BUILT FORM

Assessing E-Motor Bikes Adoption: Challenges and Opportunities, The Case of Nyarugenge District

Albert Patrick Furaha [1†] **Jeanne Darc Mukashema** [2] **Jeannette Francine Ishimwe** [3] **Fidele Mwizerwa** [4] **Emmanuel Muyombano** [5] **Dyna Uwambajimana** [6]

[1]Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, Kigali, Rwanda, Email: furahaapatrick@gmail.com. [2]Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, Kigali, Rwanda, Email: jeannedarcmukashema41@gmail.com. [3]Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, Kigali, Rwanda, Email: jeannetteishimwe58@gmail.com. [4]Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, Kigali, Rwanda, Email: mwizerwaf@gmail.com. [5] Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, Kigali, Rwanda, Email: emmanuelmuyombano@gmail.com. [6]Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, Kigali, Rwanda, Email: dynamereki@gmail.com.

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Abstract

Electric mobility offers a sustainable solution to transportation-related environmental and socioeconomic challenges. This study assesses the adoption of electric motorbikes (e-motorbikes) in Kigali City, with a focus on Nyarugenge District. Using mixed methods literature review, GIS mapping, field observation, surveys, and stakeholder interviews. we evaluate user awareness, infrastructure, technical feasibility, and policy readiness. Despite high awareness (98%) and usage (97%), adoption remains low due to battery limitations, poor service access, and regulatory delays. However, respondents support e-motorbikes' environmental benefits and would adopt them with incentives. The study recommends expanding infrastructure, improving batteries, and fostering multisector collaboration to advance Rwanda's sustainable urban transport goals.

Research article

Introduction

Transportation is a fundamental driver of social and economic development, enabling mobility and facilitating trade, yet it is also one of the largest contributors to environmental degradation. Globally, the sector accounts for nearly a quarter of energy-related greenhouse gas (GHG) emissions, with road transport responsible for most of this output (Farahani et al., 2013). Emissions from vehicles, including carbon monoxide (CO) and nitrogen oxides (NOx), contribute

[†]**Contact** Albert Patrick Furaha, E-mail: furahaapatrick@gmail.com, Department of Spatial Planning, School of Architecture and Built Environment, College of Science and Technology, University of Rwanda, Kigali, Rwanda.

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significantly to urban air quality deterioration (Schuetzle et al., 1994). This underscores the urgent need to transition toward sustainable transport systems. Among the modes of transport, motorcycles are increasingly important in many developing regions because of their affordability, low operating costs, and efficiency (Bakker, 2019). However, their reliance on internal combustion engines (ICEs) exacerbates air pollution, noise, and fossil fuel dependency. Promoting the shift from traditional motorcycles to electric motorbikes (e-motos) has thus become a central strategy in sustainable urban mobility (Nguyen-Phuoc, 2023).

Globally, the motorcycle industry is expanding rapidly. In Asia, particularly in ASEAN countries, motorcycles account for more than 25% of the global market. By 2019, Indonesia had 106 million registered motorcycles, Vietnam 62 million, and Thailand 21 million (Nguyen-Phuoc et al., 2023). In Europe, 12% of vehicles are motorcycles, while in Africa they make up approximately 20% of the global registered motorcycle population. In Burkina Faso, motorcycles represent 85% of vehicles, and in Uganda they account for 70% (Ayetor et al., 2023a). This widespread reliance reflects both socioeconomic accessibility and mobility needs, but also highlights growing environmental concerns. To address these, countries worldwide are prioritizing e-mobility. China leads electric motorbike sales, with approximately 30 million units and a stock of 250 million, followed by Europe with 2.3 million, and other regions with around 1 million (Bakker, 2019). Aligned with the UN Sustainable Development Goals, many nations—including Denmark, France, India, and the UK—are working to phase out fuel-based motorcycles by 2030–2040 (Zainol et al., 2019).

In 2015, electric motorcycles were more dominant in various countries, including China (7%), Denmark, the Netherlands, and Japan (2-4%). China is leading electric Motorbike sales with approximately 30 million and a stock of 250 million, followed by Europe with 2.3 million, and the rest of the globe with about 1 million (Bakker, 2019).

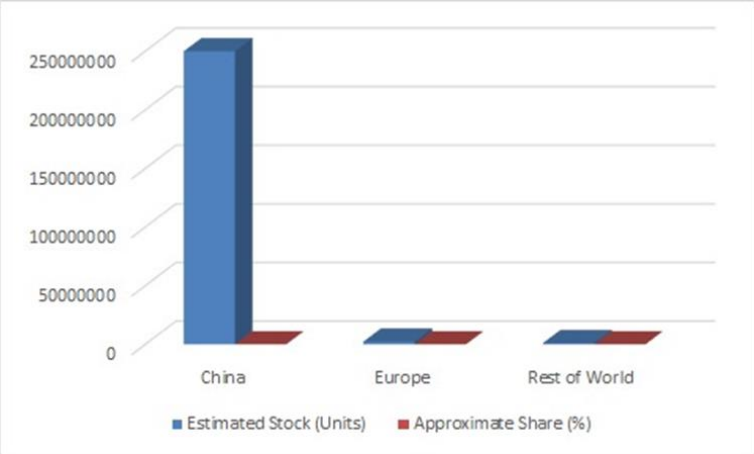

Figure 1. Global Electric Motorbike Stock Distribution (2015), (Bakker, 2019)

The figure above shows the status of 2015, electric motorcycles were more dominant in various countries, including China (7%), Denmark, the Netherlands, and Japan (2-4%). China is leading electric Motorbike sales with approximately 30 million and a stock of 250 million, followed by Europe with 2.3 million, and the rest of the globe with about 1 million (Bakker, 2019).

