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RESEARCH ARTICLE

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# Making Kenyan Urban Transportation System Smart: The Case of Eldoret Municipality

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**Abstract**

*Transportation systems are the fundamental to the economic prosperity of any nation. Nonetheless, transportation itself more so the use of automobiles has unintended negative environmental impacts that threaten the very existence of humanity through production of green house gases leading to climate change. Other negative impacts of transportation include compromise of human safety through traffic accidents causing injury and even deaths. This study sought to establish urban mobility patterns within Eldoret Municipality as a means to establish a green transportation planning. Traffic modal split was measured at different Gordon points on the major routes traversing through Eldoret Municipality. Findings illustrates that transportation in Eldoret municipality is unsustainable. There is heavy use of automobiles as compared to greener options such as cycling and walking. The study concludes that in order to achieve green urban transportation system there is need for an integrated approach in the implementation of transportation policy. Provision of feasible and convenient alternatives to car use, provision of high-quality public transportation systems as well as secure and opportune walking and cycling facilities have been recommended as opportunities for making urban transport green in Eldoret Municipality.*

**Keywords**: Urban Mobility, Traffic Modal Split, Transportation, Economic Prosperity

## INTRODUCTION

The designing and development of sustainable transportation system is considered one of the most urgent issues in developing countries. Given the rapid urban population and sprawling of developments into low density downtown, most urban dwellers heavily rely on the use of automobile which have negative environmental consequences (Bart, 2010). It is unclear what is the best way to attain a sustainable future given the multitude of stakeholders involved, the complexity of urban ecosystems and the split decision-making nature in most urban regions (Zhuang et al., 2019).

Making the Kenyan urban transportation system green calls for policies that promote a change in travel behaviour. Whereas it might be more challenging to achieve than enhanced technology, travel behaviour change has proven to be of greater and lasting sustainability gains in German (Martens, 2007). In the transport sector to achieve sustainability means, first, promoting the use of less energy demanding and environment friendly modes of transport for shorter trips. Second, promote economic development, improving transport safety, achieving equal access to destination for all members of the society and better quality of life (Buehler et al., 2009; Shaw, 2014).

One major international example which the study is based on is German. The transportation sector in German has evolved over decades through the enactment of a number of policies at all levels of government to influence travel behaviour. Pricing, restrictions and compulsory technological enhancements have greatly mitigated the negative environmental impacts of automobile use. In the country, German, public transportation is integrated both at the metropolitan and national levels to offer effective and efficient alternatives to car. They have employed the use of targeted regional land planning policies that promote compact and mixed-use developments that have maintained trip distances short and practicable for walking and cycling(Buehler et al., 2009). This German experience offers our country Kenya an opportunity to understand the significant of public policy in improving her own transportation system.

A new era in the transportation system is emerging in Kenya with the government investing huge capital recently in the standard gauge railway from Mombasa to Nairobi to Naivasha and the Nairobi Expressway (Chege et al., 2019; Kosgei & Kioko-Mutinda, 2019). Nonetheless the country has recently been on an impending transportation crisis with highly volatile energy prices more than ever. This calls for prioritization and commitment to transportation policy change both the national and county government. There is need for proper investment in infrastructure that promote competitiveness and environmental sustainability of the county and the nation as a whole. This calls for integration of transportation, land use, housing and economic development plans in order to lower the per capita carbon foot print in the transportation sector like German did to ensure sustainability (Buehler et al., 2009).

## METHODOLOGY

This study sought to establish urban mobility patterns within Eldoret Municipality as a means to establish a green transportation planning. Traffic modal split was measured at different Gordon points on the major routes traversing through Eldoret Municipality.

The study area covered the entire Eldoret Municipality in Uasin Gishu. The research employed purposive sampling where four Gordon points on the major routes entering in and out of the Municipality that is Eldoret - Kisumu Road and Uganda road were selected for traffic counts. This traffic counts sought to establish the traffic modal split in Eldoret Municipality. The four major Gordon points included Kipchoge Stadium and Sosiani River on Eldoret - Kisumu Road, Poa Place Junction and Paul's Bakery on Uganda road. The data included Daily Average Outgoing and incoming Traffic Volumes across Various Modes of Transport. This data was collected daily from 7am to 7pm for seven consecutive days. Questionnaires were also administered to residents of Eldoret Municipality both in the residential and commercial centres to get first-hand information on the state of transportation system in the municipality. This data was analysed using SPSS version 20 and presented using figures.

