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COST BENEFIT ANALYSIS OF ADOPTION OF E-MOBILITY ON SUSTAINABLE LIVELIHOODS IN NAIROBI COUNTY, KENYA

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Abstract

A number of benefits have been put forth to front the transition to e-mobility from internally combusting engines across the world and presently in Kenya. This study sought to examine the cost benefit analysis of adoption of e-mobility on sustainable livelihoods in Nairobi, Kenya led by the specific objectives which are to determine the initial cost of ownership on e-motorcycles vs. ICE powered motorcycles, to determine the operation costs for e-motorcycles vs. ICE motorcycles, to compute monthly income for both users, calculate the level of CO_2 emissions from ICEs and the cost of electricity consumption and subsequently run a test of significance in livelihoods for users. The study was theoretically guided by the sustainable livelihoods approach. The study adopted a cross-sectional survey design, purposive sampling was used to identify target population of 100 electric motorcycle users along the Ngong road corridor and Waiyaki way corridors. Primary data that was collected using questionnaires while secondary data was collected from the Kenya Revenue Authority and other relevant government board. The results were analyzed using cost benefit values assigned for a CBA ratio. The data analysis showed that there is no significant benefit to end users in indicators of sustainability including income and health. Government revenue was significantly more at the point of ICO for ICE motorcycles than E-motorcycles, however recurrent government revenue from both e-motorcycles and ICE was insignificantly differed. The research recommends policy instruments to do further analysis on human development and sustainability factors before running future e-mobility projects.

Keywords: *Cost Benefit Analysis, E-Mobility, Sustainable Livelihoods*

INTRODUCTION

One of the major global advancements towards sustainable development presently is Electro-mobility. Electro-mobility refers to vehicles that can be fueled by the electricity network with or without an auxiliary internal combustion engine as part of the landscape of ultra-low emissions vehicle-based transport, mostly in urban environments (Filho et al, 2021). Electric Mobility technologies in various countries has gained prominence as a strategy to mitigate greenhouse gas emissions, improve air quality, decrease dependency on fossil fuel and boost energy security. Electric vehicles are considered to be environmentally friendly because they emit less pollutants, are less noisy, use long lasting and recyclable batteries, have affordable maintenance and running costs and are cost-effective (Engola, 2022).

In the current global developmental issue of increasing populations and personal vehicles in cities, there has been an increase in global warming which is fast leading to climate change, air pollution, compromised quality of life and unreliable energy source. The innovation of e-mobility has brought forth and represent remarkable solutions as mentioned above and energy security if connected to renewable energy (RE) as well as closer/closed resource loop cycles, and if developed at scale with an efficiency increase also in terms of fuel cost (Hassan et al, 2020). Important to note is that there are also substantial numbers of household e-mobility users commuting into cities for work, self-sufficiency, and economic wellbeing (Kester et al, 2020). Electric mobility solutions should be part of a new culture of integrated mobility planning, focusing on high quality public transport services, well integrated with shared mobility options, walking and cycling. There is still less uptake of e- mobility and adoption of e-mobility remains low especially in Africa and in Kenya. Policies to cap import of 2^{nd} hand ICE motors, financial incentives and knowledge management to users are still in the infantry stage thus to fully benefit from the transition to electric mobility, efforts in research and development and collaborations for government and private sectors need to be implemented in the overall context of better and more compact urban planning with a focus on accessibility and urban livability (Tuts, 2020).

In Europe, E-mobility has been vital to the European sustainable development and sustainable mobility agenda whereby a projection to full green transition is aimed at by 2050, with policies geared towards scrapping fossil-fueled vehicles are and replacing them by other technological alternatives in E-mobility such as battery electric vehicles, electric bikes, and electric-trains. This has been further conjoined in a nexus to the contribution towards achieving Sustainable Development Goals (SDG): 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 11 (Sustainable Cities and Communities)—relying on the action in the domain of SDG 7 (Affordable and Clean Energy) (Coppola et al 2015). Sustainable development emphasizes the enhancement of environmental, social and economic resources, with all three of them being critical to meet the needs of current and future generations (Wick, 2016).

