wheeler Users, and Charging Infrastructure Managers, while the key informants included E-Mobility Support Staff, National Transport/Regulatory Employees, and Nyarugenge District Transport Staff. Stratified sampling was used to ensure representation of the relevant categories of respondents, while purposive sampling was used to select key informants because they possessed relevant knowledge and experience concerning electric mobility initiatives, regulation, infrastructure, and urban transport activities.

The study used both primary and secondary data to obtain relevant information concerning Electric Two-Wheeler

Initiatives and Urban Transport Efficiency. Primary data were collected using structured questionnaires and semi-structured interviews. The questionnaire collected quantitative information concerning the availability, accessibility, usage, reliability, and operational performance of electric two-wheelers and their contribution to Urban Transport Efficiency. Interviews were conducted with purposively selected key informants to obtain detailed information concerning the implementation, management, regulation, challenges, and opportunities associated with electric two-wheeler initiatives. Secondary data were obtained through the review of government reports, policy documents, regulatory frameworks, project reports, and other relevant publications related to electric mobility and urban transport in Rwanda.

The research instruments were subjected to piloting, validity, and reliability assessment before the main data collection exercise. The questionnaire consisted of structured, closed-ended statements mainly measured using a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). The questionnaire items focused on Electric Two-Wheeler Initiatives and Urban Transport Efficiency. A pilot study involving approximately 10% of the sample size, equivalent to 33 respondents, was conducted to assess the clarity, relevance, structure, and feasibility of the instruments. The pilot respondents were excluded from the final study to avoid bias. Content validity was assessed through expert judgment and the Content Validity Index (CVI), while reliability was assessed using Cronbach's Alpha coefficient. A CVI of 0.70 or above was considered acceptable, while values above 0.80 indicated strong validity.

The collected quantitative data were coded, entered, cleaned, and analyzed using SPSS, while qualitative information obtained from interviews was organized and analyzed thematically. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' characteristics and their perceptions of Electric Two-Wheeler Initiatives and Urban Transport Efficiency. Inferential analysis involved Pearson Product-Moment Correlation to determine the direction and strength of the relationship between Electric Two-Wheeler Initiatives and Urban Transport Efficiency. Simple linear regression analysis was then used to determine the influence of Electric Two-Wheeler Initiatives on Urban Transport Efficiency.

Simple linear regression analysis was used to determine the influence of Electric Two-Wheeler Initiatives on Urban Transport Efficiency and to test the research hypothesis at a 5% level of significance ($p \leq 0.05$). The regression model was expressed as $Y = \beta_0 + \beta_1 X_1 + \varepsilon$, where Y represented Urban Transport Efficiency, X_1 represented Electric Two-Wheeler Initiatives, β_0 represented the constant, β_1 represented the regression coefficient, and ε represented the error term. The analysis therefore established whether Electric Two-Wheeler Initiatives had a statistically significant influence on Urban Transport Efficiency in Nyarugenge District. Ethical principles were observed throughout the research process, including obtaining permission, informed consent, voluntary participation, confidentiality, anonymity, secure data handling, and honest reporting of findings.

Ethical principles were observed throughout the study by obtaining the necessary permission and informed consent from participants. Participation was voluntary, and respondents were informed of their right to withdraw at any time. Confidentiality and anonymity were maintained, and the information collected was used strictly for academic purposes. The researcher ensured that participants were not exposed to physical, psychological, or social harm and maintained honesty, objectivity, and integrity throughout data collection, analysis, and reporting.

4. Result and Discussion

This section presents the findings and discussion of the study on the role of Electric Two-Wheeler Initiatives on Urban Transport Efficiency in Nyarugenge District, Rwanda. The findings are presented and discussed in relation to the study objective, which was to assess the role of Electric Two-Wheeler Initiatives in Urban Transport Efficiency. The chapter presents the response rate, demographic characteristics of respondents, descriptive findings, correlation analysis, regression analysis, hypothesis testing, and discussion of the findings.