Data was collected from both primary and secondary sources which included both quantitative and qualitative data. The secondary sources of data entailed data from literature review while primary sources of data entailed collecting data from key institutions and personnel with relevant information. The key institutions where data was collected included; Department of Roads and Public Works, Department of Physical Planning, National Transport and Safety Authority (NTSA), Kenya National Highways Authority (KeNHA), Kenya Urban Roads Authority (KURA), Traffic Police Department as well as the Municipality of Eldoret. The table below shows the Gordon points as well as the routes and the Coordinates.

**Table 1: Gordon Points and their GPS Coordinates in the Study Area3333333**

| No. | Gordon point | Route | Coordinates |
|---|---|---|---|
| 1. | Kipchoge Stadium | Eldoret - Kisumu | 00.52721879°N, 035.27970663°E |
| 2. | Poa Place Junction | Uganda Road | 00.50405978°N, 035.30036107°E |
| 3. | Sosiani River-Kisumu Road | Eldoret – Kisumu | 00.51164412°N, 035.27573191°E |
| 4. | Paul's Bakery | Eldoret-Kitale | 00.52151170°N, 035.26251682°E |

Traffic counts established traffic volumes in both directions, peak periods (hours) and also establish the modal split. The data was from the traffic counts was coded and entered into SPSS version 20 and analyzed. The results were presented using figures and tables. The figure below illustrates the major routes and Gordon points in the study area.

