

Effect of hybrid vehicles adoption on socio-economic development in Rwanda, a case of Kicukiro District

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ABSTRACT

The study examined the effect of hybrid vehicles adoption on socio-economic development in Rwanda, with a focus on Kicukiro District. The study was underpinned by Sustainable Development Theory whose proponent is the Brundtland Commission (1987). The theory highlights that the needs of the present need not compromise the future needs for the coming generation. A descriptive research design was adopted, and the target population was 1587 individuals including hybrid vehicles users, mechanics and dealers randomly selected in 4 automobile garages located in Kicukiro District. The sample size was 188 respondents using questionnaires and interviews. They were analyzed using descriptive statistics and correlation analysis. The findings show that fuel efficiency is the main motivation for adopting hybrid vehicles, accounting for 77.7% of respondents followed by government incentives represented by 10.1% of respondents while environmental concerns were represented by 5.9% of respondents. This indicates that awareness is mainly driven by economic considerations rather than environmental factors. Results further show strong agreement that hybrid vehicles contribute to socio-economic development. The highest perceived benefit is improvement of public health through reduced pollution as proved by the mean value of 4.85, followed by reduction of fuel costs represented by the mean value of 4.74 and increased income and profitability with the mean value of 4.65. Other benefits include reduced transport costs with the mean value of 4.61 and promotion of environmental sustainability with the mean score of 4.52. However, lower agreement was recorded for reduction of public transport costs was proved by the mean value of 3.86 and support to overall economic growth with mean value of 3.85. The study established a strong positive relationship between hybrid vehicle adoption and income generation ($r = 0.871$, $p = 0.009$), indicating that increased adoption significantly improves economic outcomes through cost savings and improved efficiency. The findings also show moderate to high agreement that government efforts support hybrid vehicle adoption. Public awareness campaigns were rated highly with the mean value of 4.25 followed by government promotion of eco-friendly vehicles with mean value of 4.15. However, respondents reported weaker perceptions regarding infrastructure development, such as servicing facilities and charging stations indicating infrastructural gaps. In conclusion, the study finds that hybrid vehicle adoption positively contributes to socio-economic development in Kicukiro District, mainly through fuel savings, improved health, and increased income. However, limited environmental motivation and inadequate infrastructure hinder wider adoption. Strengthening awareness, improving infrastructure, and enhancing policy support are recommended to maximize benefits.

Keywords: Adoption, Economic Development, Environmental Impact, Fuel, Hybrid Vehicles, Social Development

I. INTRODUCTION

Hybrid and electric vehicles have been used by many people around the globe as transport innovation solution which provide sustainable solutions for environment protection. According to Walwyn (2026), electric vehicle has expanded its market in the last 10 years, surpassing 17 million in the year 2025. According to Walwyn (2026), current HEVs combine internal combustion engines running on gasoline or diesel with electric motors that use electricity stored in batteries. Jacqz and Johnston (2024) also stated that hybrid electric vehicles were first introduced to the United States in 2000 and by April 2016 over 4 million hybrid vehicles were sold, with a peak in market share of over 3% of the total light-duty vehicle market in 2013. Many countries adopted the use of hybrid vehicles such as United States of America, China, Norway and Germany as the leaders in this transport technology thanks to the development of conducive technical and infrastructural investments. It was also found that the rapid development in hybrid vehicle relies on their capacity to produce vehicle parts including batteries and renewable energy integration which have further enhanced vehicle usage and this is currently considered a crucial element in global environmental as well as socio-economic development policies (Rahman, 2017).

The use of hybrid vehicles remains beneficial as being utilized by many people due to their capacity to generate substantial social and economic opportunities such as helping to reduce full expenditure and providing energy securities of countries (Ahmadi et al., 2015). More studies also demonstrate the critical role of these types of vehicles such as

reducing the dependence on fossil fuel which translate into economic resilience and environmental sustainability in several countries in the world. As mentioned by Adnan et al., (2017). The development in green transport solutions has been one of the factors contributing to employment opportunities in several domains including vehicle manufacturing companies, battery producing firms and vehicle servicing industry. Not only did the adoption of hybrid vehicle contribute to economic opportunities, but it has also contributed to the improved health outcomes by reducing air pollution and allied diseases even if is dependent upon the level of infrastructural requirement, income and government incentives that have been leveraged for this green transport to prosper. Due to the disparities in hybrid vehicles enabling infrastructure, policy and economic factors, many counties continue to on the lead in purchasing and adopting these types of vehicles while others still lag behind (Soares et al., 2025).