In Norway, there is a fully electric car ferry program that began operating in 2015 (Lambert, 2021). There is an increase and significant uptake of e-boats which have far lower costs for fuel than conventional diesel ferries, thereby having a crucial impact in reducing carbon emissions (Wahnnschaft, 2021). Two ferries connecting Sweden and Denmark (Helsingborg to Helsingör) made the switch-over to fully electric in 2017, and a similar switch-over at a much smaller scale was implemented in the French holiday town of Cape Breton in 2019 incorporating a fully recyclable aluminum hull (Harris, 2021). The Baltic Sea Region Electric project notably collaboratively produced an action checklist for e-ferries, from which other watercourse to ensure that wealthy cities (such as Oslo and Amsterdam, which are moving towards electrification of their ferries) can benefit as well (BSR electric, 2021).

Some of the highlighted challenges within interplay in the technological advancement also exist between the automotive and the ICT of e-mobility service industry, which include fast charging systems, availability of electricity, building of the technology and Renewable energy infrastructures, insecurity of consumers and their willingness or unwillingness to take up and adapt to change, legal and regulatory policies on emerging taxation. Further challenges are seen in local trading of decentralized energy, and battery capacity its degradation, land potential renewal which poses a potential hazard to the environment calling for invention of second-life applications and the recapture of key elements in the EV batteries (Filho et al, 2021).

Sub-Saharan Africa faces many unique challenges in the electrification of transport, but it is critical that the continent is not left behind as the rest of the world transitions. Failure to create an enabling ecosystem for electric transport could see the region becoming a dumping ground for old Internal Combustion Engine (ICE) vehicles, setting back the continent's carbon-emission-reduction goals as the vehicle park continues to grow in the decades ahead. (Pais et al, 2022). While momentum is building, sub-Saharan Africa faces some unique challenges in its electric mobility transition, including, in some cases, unreliable electricity supply. A 2019 survey across 34 African countries found that fewer than half of those connected to the grid have reliable electricity. In addition, the reported 2020 System Average Interruption Disruption Index (SAIDI) for sub-Saharan Africa was 39.30 versus 0.87 for OECD high-income countries (Afrobarometer, 2019). Low vehicle affordability, and the dominance of used vehicles, affordability, shaped by comparatively low household incomes, low availability of asset finance at affordable rates, and higher price points for Evs (Dioha, 2022). the dominance of used vehicles on much of the continent driven by affordability challenges and weak regulation, with many countries allowing the import of vehicles over 15 years' old and with fairly low emissions standards (Global trade used vehicles, UNEP,2020).

In recent past, Kenya enacted two transformative laws that directly affect its transition to a low-carbon economy: the Climate Change Act 2016 and the most recent Energy Act 2019 with the initial motivation behind being to reduce Greenhouse Gas (GHG) emissions by 30% by 2030, improving resilience to climate change and promoting low-carbon climate resilient development (Eshiwani, 2019). However, the existing infrastructure for e-mobility in Kenya is still at an infant stage: slightly over 1000 EVs have been registered in the country (as per 2022). Under the global database, Kenya has currently 4.3 million vehicles with 2&3 wheelers presenting the largest share of the vehicle fleet and holding the highest rate of motorization. Policies for partnership development have been put in place with the aim to shift to electric motorcycles with several pilots being carried out by Kenya Power, UN Environment and the Siemens Stiftung in Western Kenya (Eshiwani, 2019).