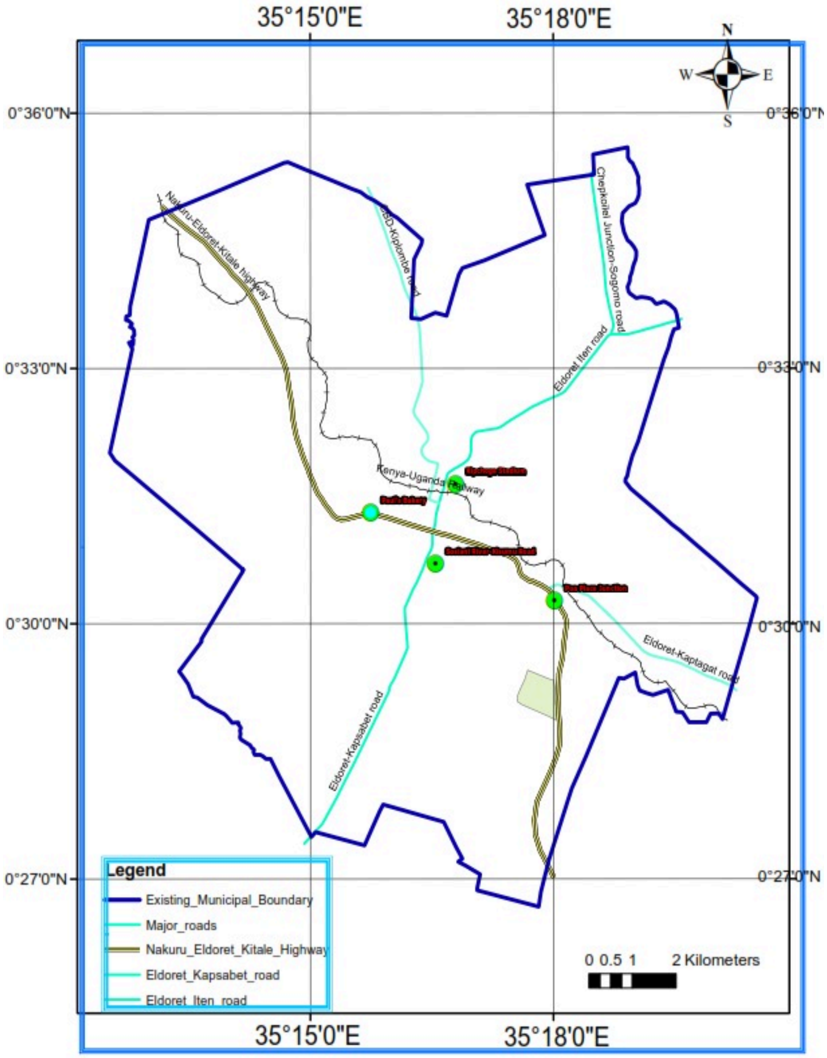


**Figure 1: A map of the study area.**

## RESULTS AND DISCUSSIONS

### Modal Split in the Study Area

The analysis of the data from the traffic counts on modal split in the study area are presented in the figure below. To mitigate the negative impact of the transportation systems, it is essential to relook at the all modes of transport available and determine the appropriate modes of transport for different occasions. In doing so, it enables us maximize on the efficiency and also promote green transport that does not impact our climate negatively. To date a substantial number of countries are in consensus on the role of greenhouse gases in climate change. Nonetheless, a lot of countries for instance the United States fall short of the target in terms of lowering greenhouse gas levels especially emissions from the transportation sector (Muller et al., 2011). Findings from the study portray a negative trajectory in terms of achieving sustainability in our nation. Majority of the trips in the study area are made by greenhouse gas producing automobiles that is matatu 39.29%, motorcycle 26.79%, bus 10.71% and tuktuk at 3.57% as opposed to green options such walking 7.14%, bicycle 0% and train 0%. Though Kenya is categorized as a developing country meaning it is lower in terms of greenhouse gas emissions, this trend not only damages the country's environment but also limits the country's potential to grow economically (Amegah & Agyei-Mensah, 2017). The high consumption of energy leads to high fuel costs among other respiratory illness due to emissions.

Countries such as German have employed policies that have led to more sustainable transport system nurturing commerce, reduction in burning of fossil fuels, carbon emissions, improved transport safety and enhanced quality of life. These policies have influenced travel behaviour change encouraging the use of modes that require less energy with less environment harm for making shorter trips. Stricter land use controls and planning regulations have promoted a more compact metropolitan development pattern in German making the use of modes such as walking and cycling viable (Buehler et al., 2009).

For Eldoret Municipality to have a green transportation system, there is need for public policy change to encourage compact development so as to increase the percentage use of bicycle and walking for transport especially when making short trips other than matatu (39.29%) as shown in the figure. Policies must encourage the use of non-polluting, less energy demanding and healthier options for us to achieve green transportation. This should be able to promote economic development, reduce carbon footprint, improve transportation safety, promote access to destination for all and improve living standards.

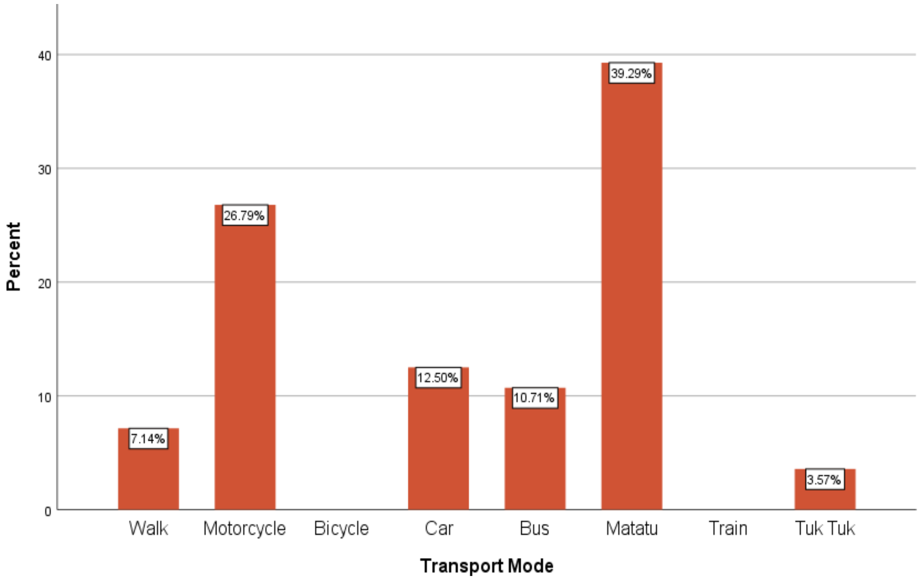


**Figure 2: Modes of Transport in the Study Area.**

**Average Daily Traffic at the Four Major Gordon Points in the Study Area**

Recognizing the mobility in urban environments is the initial stage of evaluating the long-term sustainability of transportation systems' management (Slavić & Mrnjavac, 2019). To understand this in the context of Eldoret Municipality, the study sought to determine traffic flow at four Gordon points.

The figure below illustrates the average daily incoming traffic from various origin into the town at various Gordon points namely Kipchoge, Poa Place, Sosiani and Paul's Bakery. It was noted that Kipchoge Gordon point, at Iten-Eldoret Road an average of 2687 of incoming cars per day was the highest in Eldoret Town, followed by 2603 motorbike per day, 1859 matatus a day, 1047 pedestrians, 284 lorries a day, 52 bicycles a day 28 tuk tuks a day, 22 trucks and buses being four (4) buses per day.

At Poa Place Gordon point, on average 3005 cars were recorded per day followed by574 matatus, 1299 motorcycles, 553 trucks, 428 pedestrians, 355 lorries, 106 bicycles, bus and tuktuk were the least at 25 buses and 16 tuktuks per day, respectively.