4.1 Results

The findings are presented based on data collected from respondents through questionnaires and interviews. Quantitative data were analyzed using descriptive statistics, Pearson Product-Moment Correlation, and simple linear regression analysis. Qualitative information obtained through interviews was analyzed thematically to complement the quantitative findings. The presentation focuses specifically on the relationship between Electric Two-Wheeler Initiatives (X_1) and Urban Transport Efficiency (Y).

4.1.1 Response Rate

The study targeted a sample size of 333 respondents. Of these respondents, 303 questionnaires were administered to electric two-wheeler users and electric four-wheeler users, representing 91.0% of the total sample. Out of the 303 questionnaires distributed, 279 were successfully completed and returned, yielding a response rate of 92.1%. However, 24 questionnaires were not returned, representing 7.9% of the distributed questionnaires. In addition, 30 key informants were interviewed, comprising 4 Charging Infrastructure Managers, 2 Nyarugenge District Transport Staff, 1 National Transport/Regulatory Employee, and 23 E-Mobility Support Staff. These respondents were purposively selected because of their direct involvement in the planning, implementation, regulation, and promotion of electric mobility initiatives in Nyarugenge District.

Table 1: Response Rate of Respondents

Response Rate	Frequency	Percentage (%)
Questionnaires Returned	279	92.1
Questionnaires Not Returned	24	7.9
Total	**303**	**100**

Source: Field Data, 2026

The high response rate indicates a strong level of participation among respondents and provided sufficient data for reliable analysis and interpretation. According to Mugenda and Mugenda (2003), a response rate of 70% and above is considered very good for analysis. Therefore, the response rate of 92.1% achieved in this study was considered excellent and adequate for drawing valid conclusions regarding the role of electric mobility projects on urban transport efficiency in Nyarugenge District, Rwanda.

4.1.2 Descriptive Statistics of Electric Two-Wheeler Initiatives

Table 2 presents respondents' perceptions regarding electric two-wheeler initiatives in Nyarugenge District. A five-point Likert scale was used where 5 = Strongly Agree (SA), 4 = Agree (A), 3 = Neutral (N), 2 = Disagree (D), and 1 = Strongly Disagree (SD). The analysis was intended to assess how electric two-wheeler initiatives contribute to urban transport efficiency.

Table 2: Descriptive Statistics on Electric Two-Wheeler Initiatives

Statements	N	Mean	Std.
Electric motorcycles (e-motos) are widely available within Nyarugenge District.	279	4.3	0.78
I frequently use electric motorcycles for daily commuting.	279	4.1	0.84
The availability of electric motorcycles reduces my waiting time for transport.	279	4.4	0.69
Using electric motorcycles shortens my overall travel time compared to conventional motorcycles.	279	4.2	0.75
Electric motorcycles are reliable and accessible whenever needed.	279	4.3	0.73
Overall Mean		**4.26**	**0.76**

Source: Field Data (2026)

Table 2 presents respondents' perceptions regarding electric two-wheeler initiatives and urban transport efficiency in Nyarugenge District. The findings indicate that respondents strongly agreed that the availability of electric motorcycles reduces waiting time for transport (M = 4.4, SD = 0.69). Respondents also agreed that electric motorcycles are widely available within Nyarugenge District (M = 4.3, SD = 0.78) and that they are reliable and accessible whenever needed (M = 4.3, SD = 0.73). These findings suggest that electric motorcycles have become an important component of the urban transport system by providing readily available transport services for commuters. The findings further reveal that respondents agreed that using electric motorcycles shortens overall travel time compared to conventional motorcycles (M = 4.2, SD = 0.75). Similarly, respondents indicated that they frequently use electric motorcycles for daily commuting (M = 4.1, SD = 0.84). These findings imply that electric motorcycles have improved mobility by reducing travel delays and providing convenient transport services within Nyarugenge District.