In Rwanda, motorcycles dominate the transport sector, accounting for 52% of the 221,000 registered vehicles in Kigali, with the fleet growing at nearly 12% annually (Umutoni et al., 2024). While they provide essential mobility, their proliferation raises concern over deteriorating air quality and increasing reliance on fuel imports, which account for 12% of the country's total import bill (Bajpai & Bower, 2020). In August 2019, the Government of Rwanda (GoR)

announced an ambitious plan to phase out ICE motorcycles and replace them with electric ones (Kalisa et al., 2021). The Ministry of Infrastructure (MININFRA) and the International Growth Centre (IGC) have since spearheaded e-mobility initiatives, while companies such as Ampersand, Spiro, and Gorilla have introduced e-motorbikes in Kigali. Government incentives, including zero VAT on electric vehicle equipment, tax exemptions on imports, and provision of land for charging stations, have been introduced to encourage adoption (MININFRA, 2021). Studies further show that e-motorbikes reduce emissions and improve driver income compared to conventional motorcycles (Niyonsaba et al., 2021).

Despite these initiatives, adoption remains low. According to RURA statistics, by 2025 only 1,016 electric motorbikes were registered in Nyarugenge District compared to 12,361 fuel-powered motorcycles. Barriers include limited charging infrastructure (Nshimiyimana, 2025), range anxiety (Wahab & Jiang, 2019), high upfront costs (Bajpai & Bower, 2020), long charging times (Vanitha et al., 2024), expensive spare parts, poor product quality, and inadequate mechanical services. Regulatory constraints and delivery delays also discourage potential users. These challenges have created a gap between government ambition and practical adoption on the ground.

Existing research highlights both the opportunities and barriers associated with e-mobility. The diffusion of innovation theory (Rogers, 2011) has been applied to explain adoption patterns, emphasizing comparative advantage, compatibility, complexity, trialability, and observability (Weil, 2018). The sustainable mobility framework highlights integration with broader social and environmental goals, including inclusivity and equity (Holden et al., 2019; World Bank, 2017). The circular economy emphasizes resource efficiency, recycling, and long-term sustainability (Potting et al., 2017; Malooly & Daphne, 2023). While these frameworks provide useful perspectives, there is limited empirical research applying them to Rwanda's e-mobility context. Most studies emphasize environmental benefits or high-level policies (Bajpai & Bower, 2020; Khan et al., 2022), but little attention has been given to user perceptions, infrastructural readiness, or the role of cultural and behavioral factors. Few studies have integrated GIS to analyze charging infrastructure distribution, and robust cost–benefit modeling for e-moto users is also lacking.

This study addresses these gaps by assessing e-motorbike adoption in Nyarugenge District of Kigali City through the following objectives: (1) assess the current awareness and use of electric motorbikes among motorcycle users and (2) Examine the major challenges hindering the widespread adoption of electric motorbikes as well as (3) identify the key opportunities in promoting the use of electric motorbikes in Nyarugenge district.

This comprehensive analysis seeks to provide evidence-based insights to guide Rwanda's transition toward sustainable mobility and to contribute to the global discourse on e-mobility adoption in low- and middle-income contexts.

Method and material

Study area description

One of Kigali's three districts is Nyarugenge. It consists 47 Cells, and 10 Sectors (Gitega, Kanyinya, Kigali, Kimisagara, Mageragere, Muhima, Nyakabanda, Nyamirambo, Nyarugenge, and Rwezamenyo). The Nyabarongo River forms the District's border and flows along practically its whole western and southern borders (Ministry of Education, 2017).

Moreover Nyarugenge District is located in the west of the city and occupies 134.2 km² (Nyiransabimana et al., 2019), 374,319 people, mostly men, lived in Nyarugenge District, accounting for 21.4% of the total population of the City of Kigali, according to the 5th Rwanda Population and Housing Census (PHC5)(Asiva Noor Rachmayani, 2015).

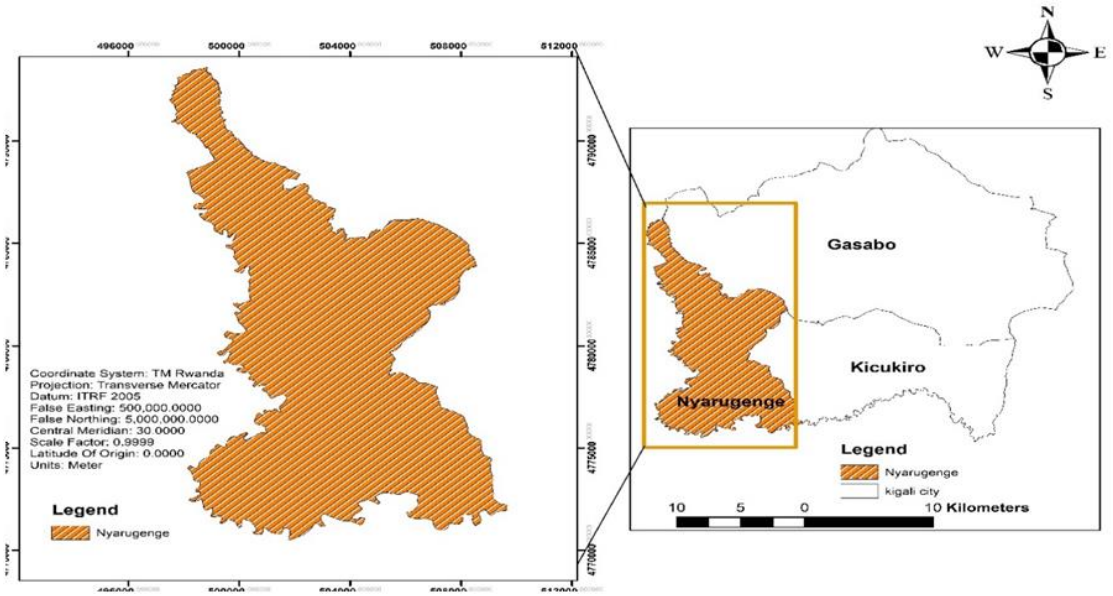

Figure 2. Administrative Map of Nyarugenge District (Prepared by the authors 2025)

During the initial stage of the study, the secondary data were used to gather information about an overview of electric e-motorbikes, their adoption, which gives us a solid foundation for any further analysis

Library research

In this section of library research, a survey of literature from requisite textbooks and articles from learned journals reveals important insights into the technologies relevant to electric vehicles, their environmental advantages and challenges, as well as relevant theses that provide local context.