The government of Kenya is also constantly working to improve its policy framework concerning e-mobility, whereby the Finance Bill 2019 introduced, tax incentives that reduced the excise duty for all EVs from 20% to 10%.Patnnerships with non-governmental and private sectors such as the United Nations Environment, Siemen Stiftung and European union have been formidable on propelling the shift to e-mobility in Kenya's capital(Government of Kenya, National Climate Change Response Strategy).In 2019, the Lake Basin Innovation and Investment Week (LBIIW) hosted a forum where opportunities ,challenges and barriers for e-mobility to take off in rural areas under a round table discussion. It was unanimously called for reduction of primary investment for renewable energy technology, availing of micro financing options for the rural dwellers, Improvement of policies towards e mobility that create an enabling environment to investment. Furthermore, East African start-ups are designing and experimenting with diverse business models for commercialization. Such potential business models are the ;Sharing economy; a broad umbrella term used for a number of economic models that have one thing in common: the joint use of goods and services through B2B or B2C variants and the Circular economy is an economic system based on closed circles or loops in which raw materials, components and products lose their value as little as possible, keeping products and material in use and regenerating natural systems (Mather 2011)This, however, requires holistic planning and multi-modal systems that involve complementary large- and small-scale transport modes operating to and from 'hubs' within villages, market centers and towns.(Siemen Stiftung,2020).There still needs an aggregated data and survey to assess the level of local awareness of this prospects to the common Kenyan citizen who is neither in business nor the policy implementing unit. The study of e-mobility projects community involvement needs assessment, initial appraisal, and monitoring and evaluation is vital. Emerging private sectors in the e-mobility space such as Craft Silicon, Drive Electric, and Nopea Ride, an EV sharing firm, have piloted the use of EVs in Nairobi and currently underway. With the current state of e-mobility, it is inevitable to put to ask a framework for monitoring and evaluating these projects development within the context of policy implementation and the contribution to identifiable sustainable development goals with respect to e-mobility. It is indispensable to look into the functionality of frameworks that integrate these new mobility solutions into medium and long-term strategies and put in place the right conditions for the development, scalability of future technologies and business models that will lead to improvement in implementation of SDGs in line with e-mobility.

Statement of the Problem

Kenya has vast renewable energy resources such as solar, wind, biomass, bio-fuel, geothermal and hydro-power, however, their use has been limited. Expansion of the sector is being catalyzed by the growing demand for and cost of electricity, increasing global oil and gas prices, environmental pressure, and frequent droughts; to achieve and maintain performance of sustainability, meet challenges of growing demand and address related environmental concerns, renewable energy therefore, continues to an important means to mitigate this problem (Kimuyu & Mutua,2015). In the 2021 Conference of Parties (COP 26), 30 countries including Kenya agreed to collaborate to ensure Zero Emission Vehicles (ZEFs) are accessible, affordable and sustainable in all regions by 2030, at the same time a new trust fund was launched by the World Bank and the Zero Emission Vehicle Transition Council to mobilize USD 200Million over the next 10 years to decarbonize road transport in emerging markets (UNFCCC, 2021).

According to Annete Gunther, 2021, study on guide to E-mobility, 92 % of Kenya's current grid-based electricity is generated from renewable energy with the country already having a vibrant and dynamic e-mobility sector. The study estimates that converting 50%of road transportation fleet (based by volume of fossil fuel consumed) to electric by 2030 could result in 8.5 million tCO2e avoided, USD 42million in carbon market revenue and USD 3billion reduction in foreign exchange on petroleum products per year. Further benefits projected from the study include employment creation, advancing research, development and innovation, electricity demand stimulation, reduction of foreign exchange spending, carbon finance and increased revenue from end users in various circular business models (Annette, 2021). Under the global database, Kenya has currently 4.3 million vehicles with 2&3 wheeler's presenting the largest share of the vehicle fleet and holding the highest rate of motorization. Policies for partnership development have been put in place with the aim to shift to electric motorcycles with several pilots being carried out by Kenya Power, UN Environment and the Siemens Stiftung in Western Kenya. (Eshiwani, 2019). Bajpai and others focusing on Rwanda note that consumer awareness, initial base infrastructure, user friendliness of new technologies and fossil fuel prices are major determinants of sustainability to E-mobility However, there exists no test of significance to improvement and sustainability of livelihoods to users with in comparison to ICE propelled vehicles. This study therefore aims to show the real costs of this transitions and their significance to sustainable livelihoods to end users in Nairobi, Kenya.