Sosian Gordon point exhibited the following modal split for vehicles entering the town. The highest number of motorcycles recorded was 3016 motorcycle per day, followed by 2873 cars, 846 pedestrians, 224 buses, 175 bicycle, 138 tuktuks and 36 trucks per day.

At Paul's Bakery Gordon point, 2465 motorcycles per day were counted followed by 2183 cars, 1816 matatus, 1256 pedestrians, 668 bicycles, 526 trucks, 490 lorries, bus and tuktuk with an average of 52 and 32 per day, respectively.

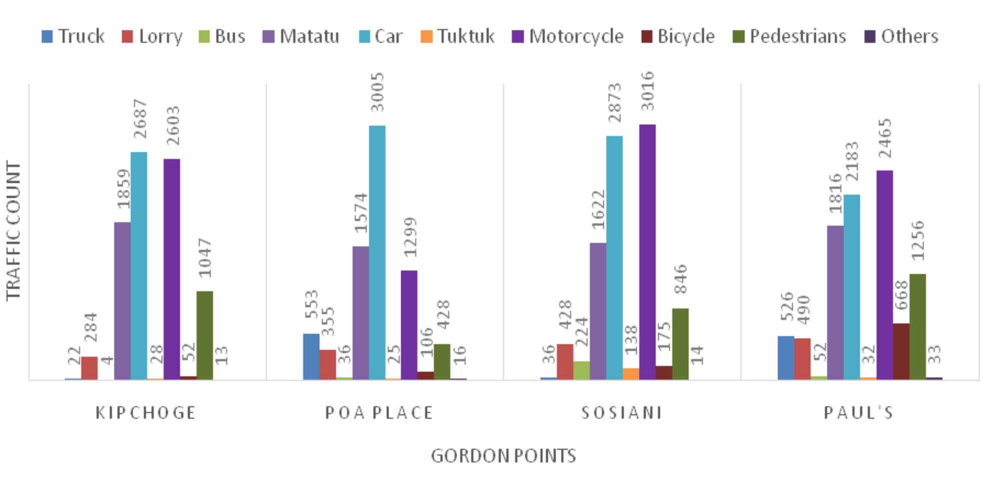


**Figure 3: Incoming Traffic at Various Gordon Points.**

The average daily outgoing traffic from town to various destination at the four Gordon points namely Kipchoge, Poa Place, Sosiani and Paul's Bakery is as shown in the figure below. The figure also shows the modal split that is different types of vehicles passing the Gordon points out of the town. An integrated approach to all levels of traffic mobility is considered the most practicable option automobile dependent cities have in avoiding life quality deterioration as a result of traffic flow (Dvir & Yemini, 2017). To have a sustainable urban mobility, there is need to integrate walking and cycling, have intermodality and mobility management (Przybyłowski, 2018). It is fundamental that stakeholder and public participation be part of sustainable mobility planning (Lindenau & Böhler-Baedeker, 2014). Sustainable urban depend on successful management of urban growth where efficiency of sustainable transport systems is key to quality of life. It is therefore crucial to understand the how traffic flow at various critical points that is Gordon points to assess sustainability. The key for sustainable urban mobility is to ease congestion, accidents and pollution. Knowledge on the actual mobility patterns is essential in understanding traffic mobility shortcomings (Przybyłowski, 2018).

At Kipchoge Gordon point, motorcycle had the highest average daily outgoing traffic (4658 motorcycles per day). Car (average of 3211 cars per day), matatu (average of 2083 cars per day), pedestrians (average of 945people per day), lorry (average of 312 per day), bicycle (average of 98 bicycles per day), tuktuk (average of 34 vehicles per day) and lorry (average of 28 lorries per day).

At Poa Place Gordon point, car (average of 3524 vehicle per day) was the highest, matatu (average of 1789 vehicles per day), motorcycle (average of 1558 motorcycles per day), pedestrians (average of 712 people per day), truck (average of 659 trucks per day), lorry (average of 390 lorries per day), bicycle (average of 131 bicycles per day), bus (average of 59 buses per day) and tuktuk (average of 31 tuktuks per day).

At Sosiani Gordon point, average outgoing car was the highest transport mode at 2280 cars per day, motorcycle (average of 1828 motorcycle per day), matatu (average of 1245 vehicles per day), pedestrian (average of 909 people per day), lorry (average of 308 vehicles per day), tuktuk (average of 188 of tuktuks per day), trucks (average of 36 lorries per day) and bicycles (average of 16 bicycles per day).