In Africa, the leading countries to adopt hybrid vehicle are also the ones in promoting green energy and transport policy such as South Africa, Ethiopia, Kenya Morocco and Rwanda (Ajao et al., 2025). These transport innovation has contributed to social and economic opportunities even if there are still in infant stages depending on the limited required infrastructure, maintenance personnel and government policy that significantly incentivize the optimum adoption of hybrid vehicles. The introduction of policies that promote cleaner transport technologies such as leveraging the accessible charging infrastructures are the ones that distinguish the level of adoption of hybrid vehicles in African countries while may have adopted it as sustainable mobility solution for achieving climate and socio-economic development goals in Africa (Lukuyu et al., 2024).

In Rwanda, the country established several strategies aiming to development he green mobility through transport technology as one the leading countries in Africa. Such strategies include promotion of hybrid vehicle incentives such as reducing tax associate with hybrid vehicles and policy reforms, infrastructures development to motivate the rapid adoption with key strategies for social, economic and environmental concerns (Lukuyu et al., 2024). The adoption was attracted by the government interest in leveraging supportive policy environment in clean transportation and encouraged consumer interest in hybrid vehicles whereby the highest level of adoption is concentrated in cities like Kigali and other secondary cities thanks to the accessibility of required infrastructure and maintenance personnel (Chukwuma, 2022). In the Rwanda the number hybrid vehicle imported surged from 2021 to 2024 contributing to reduced fuel consumption and dependence on fuel import and lowered transported costs four households thereby stimulating business operations. Together, hybrid vehicle innovation sector has stimulated economic activities related to vehicle importation, maintenance services, and green technologies.

Although Rwanda has recorded significant achievements in hybrid vehicles adoption, numerous setbacks persist diminishing the rapid and the widespread adoption of hybrid vehicles in Rwanda both in urban and rural areas. These include the initial purchase of hybrid vehicles which is still exorbitant compounded with limited technical expertise and inadequate supporting infrastructure which are still also affecting the efficient operation and maintenance of hybrid vehicles in Rwanda. It is against this background that this study was conducted to examine the effect of hybrid vehicle adoption on socio-economic development in Rwanda with particular focus on Kicukiro District.

1.1 Statement of the Problem

The rising fuel costs, environmental pollution, and the need for sustainable economic development (Chukwuma, 2022) are the major challenges that Rwanda is facing. They are major causes for the country to introduce the use of hybrid vehicles as an alternative transport technology that is presumed to reduce fuel consumption and emissions thereby improving transport efficiency. Even though the government has demonstrated significant efforts to promote environmentally friendly vehicles such hybrid and electric ones, the level of hybrid vehicle adoption remains relatively low depending on various challenges mentioned such as limited incentives, technical expertise in maintaining hybrid vehicles and initial cost which is still high. Moreover, there is limited empirical evidence on how their adoption contributes to socio-economic development at the local level (Getie et al., 2024).The insufficient information regarding the extent to which hybrid vehicle adoption influences income generation, transport costs, public health, environmental sustainability, and overall economic well-being in districts such as Kicukiro District was the main motivation for this research.

1.2 Research Objectives

- i. To evaluate the socio-economic benefits of using hybrid vehicles in Kicukiro District
- ii. To examine the relationship between hybrid vehicle adoption and socio-economic benefits in Kicukiro District.

II. LITERATURE REVIEW

2.1 Theoretical Review

The present study is guided by Sustainable Development Theory, whose proponent is the Brundtland Commission (1987). The theory highlights that the needs of the present need not compromise the future needs for the

coming generation. Concerning this study, this study demonstrates the foundation for understanding the social-economic impact of hybrid vehicles (Khachatryan et al., 2026). From an economic perspective, this theory shows the importance of efficient resource utilization and long-term economic stability through the adoption of green energy and transport technology yielding employment opportunities and reduced costs in transport. Based on sustainable development theory, Rwanda promotes green energy through the adoption of hybrid vehicles, and this helps users save fuel expenses, increasing income and wellbeing without putting pressure on environment degradation through reliance on fossil fuel (Khachatryan et al., 2026). This contributes to reduced reliance on imported petroleum products strengthening Rwanda's balance of payments and enhances energy security, contributing to overall economic development.