Objectives of the Study

i. To analyze the costs of acquisition and running of e-motorcycles and ICE- motorcycles on end users in Nairobi County.
ii. To analyze the benefits of acquisition of e-motorcycles and ICE- motorcycles on end

users in Nairobi County.

LITERATURE REVIEW

Theoretical Review

The Sustainable Livelihoods Approach (SLA)

According to Chambers livelihoods comprise the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. The theory further proposes that sustainable poverty reduction will entail success only if development agents work in congruence with people and their current livelihood strategies, social environment and capabilities to adapt. At a practical level this implies a detailed analysis of people's livelihoods and their dynamics over time. Development activity tends to focus at either the macro or the micro level and focuses attention on the varying ways in which poverty is perpetuated by, for example, unemployment which leads to over-exploitation of resources, poor health caused by pollution and climate change, social exclusion, gender relations, lack of social services, and the multidimensional factors and differentiated processes that construct livelihoods and their attainment. This theory applies in context to the operationalization of e-mobility programs to sustainable livelihoods and in their corresponding to leveraging e-mobility prospects to achieve sustainability. This theory will be used to understand the social set up and how e-mobility affects employability, income levels, health, climate change and other livelihood on people who depend on it (Wathne & Heide, 2004).

Conceptual Framework

Conceptual framework identifies the concepts contemplated as informing the study and shows their relationships. The conceptual framework contributes to research by identifying research variables, and by clarifying relationships among the variables (peter, 1994). It presents the variables of the study.