Moreover, existing and planned Government policy documents were analyzed to review existing policies and regulations to determine what obstacles are present regarding the adoption of e-motorbikes and what supporting infrastructure, such as charging stations, would be required.

Moreover, this method provided with us insight on the role of governments in the adoption of electric vehicles through the analysis of financial incentives such as subsidies and tax incentives, in addition to public awareness campaigns.

Primary data collection

In the phase of primary data collection, information has been gathered using interviews, surveys as well as field observations. This provided a reasonable understanding of the various stakeholders' experiences, perceptions, and attitudes towards e-motorbikes

Interview

The interview was used to know the viewpoint of different people by assessing the challenge and opportunity adoption in Nyarugenge District, were we interviewed various interviewees among them were motorists who daily use that motorcycle of various companies, moreover we have also interviewed governmental officials, including CoK, MININFRA, RURA, RSB Furthermore we interviewed company representatives of Motorcycles, including Ampersand, Gorilla as well as Spiro.

The interview was conducted on 14th June and 16 June 2025.we have interviewed 100 motorists either in Nyarugenge district, we have also interviewed 300 passengers from Nyarugenge district some of them live in Nyarugenge district while others are not residents of Nyarugenge district.

Qualitative information regarding the experience of e-motorbike use has been collected from motorcycle taxi operators and users as well as government official. The interviews were guided by the following broad areas:

- Interview with motorist
  The interview with motorist was mainly carried out around parking area, charging facilities Those motorists have shared with us the insight on general operation of electric motorbike along with challenge they face in their daily working, furthermore they provide information about company representative about the service effectiveness and also information about quality for that motorcycle provided by those representative company.

- Interview with Motorcycle Commuter
  The study of Nyarugenge district's electric motorcycle commuters has enabled gaining insight into the awareness of the public on electric motorbikes, the problems faced by commuters day-to-day while using electric motorbikes, opportunities brought by electric motorbikes compared to traditional ICE. It has enabled us to know what suggestion, if any, the commuter has about this adoption. Interview with Government Officials
  This part enabled us to discuss with government officials such as CoK, RURA, MININFRA, RSB which give us insight on how the government utilizes electric mobility, especially electric motorbikes, how they are contributing to its widespread adoption, challenges they face, and opportunities, furthermore provided with the existing or planned policies and strategies for adoption. Thus, the paragraph discusses the details of how the interview went through each institution.
- Interview with E-Motorbike Company Representatives
  This interview has helped us to gain insight into the technical and operational perspective of electric motor bikes, such as battery lifespan, range, charging time, safety measures, as well as social-economic aspects. Moreover, we will also be looking analyzing infrastructure development, the point of transition to electric motorbikes, challenges in electric motorbikes, their opportunities, and strategies to advance.

Additionally, these company representatives were selected for this study based on analysis from charging stations available in Nyarugenge District where we found that only those three company representatives have charging facilities in our case studies. Generally, during the interview, both structured and semi-structured approaches incorporate a well-prepared question for interviewer as well as unplanned questions, but regarding our scope.

Survey

The surveys use a closed questions and open designed to collect respondents' perspective and opinion regarding electric motorbikes. Their understanding about e-motorbikes and its features will be evaluated along with the benefits of lower operating cost, environmental concern, and noiseless operation. Other barriers to adoption like high initial investment, lack of charging stations, and issues with battery lifespan will also be looked into.

In addition to that, the surveys assess respondents' readiness to adopt e-motorbikes as well as identify What factors were the most important in influencing their decisions, thus measuring their willingness to adopt. The collected data can assist researchers in looking for underlying themes and patterns that pertain to the barriers to adoption and develop plans to facilitate the adoption of e-motorbikes into the local transportation framework.

Field observation

Field observation has been done for the purpose of understanding the research problem as it has provided as with insights about the challenges and opportunities of electric motorbike adoption. Some data collected in Nyarugenge district through 10 Sectors (Gitega, Kanyinya, Kigali, Kimisagara, Mageragere, Muhima, Nyakabanda, Nyamirambo, Nyarugenge, and Rwezamenyo with the aim of observing charging station facilities, operational as well as challenges associated with them. During our field observation we have observed different companies and their motorist, the company which is mainly engaged in the road of Nyarugenge those are Ampersand, Spiro, Gorilla limited, moreover we observed different service they provide in terms of the period they take to charge or to switch batteries as well as distance between the charging facilities.

Application of GIS technology

GIS software has utilized to provide a location and map of our study area which helped us to describe research case study for further analysis, moreover the software was used to analyze and present data and information related to electric motorbike adoption, data such as road network used by e-motorbike, main motorcycle parking area, and charging facilities were mapped, moreover GPS device was used to capture the coordinates at every charging station in Nyarugenge District.This analysis has provided us with solid information for general understanding the adoption with associated physical as well as socioeconomic challenges and opportunities.

Table 1. The map with data type, their source as well as output

Product/Map	Data Type	Attribute	Data Source
Map of Nyarugenge District	Polygon	Administrative boundaries	DIVA_GIS
Map showing charging Station distribution	Point	Charging infrastructures coordinate	UTM_GPS
Map showing served sector in Nyarugenge District	Point, polygon	Charging infrastructures coordinate, Sector data	DIVA_GIS,UTM_gps
Charging Infrastructure Coverage for Electric Motorbikes (Service Area Analysis)	Point, polygon, polyline	Charging station buffered	All sources above

Techniques

We have employed various techniques such as a questionnaire, recording verbally, as well as sampling techniques as detailed in part below.

Questionnaire

This technique was used as a guiding interview for chosen government officials, a selected sample of motorist as well as motorcycle commuters the main objectives it was to gather general information on current adoption of electric motorbikes with barriers, opportunities as well as suggestions for improvement from a representative point of view additionally the questionnaire consisted of close-ended, semi-open, and open-ended questions.

Questionnaire Structure Depending on huge number of expected responder, most question were close ended ,First section was designed to welcome responder and introduce them about the electric motorbike adoption, questionnaire were formed in way that it not record the responder email, name or contact number ,we have choose this way because we want responder to feel free in providing their opinion, moreover question was made of seven section which was designed in

way that we can achieve all 3 objective as mentioned in 1.3 subpart of this document, moreover it was designed in google document to allow efficiency in data collection.