Socially, Sustainable Development Theory can explain that the adoption of hybrid vehicles improves quality of life, promoting, and ensuring access to essential services by contributing to improving public health through reduced air pollution, which lowers the prevalence of respiratory diseases that can be observed in future (Singh, et al., 2024). Additionally, it creates employment opportunities in sectors such as vehicle maintenance, transport services, and green technology (Castillo et al., 2025). In Kicukiro District, improved transport efficiency also enhances access to education, healthcare, and business opportunities, thereby supporting overall community well-being. In general, sustainable development theory highlights that hybrid vehicles contribute to long term social and economic outcomes than conventional vehicles which run on fuel and endanger the current and future environmental aspects including human life through air pollution leading to airborne and respiratory diseases.

2.2 Empirical Review

Several studies were conducted in line with the effect of hybrid vehicles on social economic development and environmental sustainability in different countries. When compared to traditional internal combustion engine cars (ICEVs), empirical research shows that hybrid electric vehicles offer quantifiable environmental benefits. In a comparative study by Castillo et al., (2025) comparing hybrid electric vehicles and conventional internal combustion engine vehicles where he used lifecycle assessment and simulation techniques, he found that hybrid systems significantly reduce fuel consumption and CO₂ emissions by 34–46% in urban driving conditions. The am study also provides clarity on the way regenerative braking and electric motor support work best in stop-and-go traffic. This makes hybrid vehicles superior those conventional vehicles systems.

Secondly, another study was carried out by Khachatryan et al., (2026) examining the Effect of socio-economic factors on EV/HEV/PHEV adoption rate in Ontario city of Canada. He measured missions using portable devices and reported that hybrid vehicles reduced urban CO₂ emissions by up to 53% and nitrogen oxide (NO_x) emissions by 68%, confirming that HEVs can substantially improve air quality in congested cities (Castillo et al., 2025). In another comparative lifecycle assessments conducted by Matsumoto et al (2021) examining the demographic, social, economic, and regional factors affecting the diffusion of hybrid electric vehicles in Japan, they also indicate that while hybrids outperform conventional vehicles in emissions reductions, fully battery electric vehicles (BEVs) achieve even greater reductions up to 73% showing that hybrids are particularly effective as transitional technologies toward full electrification (Matsumoto et al., 2021).

However, a study conducted by Khachatryan et al., (2026) examining the effect of Hybrid electric vehicles on sustainable development, they found that plug-in hybrid electric vehicles have limits in their practical performance since many drivers operate these types of vehicles primarily in combustion mode, which reduces the anticipated environmental benefits. Another study carried out by Ehsani et al., (2021) quantifying the benefits of the hybrid electric vehicle, using field measurements around Europe, came out with evidence that actual CO₂ emissions were up to five times greater than laboratory test estimates. These results highlight the fact that driver behavior, usage habits, and access to charging infrastructure all affect hybrid performance in addition to vehicle design. Therefore, the overall environmental benefits of hybrids are dependent on more general production and energy variables, as lifecycle assessments also show that emissions from vehicle and battery manufacture must be considered (Ehsani et al., 2021).

From a social perspective, a study conducted by Bento et al., (2019) employed econometric analyses of hybrid vehicle usage data and found that improved fuel efficiency lowered household transportation costs, increased disposable income, and enhanced mobility for urban residents and commercial fleet operators. Surveys and mixed-method studies conducted by Diamond (2009) also found that environmental awareness, perceived financial benefits, and social signaling significantly influence hybrid adoption, whereas barriers such as high purchase costs, limited charging infrastructure, and unfamiliarity with hybrid technology inhibit uptake. A cross-national survey conducted by Deng et al., (2024), in Pakistan and policy analysis in African countries by Getie et al., (2024) further confirmed that environmental concern, peer influence, and economic incentives are major determinants of adoption, highlighting the importance of social and cultural factors in shaping hybrid vehicle usage and its consequent environmental impact.

From a social viewpoint, research by Eppstein et al., (2011) utilized econometric analyses of data on hybrid vehicle usage and discovered that better fuel efficiency decreased transportation expenses for households and raised

disposable income, and improved mobility for urban dwellers and commercial fleet operators. Research and mixed-method studies by Adnan et al., (2017) revealed that environmental consciousness, perceived economic advantages, and social signaling play a crucial role in hybrid adoption, while obstacles like high purchase prices, insufficient charging facilities, and lack of familiarity with hybrid technology hinder acceptance. Moreover, in a study by Langford and Gillingham (2022), they found that hybrid vehicles provide health outcomes through reduction of air pollution leading to airborne diseases.