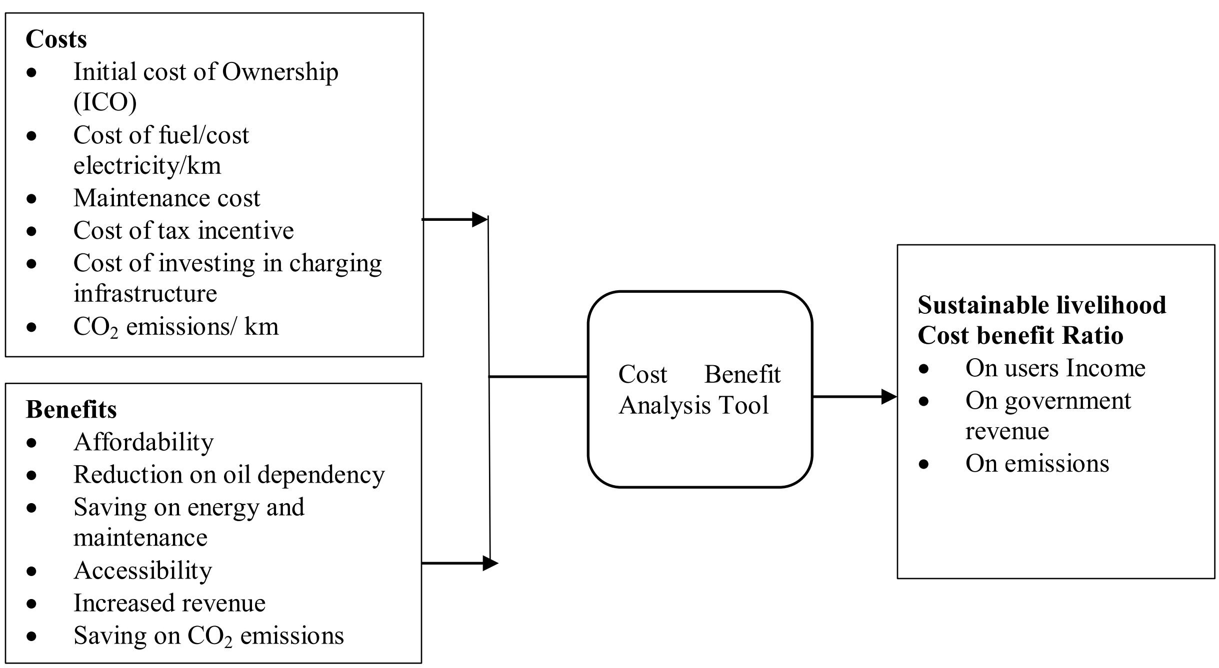

Figure 2.1 Conceptual Framework

Empirical Review

A comprehensive analysis of Cost benefit analysis for any development projects is necessary to users. Cost-benefit analysis (CBA) is a tool designed to compare the costs of a project or program with its benefits. CBA was first developed as an economic appraisal tool. It is normally used by large agencies when planning major projects or programs, such as the construction of a new hydro-electric power station or the development of a new transport policy. However, it can be used to compare the costs and benefits of any project or program (Nigel et al 2017) In this context, energy efficiency in transportation within a gas crisis and circular economy, as well as the major issues of sustainability such as global warming and shifts in energy sector employment—necessitates a focus on electric mobility, which is a rapidly developing and essential sector.(Sitnikov et al2020) There are many studies concentrating on the technical or environmental elements of e-mobility (Coppola and Arsenio, 2015), but few that provide a full Cost Benefit Analysis evaluation that considers end uses linking the uptake of e-mobility projects to sustainable livelihoods.

When it comes to the energy business, the broad adoption of e-mobility is predicted to generate structural changes, such as job shifts in the petroleum supply chain and gains in tax revenue and profitability in the power production sector. The potential environmental and economic advantages of e-mobility technologies are still up for debate (Reichmuth, 2020; Canzler and Knie, 2016) at environmental and economic levels, with governmental actions being critical in this situation. A major barrier to the use of renewable energy is its cost to users. RET investment costs are usually higher than comparable conventional energy options and traditional fuels. For instance, a solar PV system has a high start-up cost associated with acquiring the technology against a backdrop of 46% of Kenya's population living in poverty. The greater focus on a sustainable economy and development reflects the 'growing recognition that achieving sustainability rests almost entirely on getting the economy right' (UNEP, 2011b: 17). Among the advocated initiatives for green growth include use of low carbon technologies and cleaner productions such as e-mobility (OECD, 2010: 9).

East African start-ups are designing and experimenting with diverse business models for commercialization. Such potential business models are the; Sharing economy; a broad umbrella term used for a number of economic models that have one thing in common: the joint use of goods and services through B2B or B2C variants and the Circular economy is an economic system based on closed circles or loops in which raw materials, components and products lose their value as little as possible, keeping products and material in use and regenerating natural systems (Mather 2011). This, however, requires holistic planning and multi-modal systems that involve complementary large- and small-scale transport modes operating to and from 'hubs' within villages, market centers and towns. (Siemen Stiftung, 2020)There still needs an aggregated data and survey to assess the level of local awareness of this prospects to the common Kenyan citizen who is neither in business nor the policy implementing unit (Ongeri & Osoro, 2021).

A study on the roadmap to E-mobility in Kenya by the Embassy of the federal republic of Germany in Kenya and the delegation of the German industry and commerce for Eastern Africa (AHK) shows that the transition to e-mobility will require manufacturers and assemblers to produce low-cost user-friendly electric vehicles and electric vehicle components in order to attract more players and increase job opportunities. The study of e-mobility projects community involvement, needs assessment, initial appraisal, and monitoring and evaluation is vital. Some notable e-mobility drivers in Kenya include but not limited to; First African Bicycle Information

Organization (FABIO), European Institute for Sustainable Transport (EURIST) EV, Bracket Electric Motor, WEtu (We) mobility, Solar E-Cycles Kenya-Light, Ebee Africa, Little ebikes-TechCabal, JUA ebike, Solar e cycles, Kiri EV, Fika Clean mobility, Opibus, Mazi Mobility, ARC ride, Ecobodaa, Drive Electric, BasiGo, Energy, Petroleum Regulatory Authority, Siemen Stiftung. Present mass adopters of e-mobility in Kenya include; Uber- Launched in 2016, offering cab services and has been integrating electric fleets into ICE from 2020, Nopea ride; a first electric taxi company in Africa, Bolt; began operating in Kenya in 2017 offering taxi services and is increasingly integrating electric fleets, Jumia logistics company, GetBoda, Ebee; a Kenyan startup of 2020 that offers electric bicycles on subscription for deliveries and Little ride Kenya run by Craft silicon and offers services to consumers and businesses via B2B and B2C.