Appendix (6) shows a sample of the General guiding questionnaire

Recording

This technique also helped us to store information gathered through some interviews in case the questionnaire seems inappropriate, moreover, helped us for store information for further analysis. Additionally, recording techniques were among the most motorists as well as some of motorcycle commuters since they had limited time.

Sampling design and rationale

The research final decision represents the whole individual or organization, however in reality, only a representative sample is chosen. As a segment of the wider population, it requires less money, time, and labor(references).

During data collection in our research, sampling techniques were also applied among electric motorcycle motorist, commuter, government officials concerned with e-mobility as well as company representatives that seems to operate most in Nyarugenge district. For motorist and motorcycle commuter simple random sampling type used by which the population must be homogeneous and every element contain same kind of characteristic that meet the described criteria, in addition to that since the motorists was unevenly distributed and time was limited; thus, random electric motorists were interviewed.

The sample size was calculated using Yamane formula (Naing, 2003)

(Yamane's):

$$n = \frac{\mathbf{N}}{\mathbf{1+N(e)^2}}$$

Where:

n = sample size

N = population (motorist)

e = margin of error (e.g., 5% or 0.05)

Thus, the Nyarugenge population according to recent population survey (nisr, 2023)

As follow:374,319

$$n = \frac{\mathbf{374319}}{\mathbf{1+374319(e)^2}} \approx 399.5 = 400$$

On other hand, Government official and company representatives were sampled based on purposive sampling were, this sampling technique was found appropriate since the government officials to be interviewed were chosen based on criteria such as the type of data needed and those with a high interest in our research as well as electric motorbike company representative since they have chosen based on condition thus, Only those with a charging station located in Nyarugenge district were interviewed. See table for motorist and motorcycle commuter.

Table 2. The sample population for motorcycle commuters and motorists

Occupation	Total population	sample	Sample by occupation
Motorist	374,319	400	100
Commuter			300

Table 1. Summary of the sample for government officials and company representatives

Occupation	Sample size
Government officials	4
Company representatives	3

Methodological framework

The Methodological framework summarizes the methods, techniques and sampling design that used in assessing the adoption of electric motorbike challenges and opportunities in Nyarugenge sector (see Figure 3).

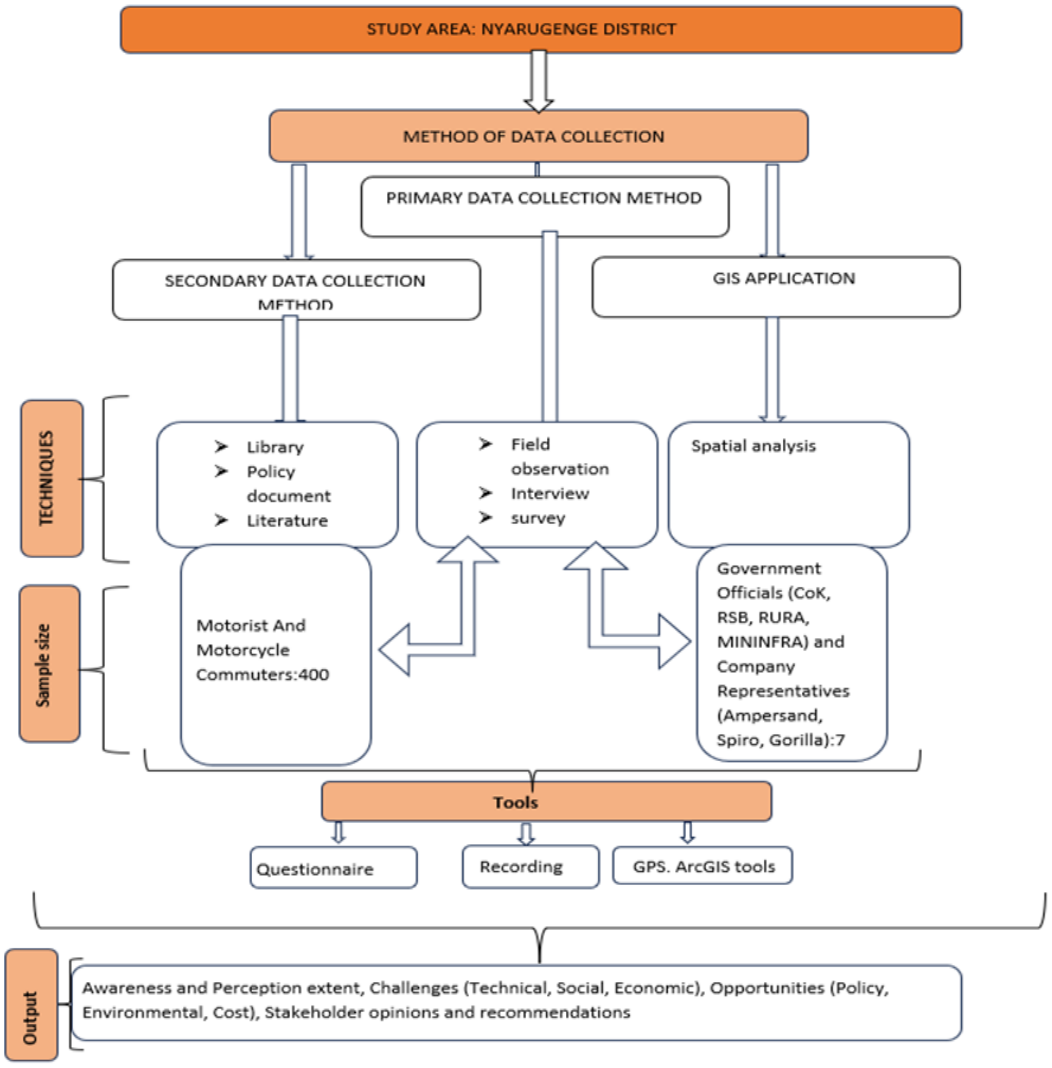

Figure 3. Methodological workflow

Results

This part presents the findings from the overall data collected. Moreover, it provides results of the analysis as well as interpretations. In this chapter, the objectives and research questions are discussed. It includes finding about current awareness and use of electric motorbikes among motorcycle users, the significant challenges hindering the widespread adoption of electric motorbikes as well as key opportunities in promoting the use of electric motorbikes in Nyarugenge district and what it implies.