III. METHODOLOGY

3.1. Research Design

This study used a descriptive method with mixed approaches. Descriptive research refers to observing and measuring without manipulating variables. It looked at the population by picking some individuals to study and examine the study variables in the present research. The benefits of this design were that it helped to gather and analyze data at a reasonable cost (Creswell & Creswell, 2018).

3.2 Target Population

Kothari (2004) defined a population as a set of cases from which a sample is drawn and to which research wants to generalize. The study population was based on hybrid vehicle owners, people with internal combustion engine vehicles and mechanics identified in 4 registered garages in Kicukiro District. It includes selected garages such as ATECAR Garage Ltd, Rwanda Motor Ltd, Garage Mecanique et Debosselage Moderne (GM and DM) Ltd and Garage Jeffer. The total population is 1587 people.

3.3 Sample Size

Saunders et al. (2019) defined a sample as a carefully chosen subset of the target population intended to represent it. Yin (2018) asserts that the sample size should be ideal and neither too large nor too small, with a suitable sample being one that satisfies the requirements of efficiency, representativeness, adaptability, and reliability. The sample was 188 respondents determined by using the formula of Alain Bouchard. The sample size was selected using purposive sampling and simple random sampling techniques.

3.4. Data Collection Instruments

Questionnaire was main tool of data collection that was used. According to Bryman and Bell (2015) a questionnaire is a method or research tool that consists of a set of inquiries intended to collect data from respondents. Given that the primary focus of the research is the target population's views, opinions, feelings, and attitudes, questionnaires and interviewing techniques were the most effective ways to gather this data. Questionnaires were used because the research sought to examine factors that are not directly observable, like people's attitudes, beliefs, opinions, and perceptions about a given issue. In every instance, open-ended questions were chosen because they let respondents share their opinions and thoughts on the subject at hand without limiting them to a predetermined range of responses (Kothari, 2004).

3.5. Data Analysis

In this study data were analyzed using the Statistical Package for Social Science (SPSS) by also utilizing descriptive statistics. The averages and standard deviations for the variables under investigation were calculated using descriptive statistics to assess the effect of hybrid vehicles on social-economic development in Kicukiro District.

IV. FINDINGS & DISCUSSION

4.1 Findings

4.1.1. Adoption of Hybrid Vehicles in Kicukiro District

The study examined the motivation behind the adoption of hybrid vehicles in Kicukiro District. The results were presented in the table below.

Table 1: *Adoption of hybrid vehicles in Kicukiro District*

Adoption of hybrid vehicles in Kicukiro District	N	Mini mum	Maxi mum	Mean	Std. Deviation
Adoption of hybrid vehicle for personal or business transportation needs	188	4.00	5.00	4.85	0.245
Regular use of a hybrid vehicle instead of a conventional vehicle	188	2.00	5.00	4.52	0.498
Adoption of hybrid vehicles based on their availability	188	1.00	5.00	3.87	0.765
Adoption of hybrid vehicles based on their fuel efficiency	188	4.00	5.00	4.88	0.416
Adoption by of hybrid vehicles based on their environmental benefits	188	2.00	5.00	4.13	0.657
Intention to continue using hybrid vehicles due to their overall benefits	188	3.00	5.00	4.27	0.565

The study examined the level and motivation to adopt hybrid vehicles in Kicukiro district. Based on the first stamen in the table, respondents strongly agree that they have chosen to adopt hybrid vehicles for personal and business transportation needs. This was revealed by the corresponding high mean value of 4.85 and lowest standard deviation of 0.245 which denotes a very slight variation of responses. Secondly, the findings showed that respondents regularly use hybrid vehicle instead of a conventional vehicle mainly based on their advantages. This was revealed by the mean value of 4.52. The results also showed that the adoption of hybrid vehicles was based on their availability in Rwandan vehicle market as represented by the mean value of 3.87 which is also above the average (3) on the likert scale used. Furthermore, the results in table show that the respondents believe that Adoption of hybrid vehicles was mainly based on their fuel efficiency opportunities in Kicukiro district as the fuel keeps rising. This was indicated by the mean value of 4.88 which is so close to the maximum (5) on the likert scale that was used in data collection. Additionally, the adoption of hybrid vehicles is based on their environmental benefits. This was indicated by the mean value of 4.13 referring to the government policies of green mobility via new transport technology development in Rwanda. The findings align with Khachatryan et al., (2026) who mentioned that HEVs can substantially improve air quality in congested cities thereby yielding social and economic benefits such as enabling vehicle users to save fuel cost especially those frequently involved in regular transport businesses. According to Ehsani et al., (2021), the expansion of the hybrid vehicle sector has stimulated economic activities related to vehicle importation, maintenance services, and green technologies. Moreover, reduced emissions from hybrid vehicles support environmental sustainability by improving air quality and reducing greenhouse gas emissions.