Guided by this empirical literature, this paper shall involves working out and combining the total potential costs for acquiring and running e-motorcycles and ICE motorcycles by assigning value to both financial and non-financial benefits and translating them to a dollar and asses the benefits of the same. Agencies at the forefront have projected that the broad use of e-mobility might help optimize potential environmental advantages by adopting sustainable energy development plans for governments and renewable energy sources'- mobility if designed and executed in a deep sustainability way, is relevant to contributing towards the United Nations (UN)'s Sustainable Development Goal (SDG) 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities)—relying on the action in the domain of SDG 7 (Affordable and Clean Energy).(Filho et al 2021).Kenya itself is host to the United Nations Environmental Program(UNEP)in Nairobi, among the countries in the global south. Furthermore, the city holds the Nairobi national park, thus the importance of environmental conservation cannot be underscored, thus adopting E- mobility which various scholars have proportioned with the green transition, biodiversity and environmental governance could drive a great potential for support of the environmental situation (Lusweti, 2011).

Kenya has been working diligently to position itself at the forefront of the energy transition race in East Africa (Siemens Stiftung 2020), Kenya enacted two transformative laws that directly affect its transition to a low-carbon economy: the Climate Change Act 2016 and the Energy Act 2019. The main aim of this policies was to reduce Greenhouse Gas (GHG) emissions by 30% by 2030, improving resilience to climate change and promoting low carbon climate resilient development. (UEMI, 2020). Policies for partnership development have 14 been put in place with the aim to shift to electric motorcycles with several pilots being carried out by Kenya Power, UN Environment and the Siemens Stiftung in Western Kenya (Eshiwani, 2019).

Kester et al.(2018) in their study of Policy incentives to accelerate electric vehicle adoption liken the logic and arguments behind Electric Vehicles incentives and policy mechanisms among Nordic cities, they concluded that the highest incentives to accelerate e-mobility were the cost reduction mechanisms mostly applied through tax exemptions, government input to infrastructural support for public and residential charging center, intensive consumer awareness, and systems created in procurement programs and creation of environmental zones are necessary. However, it is important to note that the application, advantage and disadvantages of these mechanisms are relative to different environments and vary by nation, transport segment, the transition phase, and market share therefore a strong stable national target and price incentives combined with local flexibility to implement secondary benefits and give more attention to awareness campaigns to advance the implementation of electric vehicles is called foe

(Kotilainen et al, 2019). In Sweden, for instance, the vehicle cost, range, and infrastructure development hinder consumer acceptance of EVs , The Netherlands however has ambitious e-mobility targets, expecting to sell only "zero-emissions" cars by 2030, maintaining the increase in the number of EVs and continues to offer of financial incentives to remain among Europe's leaders in e mobility.(NEA,2018) whereas in application here in Kenya, primarily lack of awareness, technology slag and initial costs maybe the most impending drawback to uptake of e-mobility subject to research.

Steps have been made to stir the RE sector such as the Kenyan adopted a renewable energy feed-in-tariffs (REFIT) in 2008, a policy it revised in January 2010. Government Agencies such as NEMA also contribute mainstreaming functions of the REFIT aims to stimulate market penetration for renewable energy technologies by making creating enabling market conditions. (AFREPEN/WP 2009). The government of Kenya is also constantly working to improve its policy framework concerning e-mobility, whereby the Finance Bill 2019 introduced, tax incentives that reduced the excise duty for all EVs from 20% to 10%. Partnerships with non-governmental and private sectors such as the United Nations Environment, Siemen Stiftung and European Union have been formidable on propelling the shift to e-mobility in Kenya's capital (Government of Kenya, National Climate Change Response Strategy. In 2019, the Lake Basin Innovation and Investment Week (LBIIW) hosted a forum where opportunities, challenges and barriers for e-mobility to take off in rural areas under a round table discussion. It was unanimously called for reduction of primary investment for renewable energy technology, availing of micro financing options for the rural dwellers, Improvement of policies towards e mobility that create an enabling environment to investment.