General information

This section gives an overview of participants' age, gender, occupation as well as whether they live in Nyarugenge district or not, Moreover the number of respondents stated in methodology were asked, among 401 Responses 44% were between 18_25 age Groupe, only 2% were above 50 years as shown on figure(4) , participant 49% were male while 43% as shown on figure(4),Moreover most of them reside in Nyarugenge district see figure working most in occupation such as Student, motorist, self-employed ,Passenger, Driver, Business, unemployed, technician, engineer (see Figure 5).

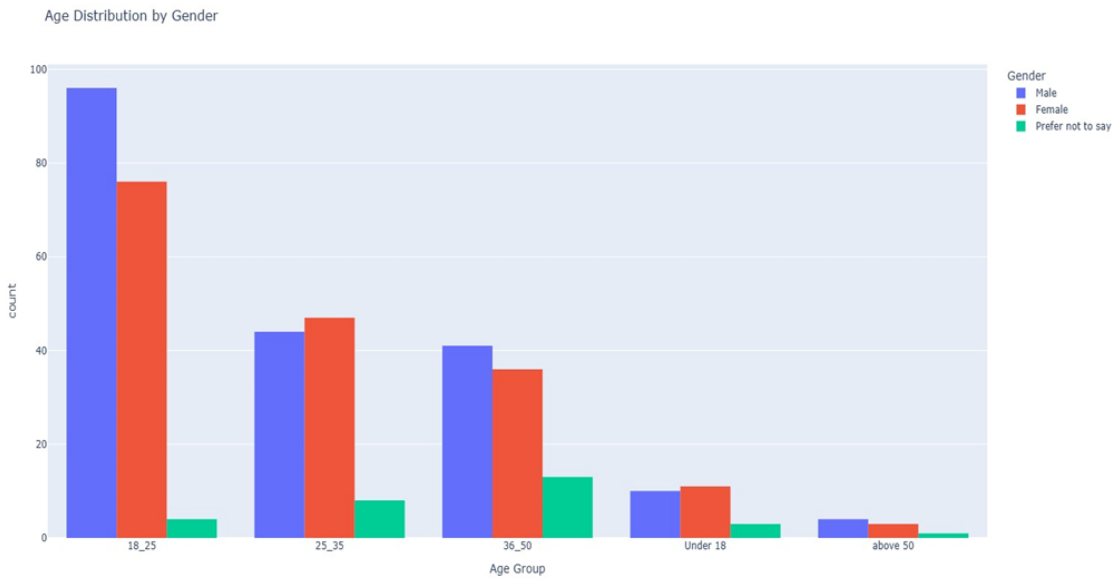

Figure 4. Age distribution of respondents showing that most participants were aged 18–25, followed by 25–35 and 36–50 with gender characteristics

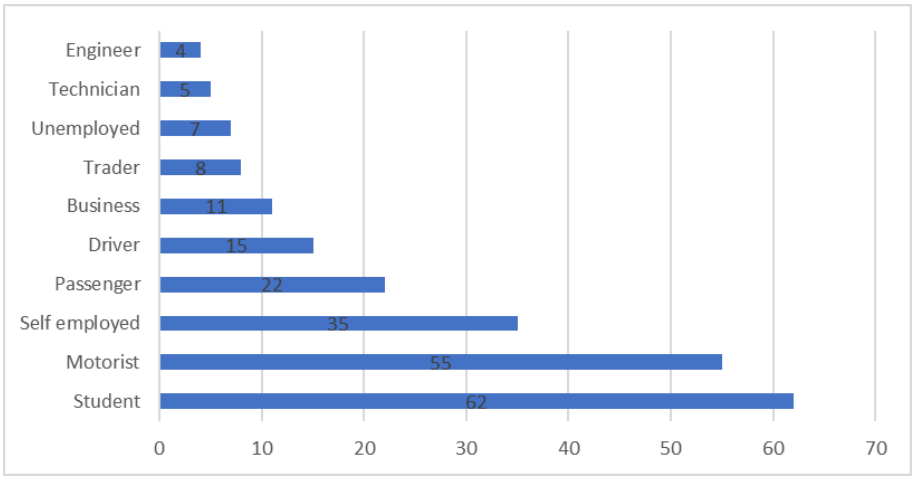

Figure 5. The occupation frequencies among participants

Awareness and usage of e-motos

The data collected indicated that familiarity and usage among Nyarugenge district participant are very high at extent of 98% of those heard about electric motorbike and 97% experienced it as commuter or even motorist (see Figure 6).

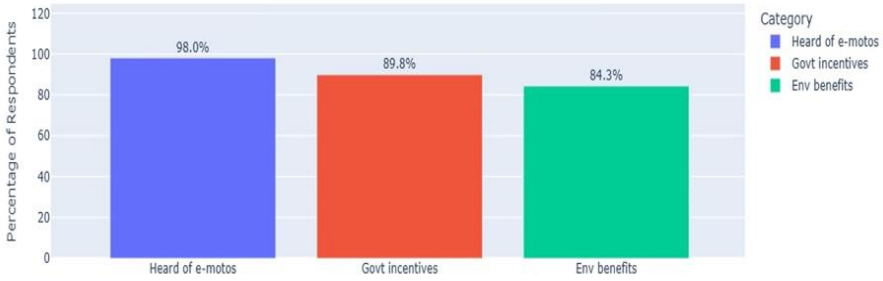

Figure 5. Awareness levels of respondents, showing that most have heard of e-motos, fewer know about government incentives, and many believe in environmental benefits.

Figure 6. Satisfaction levels of respondents who have used e-motos, with most reporting positive experiences.