4.1.2 Socio-Economic Benefits Associated with the Adoption of Hybrid Vehicles

This section of the study presents the respondents' views on the socio-economic impact associated with hybrid vehicles adoption in Kicukiro District. The results were presented in Table 1 below with interpretations based on the findings

Table 2: *Socio-economic benefits associated with the adoption of hybrid vehicles*

Socio-economic benefits associated with the adoption of hybrid vehicles	N	Mini mum	Maxim um	Mea n	Std. Deviation
Reduction of fuel costs	188	4.00	5.00	4.74	0.216
Increase in income and profitability	188	4.00	5.00	4.65	0.366
Reduction of fuel import dependency	188	2.00	5.00	4.35	0.645
Reduction of transportation costs for individual car users.	188	3.00	5.00	4.61	0.556
Reduction of public transport cost in Kicukiro District	188	1.00	5.00	3.86	0.841
Creation of new job opportunities (e.g. in repair and maintenance).	188	2.00	5.00	4.48	0.664
Improvement of public health by reducing pollution	188	4.00	5.00	4.85	0.266
Support to economic growth and sustainability.	188	2.00	5.00	3.85	0.645
Promotion of environmental sustainability	188	3.00	5.00	4.52	0.556

The results are based on 188 respondents and show a generally strong perception that hybrid vehicles generate positive socio-economic impacts. Most of the mean scores are above 4.0, indicating high levels of agreement, while the relatively low standard deviations in several items suggest that respondents' views are consistent. The highest level of agreement was recorded on the improvement of public health by reducing pollution as represented by the mean score of 4.85. The findings highlight that respondents believe that conventional vehicles using fuel provide harmful gases which are dangerous to human lives. These findings were also supported by Soares et al., (2025), who posited that reducing vehicle emissions contributes to lower rates of respiratory and cardiovascular diseases associated with air pollution. The high increase of vehicles with little or zero emissions can improve community health outcomes.

Moreover, the findings also showed that the adoption of hybrid vehicles has contributed to reduction of fuel cost for the users which also contributes to saving and investment in other businesses. This was evidenced by the mean

value of 4.74 which is close to the maximum or in the position of strongly agree with reference to the Likert scale used in data collection. The findings align with Matsumoto et al (2021) who viewed that the major benefits of that incite consumers to buy hybrid vehicles is that it contributes to long-term saving from transport costs especially countries where fuel is expensive. Similarly, respondents agreed that hybrid vehicles increase income and profitability with the mean value of 4.65 and reduce transportation costs for individual car users with mean score of 4.61. These findings imply that respondents associate hybrid vehicles adoption with financial benefits both at individual and business levels. The findings also align with Lukuyu et al., (2024) who mentioned that saving and reduction of transport costs increase profitability especially for those involved in commercial transport services and business which heavily rely on transport. They found that HEV can cut down the expenditure thereby contributing to revenue growth and business performance.

The promotion of environmental sustainability also received a high mean score of 4.52 reflecting strong agreement that hybrid vehicles contribute to environmental conservation efforts. Similarly, the findings in table 1 show that respondents have witnessed the benefits of adopting hybrid vehicles such as proviso of new jobs such as maintenance and repair services as revealed by the mean value of 4.48 which is also in the position of strong agreement. To this point, Soares et al., (2025) also stated that these types of hybrid vesicles are believed to reduce gas emission helping countries to reduce environmental degradation to meet climate change migration targets thereby contributing to environment sustainability. The findings also provided a clear picture of the way respondents viewed that the adoption of hybrid vehicles in Kicukiro district has contributed to improvement of public health by reducing pollution. This was proved by the mean value of 4.85 which is close to the maximum implying that they have information on how burnt fuel gases are harmful to lives leading to respiratory diseases (Walwyn, 2026).