Kenya is currently considering an eco-levy that will impose carbon taxation to lead the shift towards e-mobility. Capturing data and doing a real analysis from the end users of e-motorcycles, we are able to know the real socio economic benefits to the people, something that misses and is gapped by most of the empirical body and focus on implementing bodies. Choosing one group of users is informed by the users themselves have the potential to provide reliable information on analysis. (Anderson et. al. 2013) have carried out CBA in participatory way with communities. Their argument is that communities are well able to identify and assess potential benefits within their own situations. Carrying out CBA in a participatory way can offset the tendency of CBA to be carried out as an expert led, technical, top-down approach thus it can help with the planning of future projects and programs.

METHODOLOGY

This study used a cross sectional baseline survey research design which examined social issues in a cross section of the population at a point in time, focusing on links among a number of key variables based on written questionnaires and interviews (Mugenda & Mugenda, 2008). The research target population was 100 respondents from e-motorcycle user's ll corridors, I along Ngong road and II along Waiyaki way in Nairobi. As this is a survey, the whole target population of 200 users totaling from 100 e-motorcycle users and 100 ICE-motorcycle users is included in the sampling frame.

Primary data was collected using questionnaire while secondary data drawn from existing statistics with the NEMA. Data analysis involved coding of costs and benefits and further analyses using descriptive statistics in order to express frequency distributions, for mean and standard deviations. Cost benefit ratio will be undertaken and results is now presented in the formula as follows

C/B ratio = $\sum_{t}^{t}$= 1 Bt/(1+r)t/ $\sum_{t}^{t}$= 1 Ct/(1+r)t

Where Bt is the mean benefit mean value

Ct is the mean cost value

t-time in year

r- incentive rate for e-motorcycles

Decision criteria

CB >1 accept benefits, CB < 1 reject and CB=1 indecision

FINDINGS AND DISCUSSIONS

Response Rate

Out of 180 questionnaires after taking away the 10% piloted respondents that were circulated to the respondents, 150 of the respondents dully filled and retuned questionnaires; yielding a response of 83.3%. This was considered to be a very reliable response rate for the generalization of study findings is in line with Sharma (2018), states that a response rate of 70% and above is believed to be a reliable response rate.

Costs of acquisition (ICO) of e-motorcycles and ICE- motorcycles on end users

Table 1: Initial cost of ownership

UNIT	Description	Mean Cost	Cost Value
ICE	125cc	139,000	1
ELECTRIC	Veo	169,000	0

The response showed that the least costing motorcycles for ICE and e-motorcycles is 139,000 kes and 169,000 kes respectfully. Upfront cost of e-bikes might deter many consumers. The initial purchase price of electric motorcycles is often higher than that of their internal combustion engine counterparts by tens of thousands. Other outlying factors noted things that might hinder affordability for potential buyers are the lack of well-established financing infrastructure and a second-hand market for electric motorcycles in Kenya.

Table 2: Cost of fuel and electricity

UNIT	Distance	Fuel Cost	Cost Value
ICE	80km	406 kes	0
ELECTRIC	80km	500 kes	-1

Respondents indicated that they have to swap batteries at least once before the 80km mark and the cost of charging is inversely proportional to the amount of charge remaining, with the mean value calculated to 500 kes. For the same distance covered, respondents using ICE motorcycles use 2 liters of petrol for the same distance as shown.

Table 3: Maintenance Cost

Description	E-motorcycle	ICE
Distance	500km	500km
Frequency of service	1	0
Weight	104 tw	125tw
Availability of mechanics	10	1
Value	0	1

Respondents indicated that for every 500km travelled they do oil change for ICE motorcycles, which did not apply to electric motorcycles. In terms of functionality, respondents noted that the Electric motorcycles tend to be heavier than their ICE counterparts due to the additional weight of battery packs thus limit weight of goods carried as this extra weight can affect handling and maneuverability, particularly at lower speeds or when navigating tight spaces.