Apart from that, the perception of using electric motorbikes shows that 65% of users shared a satisfaction level of 4 or 5 out of 5, which is very good. On the other hand, a very small percentage of 2.5% showed negative satisfaction, as shown in the figure 6. above. This result shows that the public awareness and engagement with electric mobility approach as already improving but also there is battle is not yet over, those 2.5% means something and need to be targeted. Moreover,

registered electric motorcycle is still low compared to fuel motorcycle in Kigali city, especially in Nyarugenge district, according to RURA the registered fuel motorbike was 53,347 while electric motorbike in Kigali city 14,792, on other hand Nyarugenge as case studies registered fuel motorbike are 12,361 while electric motorbike is 1,016, see figure (7) from 2023_2025. This huge gap indicates that although awareness which is high in Nyarugenge District, but the high awareness does not mean high yet it is still at lower stage in overall usage among communities.

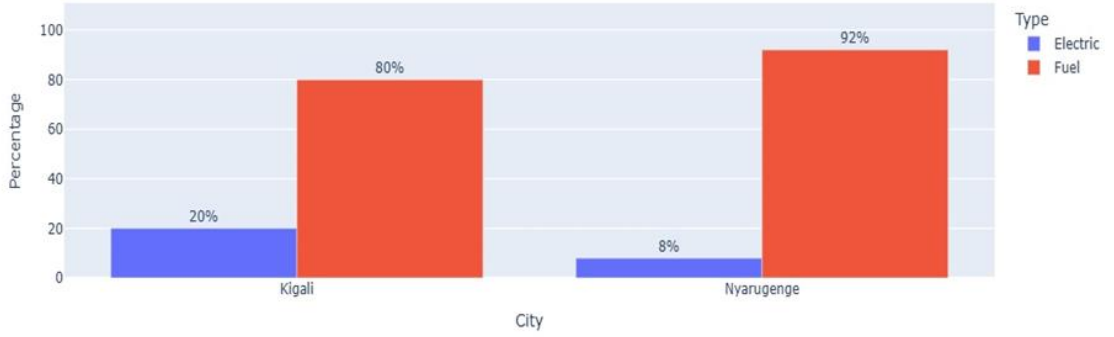

Figure 7. Comparison of motorbike usage between Kigali City and Nyarugenge District.

Motorbike usage in Kigali City, where 20% of motorbikes are electric and 80% fuel-powered.

Motorbike usage in Nyarugenge District, where only 8% are electric while 92% remain fuel-powered.

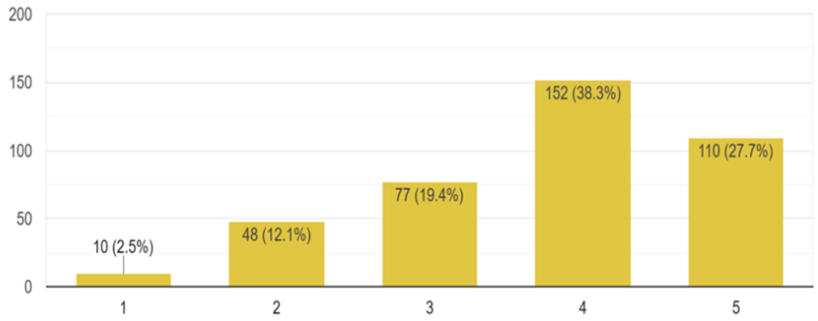

Figure 8. The level of experience with electric motorbikes by percentage

Barriers to adoption

Although electric motorbike awareness seems to be high, this technology still faces several barriers noted in our research; generally, the barriers for electric motorbikes worldwide are almost the same in our context. Both Situational, technical AND socioeconomic limitation are most prevalent in Nyarugenge district. Limitations such as a few charging stations, range anxiety and unreliability, long charging time, the expense of spare parts for electric motorbikes, low standard product quality, regulatory gaps, slow delivery of electric motorbikes purchased, as well as financial gaps are most reported by both interview and respondents in the adoption of electric motorbikes.

Charging station gap

More than 41% of respondent reported that lack of charging station in area is the main reason that make them unwilling to use electric motorbike, in addition to that spatial analysis in Nyarugenge district by with data collected using GPS on charging station show that only Nyamirambo, Muhima, Kimisagara, Nyarugenge, Rwezamenyo, Kigali, Gitega as well as Nyakabanda sector are only one with charging station among 10 sectors of Nyarugenge district thus, this highlights the limitedness of charging station see figure(9) where even if many sector seems to be covered put those charging station are concentered in one region.

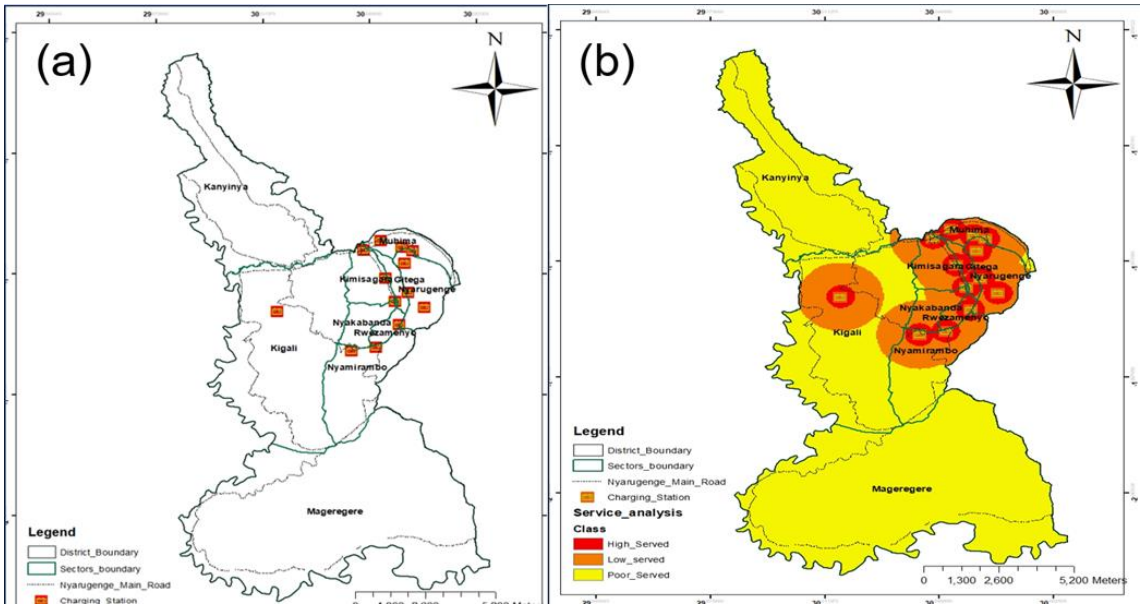

Figure 9. Charging station availability and service coverage in Nyarugenge District. (a) Spatial distribution of charging points across the district. (b) Service coverage analysis showing high-, low-, and poorly-served sectors