The overall mean score of 4.26 with a standard deviation of 0.76 indicates that respondents generally agreed that electric two-wheeler initiatives have made a positive contribution to urban transport efficiency. The relatively low standard deviation further suggests that respondents shared similar views regarding the positive influence of electric motorcycles on accessibility, travel time, and reliability of urban transport. From the findings, the study revealed that electric two-wheeler initiatives play a significant role in enhancing urban transport efficiency. The results indicate that the increased availability and accessibility of electric motorcycles have reduced commuter waiting time, shortened travel time, and improved the reliability of urban transport services. These findings imply that expanding electric motorcycle initiatives can contribute to more efficient, accessible, and sustainable urban transport systems in Nyarugenge District.

The qualitative findings from the interviews further supported the quantitative results regarding the role of electric two-wheeler initiatives in enhancing urban transport efficiency. The majority of interviewees indicated that the introduction of electric motorcycles has improved the accessibility of transport services while reducing operational costs for operators. Respondents explained that battery-swapping technology and improved vehicle reliability have enabled operators to serve more passengers with fewer interruptions during daily operations.

One respondent explained: *"The introduction of electric motorcycles has transformed urban transport in Nyarugenge. Operators spend less time looking for fuel because battery-swapping stations are readily available, allowing them to serve more passengers within a shorter period. This has improved transport efficiency and increased customer satisfaction."* Another respondent emphasized that electric motorcycles have reduced commuter waiting time because more vehicles remain operational throughout the day. *"Electric motorcycles are available almost throughout the day because replacing batteries is faster than refueling conventional motorcycles. This has significantly reduced waiting time for passengers and improved transport services."* Similarly, another respondent highlighted that electric motorcycles have contributed to environmental sustainability while improving transport operations. *"Apart from reducing emissions, electric motorcycles are quieter and easier to maintain. Their growing adoption has improved the quality of transport services while supporting Rwanda's environmental sustainability agenda."*

These findings are consistent with the study by the International Energy Agency (2023), which found that electric two-wheelers reduce traffic congestion, lower greenhouse gas emissions, and improve commuter satisfaction through enhanced transport efficiency. The findings also agree with Smith and Johnson (2023), who established that electric motorcycles and scooters reduced travel time, improved service reliability, and enhanced commuter satisfaction in urban areas. Similarly, Green Mobility Africa (2024) found that structured deployment of electric motorcycles supported by battery-swapping stations significantly reduced travel time and improved transport reliability. The present findings further concur with Kabera and Uwizeye (2024), who reported that electric two-wheelers reduced operational costs, shortened travel time, increased commuter satisfaction, and contributed to improved urban transport efficiency in Kigali. These findings collectively support the view that electric two-wheeler initiatives play a significant role in improving urban transport efficiency.

4.1.3 Correlation Analysis

Pearson Product-Moment Correlation analysis was conducted to determine the direction and strength of the relationship between Electric Two-Wheeler Initiatives and Urban Transport Efficiency in Nyarugenge District. The correlation coefficient (r) was used to establish the strength and direction of the relationship, while the significance value (p-value) was used to determine whether the observed relationship was statistically significant at the 5% level of significance. The results were presented in Table 3:

Table 3: Pearson Matrix between independent variable and dependent variable

		Electric Two-Wheeler Initiatives	**Urban Transport Efficiency**
Electric Two-Wheeler Initiatives	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	279	
Urban Transport Efficiency	Pearson Correlation	.766**	1
	Sig. (2-tailed)	.000	
	N	279	279

Source: Field data, 2026

The results in Table 3 indicate that there is a strong positive relationship between Electric Two-Wheeler Initiatives and Urban Transport Efficiency ($r = 0.766$, $p = 0.000$). The positive correlation coefficient implies that improvements in electric two-wheeler initiatives are associated with improvements in urban transport efficiency. The significance value ($p < 0.05$) indicates that the relationship is statistically significant at the 5% level of significance. Therefore, the findings suggest that increased adoption and utilization of electric two-wheelers contribute positively to enhancing urban transport efficiency in Nyarugenge District. This may be attributed to the ability of electric two-wheelers to improve accessibility, reduce travel time, lower transportation costs, and provide a more environmentally friendly mode of urban transport. According to Cohen (1988), a correlation coefficient above 0.70 indicates a strong relationship between variables, further confirming the importance of Electric Two-Wheeler Initiatives in improving Urban Transport Efficiency