In table 1, the findings also showed that respondents agreed that the adoption of hybrid vehicles contributed to economic growth and sustainability as they have witnessed their impact on job creation, saving, and protection of environment which translated to current and future economic growth and environment sustainability. This was also proven by the mean value of 3.85, which is also above the average on the Likert scale in the position of agreement. Similar to these findings, promotion of environmental sustainability was also confirmed as one of the core benefits of using hybrid vehicles in Kicukiro District as revealed by the mean value of 4.52. According to Singh (2024), the adoption of low-emission vehicle technologies such as hybrid vehicles plays a substantial contribution in achieving sustainable transportation solution which also diminish carbon emissions from vehicles.

4.1.3 Relationship Between Hybrid Vehicle Adoption and Socio-Economic Development in Kicukiro Sector

This section analyzes the relationship between hybrid vehicle adoption and socio-economic development in Kicukiro Sector, focusing on how the use of hybrid vehicles influences economic benefits, cost reduction, and overall improvement in livelihood.

Table 3: Correlation between hybrid vehicle adoption and socio-economic development in Kicukiro sector

		Hybrid vehicle	Socio-economic development
hybrid vehicle	Pearson Correlation	1	.871**
	Sig. (2-tailed)		.009
	N	188	188
Socio-economic development	Pearson Correlation	.871**	1
	Sig. (2-tailed)	.009	
	N	188	188

** . Correlation is significant at the 0.01 level (2-tailed).

The results indicate a very strong positive relationship between hybrid vehicle adoption and Socio-economic development ($r = 0.871$, $p = 0.009$, $N = 188$). The Pearson correlation coefficient of 0.871 suggests that increases in the use of hybrid vehicles are strongly associated with increases in socio-economic development outcomes of respondents. This implies that individuals or businesses adopting hybrid vehicles are likely to experience improved financial and wellbeing outcomes, possibly due to reduced fuel costs and increased operational efficiency.

The significance value ($p = 0.009$) is less than 0.01, indicating that the relationship is statistically significant at the 1% level. This means that the observed correlation is unlikely to have occurred by chance, and there is strong evidence of a meaningful association between the two variables. In summary, the findings suggest that hybrid vehicle adoption plays an important role in enhancing socio-economic wellbeing in Kicukiro Sector, highlighting its contribution to socio-economic development.

These findings align with Langford and Gillingham (2022) by proving that hybrid vehicles reduce the dependence on fossil fuel which translates into economic resilience and environmental sustainability in several countries in the world. As mentioned by Langford and Gillingham (2022), the development in green transport solutions has been one of the factors contributing to employment opportunities in several domains including vehicle manufacturing

companies, battery producing firms and vehicle servicing industry. Not only did the adoption of hybrid vehicle contribute to economic opportunities, but it has also contributed to the improved health outcomes by reducing air pollution and allied respiratory diseases.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study examined the socio-economic impact of hybrid vehicle adoption in Kicukiro District. Based on the findings of study, respondents have a degree of awareness of the socio-economic impact driven from the adoption of hybrid vehicles. The results prove that hybrid vehicle adoption has contributed to reduction of fuel cost, increase in income and profitability of business relying heavily on transport services, deduction of fuel import dependency on national level and created new job opportunities such as repair and maintenance. The findings highlight that respondents believe that conventional vehicles using fuel provide harmful gases which are dangerous to human lives whereby hybrid vehicles contribute to lower rates of respiratory and cardiovascular diseases associated with air pollution. The findings reveal that what incites consumers to buy hybrid vehicles is that it contributes to long-term saving from transport costs especially in periods where fuel is expensive. The study concludes that the adoption of hybrid vehicles in Kicukiro district has demonstrated substantial contribution to socio-economic development such as reduction of fuel costs, emission gas and overall health outcomes.

5.2 Recommendations

Based on the findings of this study, the following recommendations are provided to address the factors affecting the adoption of hybrid vehicles and accelerate the transition toward greener mobility and socio-economic development in Rwanda. The Government of Rwanda should strengthen fiscal incentives by providing or expanding incentives such as full or partial import tax exemptions, VAT waivers, and registration fee reductions specifically for hybrid vehicles. There is a need to establish more maintenance centers and train local technicians to handle hybrid vehicle technology, ensuring reliable service and support. The government and stakeholders should address the high cost of hybrid vehicle batteries by introducing targeted subsidies, tax reductions on battery imports, and support for battery recycling and replacement programs. Moreover, the public or vehicle users need to evaluate the total cost of ownership, including fuel savings, lower maintenance, and environmental impact, when considering a vehicle. They should also adopt proper maintenance practices to extend battery life and overall vehicle performance.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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