Table 4: Cost of Tax incentives

Cost centers	ICE	E-motorcycle
Import levy	25% of CIF	0
Excise duty	20% of CIF+Import duty	10% of CIF +Import duty
VAT	14% of Custom value +Import duty	0
Railway development levy	2% of Custom	0
Import declaration fee	3.5% of custom	0
Cost Value	0	1

Adapted from secondary data on the Kenya Revenue Authority guidelines of 2024, the table shows the tax costs for importing e-motorcycle and ICE motorcycles. Consumer benefit for e-motorcycles is above that of ICE motorcycle importers from government instruments.

Table 5: Cost of charging infrastructure

Description	ICE	E-motorcycles
Distance/radius	35km	35km
Charging/refilling stations	12	2
Cost value	1	0

Respondents indicated that at a radius of 35km there's only 2 swapping centers where's refiling stations for ICE are in plenty. At the moment, the charging infrastructure for an electric motorcycle is typically provided by the importing company within a restricted radius that each user need to operate from to enable the battery swapping to be smooth. Additionally, the availability of charging infrastructure may be limited, particularly outside Nairobi, leading to potential thus long-distance journeys cannot be planned by e-motorcyclists due to limited access to charging stations.

Benefits of Acquisition of E-Motorcycles and ICE- Motorcycles on End Users

Table 6: Benefits indicator mean values

	ICE	E-motorcycle
Affordability	**1**	**0**
Reduction on oil dependency	**0**	**1**
Saving on energy and maintenance	**1**	**0**
Accessibility	**1**	**0**
Increased revenue	**0**	**1**
Saving on CO_2 emissions	**0**	**0**

Respondents were asked in priority basis to indicate the benefits so far in their work to the above value centers. The mean showed as above, respondents preferred ICE motorcycles for affordability, energy saving, and accessibility whereas E-motorcycle were preferred for reduction of oil dependency, increased revenue and none preferred for reduction of Emisions.

Sustainable livelihood outcomes

Table 7: Sustainable livelihood outcomes

	ICE motorcycles	E-motorcycles
Average Daily income to users	**2000**	**2600**

Government revenue	25% of CIF 20% of CIF+Import duty 14% of Custom value +Import duty 2% of Custom 3.5% of custom Fuel levy/ltr 40% of price	20% of CIF+Import duty FCC charge/ FERFA/ IA/ WARMA/ EPRA/ REP/ VAT
CO_2 Emisions significance	**1**	**1**

The research used respondent's income per day for each of the categories with e-motorcycles users indicating an average income of 2600 kes in a day while those using e-motorcycles responded to a mean income of 2000 kes in a day. To determine significant change in health from emissions, all respondents' average was indifferent towards the change in health as their use on health finance remains the same. Using secondary data for government income, the statistic shows significant revenue attained continuously from charging a 15 kW batter to charges of real consumption of 286.20

FCC= 50.85
FERFA=17.23
IA=5.70
WARMA=0.21
EPRA=0.45
REP=14.31
VAT=53.88.
Total charged amount = 428.88

Whereas 40% of the price of petrol per liters charged to VAT, excise duty, road maintenance levy, petroleum development levy, import declaration fee, railway development levy, anti-adulteration levy, merchant shipping and petroleum regulatory levy, over 40 % from electricity per 15kw battery also goes back to government as revenue. This result shows a significance income to government than to end users of whichever model that motorcycle riders use thus dent significantly see a part use of e-motorcycles.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Electric motorcycles offer lower maintenance costs and reduced environmental impact compared to petrol-fueled bikes. However, they have limitations such as shorter battery life, limited range, and a less DIY-friendly nature. While battery technology is improving, battery replacement remains a significant cost factor. Despite these challenges, electric motorcycles are becoming increasingly popular, particularly for urban commuting. However, a lack of awareness about the environmental and economic benefits of electric mobility hinders wider adoption.

Recommendations

An in depth civic education and understanding of policies that support electric mobility should be undertaken and an extended analysis should be done to determine the economic analysis from the state perspective and that of users finances, and the significance of tax incentives for electric mobility products.

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