4.1.4 Regression Analysis

Simple linear regression analysis was conducted to examine the influence of Electric Two-Wheeler Initiatives on Urban Transport Efficiency in Nyarugenge District. The analysis was used to determine whether Electric Two-Wheeler Initiatives significantly predicted changes in Urban Transport Efficiency. The regression analysis focused on the direction and magnitude of the relationship between the independent variable and the dependent variable, as well as the proportion of variation in Urban Transport Efficiency explained by Electric Two-Wheeler Initiatives. The statistical significance of the regression model and coefficient was assessed at the 5% level of significance ($p \leq 0.05$). The results of the regression analysis are presented in the following tables.

Table 4. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.776[a]	.602	.600	.32223

a. Predictor: (Constant), Electric Two-Wheeler Initiatives

The results in Table 4 indicate a strong positive relationship between Electric Two-Wheeler Initiatives and Urban Transport Efficiency, as shown by R = 0.776. The R Square value of 0.602 indicates that Electric Two-Wheeler Initiatives explain 60.2% of the variation in Urban Transport Efficiency, while the remaining 39.8% is explained by other factors not included in the model. The Adjusted R Square of 0.600 shows that the model continues to explain approximately 60.0% of the variation after adjustment, with the small difference between R Square and Adjusted R Square indicating a relatively stable model. The standard error of the estimate of 0.32223 indicates the average difference between the observed and predicted values of Urban Transport Efficiency. Overall, the results suggest that Electric Two-Wheeler Initiatives have substantial explanatory power in relation to Urban Transport Efficiency.

Table 5. ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	43.455	1	43.455	418.500	.000[b]
	Residual	28.762	277	.104		
	Total	72.217	278			

a. Dependent Variable: Urban Transport Efficiency

b. Predictors: (Constant), Electric Two-Wheeler Initiatives

The results in Table 5 show that the regression model was statistically significant, with an F-value of 418.500 and a significance value of 0.000, which is below the 0.05 level of significance. This indicates that Electric Two-Wheeler Initiatives have a statistically significant influence on Urban Transport Efficiency. The regression sum of squares (43.455) is higher than the residual sum of squares (28.762), indicating that a substantial proportion of the variation in Urban Transport Efficiency is explained by Electric Two-Wheeler Initiatives. Overall, the results demonstrate that the regression model provides a significant explanation of the relationship between Electric Two-Wheeler Initiatives and Urban Transport Efficiency

Table 6. Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.789	.144		5.480	.000
	Electric Two-Wheeler Initiatives	.873	.043	.776	20.457	.000

a. Dependent Variable: Urban Transport Efficiency

The results in Table 6 show that Electric Two-Wheeler Initiatives have a positive and statistically significant influence on Urban Transport Efficiency. The unstandardized coefficient (B = 0.873) indicates that a one-unit increase in Electric Two-Wheeler Initiatives is associated with a 0.873-unit increase in Urban Transport Efficiency. The standardized beta coefficient ($\beta = 0.776$) further indicates a strong positive influence of Electric Two-Wheeler Initiatives on Urban Transport Efficiency. The relationship is statistically significant because the significance value is 0.000, which is below the 0.05 level. The t-value of 20.457 further supports the statistical significance of the predictor. Therefore, improvements in the availability, accessibility, reliability, and use of electric two-wheelers are associated with improved Urban Transport Efficiency in Nyarugenge District.

4.2 Discussion of Findings

This study examined the role of Electric Two-Wheeler Initiatives on Urban Transport Efficiency in Nyarugenge District, Rwanda. The findings indicate that electric two-wheelers make a positive contribution to urban transport efficiency. Respondents generally agreed that electric motorcycles are widely available within Nyarugenge District and are frequently used for daily commuting. They also indicated that electric motorcycles are reliable and accessible when needed. In addition, respondents reported that the use of electric motorcycles reduces passenger waiting time and shortens overall travel time compared with conventional motorcycles. These findings suggest that the availability and regular use of electric two-wheelers have improved the convenience and accessibility of urban transport services. The qualitative findings also supported this observation, as interview participants explained that battery-swapping technology allows operators to replace batteries quickly and continue serving passengers with fewer interruptions. This enables electric motorcycle operators to make more trips during the day and improves the continuity of transport services.