Moreover, few charging station also is challenge because sometime one charging station may have unexpected issues such as lack of electricity, for instance during interview charging station of ampersand located in Nyamirambo were out of electricity that day, thus many motorists were not working that time. Additionally, it is critical that motorcycle can operate in one district so limitedness of charging station in other part of countries make electric motorbike less preferred.

Range anxiety and reliability

Report from responder shows that apart from 41 % of charging station over 27% are afraid to use electric motorbike due to low range of battery mostly between 50_90km per charge depend on company, this make electric motorbike user limiter to some trip where they are afraid that battery may run off before reaching their destination or going back to origin.

Among interview most of them talked about unreliability of battery technology by which battery may switch of unexpectedly, non-uniform range for full battery are concern confirmed by respondent and interviewer. Additionally, concern of battery life is other most prevalent, unfamiliarity with technology as new trend, preferences on fuel motorbike, lack of trust make up about 7%.

Product quality

Another concern raised by motorist is strength of electric motorbike parts, interviewee showed that his electric motorbike has started to show sign of deteriorating only in not more than 2 years usage, unlike his other owner who uses fuel motorbike that lasted over 12 years Thus, this highlight barrier to adopt this kind of motorbike because many motorists are afraid of risk, maintenance.

Poor mechanical services

This led financial burden since most of motorcycle company over charge the owner by not considering the challenges for example: motorist my spend days or week with mechanical issues searching for either for spare part waiting or poor service given by company and he/she is obliged to pay a given amount,

Inappropriate rules and regulation

This also most issues highlighted by motorist for instance electric motorbike cannot go beyond three days not working and it is only allowed to be used by owner which become serious issues when user faces unexpected circumstance such sickness, family situation and other put them on pressure so that limit other to use them.

Long charging time

Electric motorbike, such as gorilla, can be charged up to 30 minutes, make motorist limited to work whole day, and this lead to long waiting for charging station.

Insufficiency and high price for electric motorbike spare parts

This makes it also less preferred by which only company representative of electric motorbike is the one that can sell spare part this make it few on market, not only that their price is high compared to those of fuel motorbike one piece of Sprocket which cost more than 5000frw while one fuel is 1000frw. For that sprocket of electric motorbike is frequently insufficient on market sometime, which led some to fabricate them and this can lead to risk of accident. other technical challenges such hand brake, by which many motorists are not satisfied by taking brake using hand which limit user to perform another task that need hand usage such as transaction on steep road become difficult. Moreover, late in deliver of electric motorbike is still issues, by which the client waits for over 4 months after paying electric motorbike, most interview raised concern

Table 4. The challenges and their frequencies among motorists

Challenges	Frequency level
Lack of charging station	High
Low range	Very high
Poor battery performance	Moderately
Poor regulation by motorbike company owner	Very high
Poor maintenance services	Moderately
Poor standard quality	Moderately

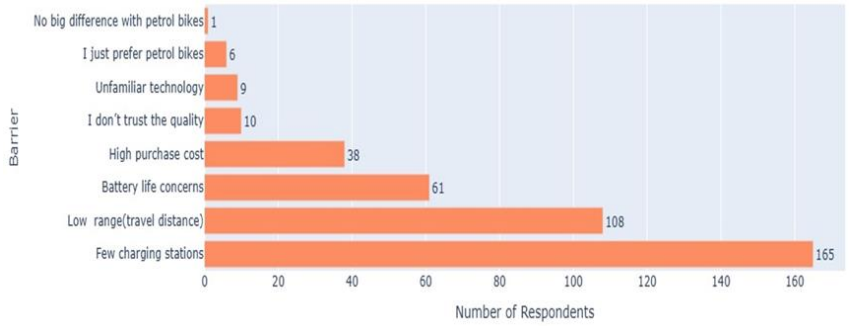

Figure 10. Challenges facing electric motorbike adoption

Figure 10 shows that lack of charging station, low range, battery life concern and lack of trust for quality are the most issues raised my respondent

Opportunities for adoption

The results provide strong evidence supporting the adoption of electric motorbikes. A large majority of respondents (85.6%) indicated that electric motorbikes help reduce air pollution, suggesting that users associate their adoption with environmental benefits. Significant cost differences between fuel and electric motorbikes is highlighted, with replacement parts such as tyres and mirrors being consistently cheaper for electric motorbikes. For example, the rear tyre for a fuel motorbike costs 50,000 RWF, while the same part for an electric motorbike is only 15,264 RWF. This indicates that the adoption of electric motorbikes reduces the financial burden of maintenance. In addition, users experience noticeable fuel savings is significant, with the largest proportion (40.9%) saving between 1,000–5,000 RWF per trip, while others reported even greater savings of over 10,000 RWF. These results demonstrate that both economic and environmental advantages are recognized by users, underscoring the favorable conditions for wider adoption of electric motorbikes.

Figure 11. Encouragement factors for adopting e-motos

Moreover, opportunities such as increasing charging station as well as battery range, more government subsides, more swap options, campaign about awareness, free or low maintenance cost highlighted as preferred an opportunity that can encourage electric motorbikes as indicated on Figure 11. In addition to that interview with informed the City of Kigali informed us that hosts e-mobility stakeholder engagements at City Hall, using these platforms to communicate developments and collect feedback. These awareness efforts target e-mobility in general, not specifically electric motorcycles. Other incentives such as lowering price on standard product to electric vehicle demand is the one tool that Rwanda Standard Board uses. Collaboration between

government officials such as COK, MININFRA, MINEMA, RSB are at highly level as well as those of company representatives.

Government incentives and support for electric vehicles, such as tax exemptions, free parking, and direct financial assistance to electric vehicle show the can positively affect the willingness of user at more than 81% as shown on Figure 12.

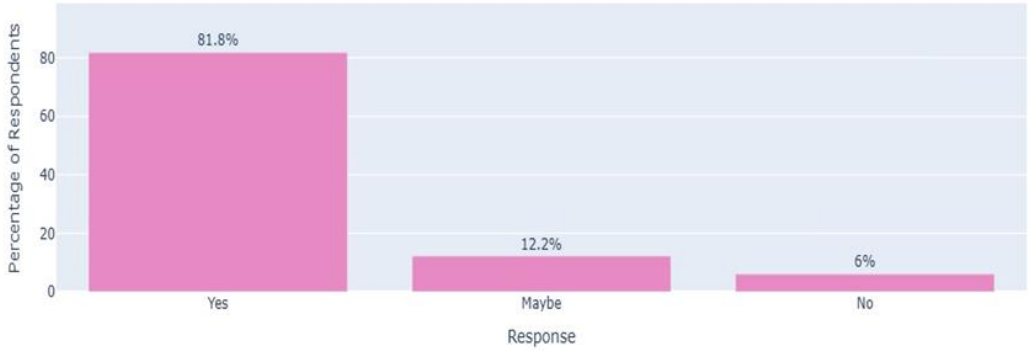

Figure 12. Willingness to switch if the government offers an incentive

Discussion

A major issue identified is the high upfront cost of e-motorbikes, compounded by limited financing options. Respondents consistently noted that although e-motorbikes offer fuel savings, the initial purchase price remains unaffordable for many riders whose income depends on daily motorcycle transport. This finding aligns with global research showing that affordability is a decisive factor in low- and middle-income countries (Priya Uteng & Turner, 2019). In such markets, cost barriers often outweigh long-term operational savings.

Another important obstacle that surfaced was infrastructure. According to GIS data, many areas of the district are underserved, as battery-swapping and charging outlets are concentrated in a few sectors. When going outside these locations, riders expressed concerns about range restrictions. The International Energy Agency (IEA) indicates that one of the biggest obstacles to the global adoption of electric two-wheelers is inadequate and unevenly distributed charging infrastructure (Selva, 2024). This scenario is consistent with larger international findings.

However, several opportunities were identified. The claim that electric mobility aligns with Rwanda's low-emission development objectives is supported by respondents' emphasis on fuel savings, reduced maintenance, and environmental benefits as primary motivators. According to (Aidam et al., 2025) from 2023, Sub-Saharan Africa can quickly decarbonize its transportation sector by electrifying motorcycle vehicles, given its lead in urban mobility.

Battery performance and charging time present another difficulty. Respondents raised concerns about battery longevity and the potential for revenue loss from extended charging times. These operational issues are consistent with research from other developing nations where commercial riders are deterred by battery dependability, range anxiety, and slow charging (Simwaba & Qutieshat, n.d.). In line with worldwide evidence that markets with little local manufacturing frequently face lengthy supply chains and maintenance issues, riders also reported delays in acquiring new units, a lack of spare parts, and unclear servicing procedures.

These results are further contextualized through international comparisons. For example, China's high adoption rates show how strong government incentives, local manufacturing, and dense charging networks hasten the uptake of electric two-wheelers (Kim et al., 2025). In the meantime, Southeast Asian nations like Vietnam and Indonesia show how battery-swapping

models benefit commercial riders by lowering downtime (Anuchitchanchai et al., 2025). These worldwide trends support the significance of the difficulties seen in Nyarugenge and point to possible solutions.

According to the study's overall findings, Nyarugenge District is still in the early stages of e-motorcycle adoption. Although adoption is hampered primarily by cost, uneven infrastructure availability, battery-related issues, and policy gaps, awareness is high and potential benefits are widely acknowledged. Scaling e-motorbike usage in the district will require addressing these obstacles through focused funding programs, infrastructure development, technical standards, and well-coordinated public-private partnerships.

Conclusion and recommendations

This study examined the adoption of electric motorbikes in Nyarugenge District and revealed that uptake is influenced by both opportunities and barriers. Awareness is remarkably high, with over 98% of respondents having heard of e-motorbikes and 97% having tried them at least once. However, ownership and consistent use remain low compared to internal combustion engine (ICE) motorcycles.

Several key challenges limit adoption: limited charging stations, range anxiety, long charging times, high costs of spare parts, declining product quality, regulatory gaps, and delays in the delivery of purchased e-motorbikes. These challenges are critical in Nyarugenge, where motorbike transport is central to daily life, supporting economic activities for over 70% of the population across distances of up to 40 km.

Despite these barriers, the study highlights significant opportunities. Government incentives such as VAT exemptions, combined with lower fuel costs, potential reductions in air pollution, and strong stakeholder willingness, provide a strong foundation for expanding e-motorbike use. The study concludes that while awareness is not a problem, infrastructure, regulations, and supply-chain efficiency must be strengthened. A collaborative approach involving government, private sector, and civil society is essential for successful transition to sustainable electric mobility in Rwanda.

To enhance adoption, the following actions are recommended:

- Strengthen Incentives: Maintain tax exemptions, import duty reductions, and regulatory clarity to promote EV adoption.
- Enhance Public–Private Collaboration: Expand clean-energy charging stations in both cities and rural areas.
- Integrate Policies into Frameworks: Develop binding national and local regulations governing infrastructure, accessibility, and standards.
- Improve Battery Capacity: Encourage innovation to extend battery life, reduce charging frequency, and ease pressure on infrastructure.
- Regulate Spare Part Pricing: Establish transparent price controls to prevent exploitation and ensure affordability.
- Promote Research on Sustainability: Support studies on recycling, circular economy practices, and long-term environmental impacts of e-motorbike adoption.
- Overall, e-motorbikes hold strong potential to transform Rwanda’s transport sector, but success depends on strategic interventions that align infrastructure, affordability, policy, and innovation.

Disclosure statement

The author reports there are no competing interests to declare.

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