The findings from the correlation and regression analyses further demonstrate the important role of Electric Two-Wheeler Initiatives in Urban Transport Efficiency. The correlation analysis showed a strong positive relationship between the two variables, indicating that improvements in electric two-wheeler initiatives are associated with improvements in urban transport efficiency. The regression analysis similarly demonstrated that Electric Two-Wheeler Initiatives significantly influence Urban Transport Efficiency. This finding suggests that improvements in the availability, accessibility, reliability, and use of electric motorcycles can contribute to better transport outcomes in Nyarugenge District. The finding may be explained by the ability of electric motorcycles to reduce waiting and travel time while providing commuters with readily available transport services. The interview findings further indicated that electric motorcycles can reduce operational interruptions and costs for operators, allowing them to provide services more consistently. These findings are also consistent with the Diffusion of Innovation Theory, which emphasizes that the perceived advantages, usefulness, and compatibility of a new technology influence its adoption and integration into an existing social system.

The findings are consistent with previous studies cited in the research. The International Energy Agency (2023) reported that electric two-wheelers can reduce traffic congestion, lower greenhouse gas emissions, and improve commuter satisfaction through improved transport efficiency. Similarly, Smith and Johnson (2023) established that electric motorcycles and scooters can reduce travel time, improve service reliability, and enhance commuter satisfaction in urban areas. Green Mobility Africa (2024) also found that the structured deployment of electric motorcycles supported by battery-swapping stations can reduce travel time and improve transport reliability. In the Rwandan context, Kabera and Uwizeye (2024) reported that electric two-wheelers can reduce operational costs, shorten travel time, increase commuter satisfaction, and improve urban transport efficiency in Kigali. The consistency between these previous findings and the present study indicates that electric two-wheelers can provide important benefits to urban transport when they are adequately available, accessible, and supported by appropriate operational systems. Therefore, this study establishes that strengthening Electric Two-Wheeler Initiatives can contribute to more accessible, reliable, convenient, and efficient urban transport services in Nyarugenge District.

5. Conclusion and Recommendations

5.1 Conclusion

This study concludes that Electric Two-Wheeler Initiatives play a significant positive role in Urban Transport Efficiency in Nyarugenge District, Rwanda. The findings showed that electric motorcycles are widely available, frequently used for daily commuting, reliable, and accessible when needed, while also reducing commuter waiting time and shortening travel time compared with conventional motorcycles. The correlation and regression findings further confirmed a strong positive and statistically significant relationship between Electric Two-Wheeler Initiatives and Urban Transport Efficiency. Therefore, strengthening the availability, accessibility, reliability, and use of electric two-wheelers can contribute to more efficient, convenient, and reliable urban transport services in Nyarugenge District.

5.2 Recommendations

Based on the study findings on the role of Electric Two-Wheeler Initiatives on Urban Transport Efficiency in Nyarugenge District, Rwanda, the following recommendations are made:

1. Electric mobility operators should increase the availability and accessibility of electric motorcycles in Nyarugenge District to ensure that commuters can easily obtain transport services when needed. This would help further reduce passenger waiting time and improve the convenience of daily commuting.
2. Electric mobility operators should strengthen the reliability and continuous operation of electric motorcycles by ensuring effective maintenance and minimizing operational interruptions. Reliable services would help sustain shorter travel times and improve the consistency of urban transport services.
3. Government authorities and other transport stakeholders should support the expansion and adoption of electric two-wheeler initiatives through appropriate policies, awareness programs, and supportive measures. Increased adoption and utilization of electric motorcycles would strengthen their contribution to accessibility, reduced waiting time, shorter travel time, and overall Urban Transport Efficiency.

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