At Paul's Bakery Gordon point, motorcycle was the highest mode of transport at average of 2525 motorcycles per day, car (average of 2116 cars per day), matatu (average of 1877 vehicles per day, pedestrians (average of 1168 people per day), bicycle (average of 638 bicycles per day), truck (average of 485 trucks per day), lorry (average of 481 lorries per day), tuktuk (average of 108 per day) and bus (average of 58 per day).

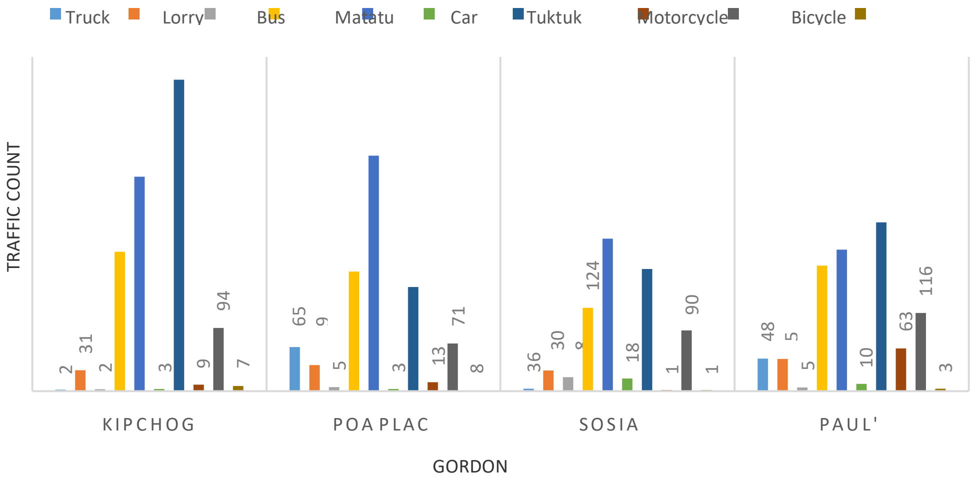


**Figure 4: Outgoing Traffic at Various Gordon Points.**

To manage mobility, calls for systematic approach (Priya Uteng & Turner, 2019). To develop a transport system that is independent calls for constant research on demand for transport infrastructure. Origin and destination patterns in urban areas require a resource efficient transport system to ensure mobility and accessibility (Jones, 2014). Sustainable urban transport for smart cities should offer accessible, sustainable, safe, integrated environmentally friendly and efficient traffic system to meet the demand of all (Kiba-Janiak & Witkowski, 2019). Smart transport for smart cities seeks to influence individual travel behaviour using various professional transport measures to reduce the use of drive alone private cars, reducing the effects of car dominance and the provision of alternative transport options. Sustainability in smart cities emphasizes on reduced car use and relocating road space to sustainable transport modes and street activities and encouraging alternative travel such as walking, cycling and promoting livable cities (Jones, 2014).

Sustainable transport can only be achieved with sustainable modes of transport as well as sustainable travel behaviour. Generally, it is agreed that, private cars do not enhance sustainability, whereas public transport and non-motorized modes such as walking and cycling promote sustainability (Broaddus, 2010). In German, pricing, restrictions and compulsory technological enhancement have helped mitigate the adverse impacts of car use. German has also improved the integration and coordination of public transportation at both the regional and national level providing feasible alternatives to the car. Compact, mixed-use development keep distances short and feasible on foot or by biking. Promoting safety for biking and walking through well-coordinated policy strengthening the positive impact (Buehler et al., 2009).

**Challenges Facing Transportation**

While the use of automobile has numerous positive impacts it brings along with its unintended negative consequences such as traffic congestion, pollution, traffic safety among others. The figure below illustrates the challenges facing transportation in Eldoret Municipality according to the responses from the questionnaires administered to residents. Traffic congestion had the highest number of respondents citing 62.96% as a transport challenge followed by poor road conditions and high transportation cost at 12.96% each, traffic accidents at 7.41% and insecurity at 3.7%. Some measures such as targeted pricing and regulation policies as implemented in German have helped manage automobile travel demands and thus reducing traffic congestion and accidents (Rehfeldt et al., 2020). To solve these challenges nations have employed range of measures. In terms of the cost of owning and operating some jurisdictions made it expensive in terms of sales taxes on new car, high annual vehicle registration fees, high cost of obtaining driver's license, high gasoline taxation and promoting the purchase of fuel-efficient cars. These taxes on owning and operating automobiles have helped generate more income to fund transport infrastructures (Rehfeldt et al., 2020).

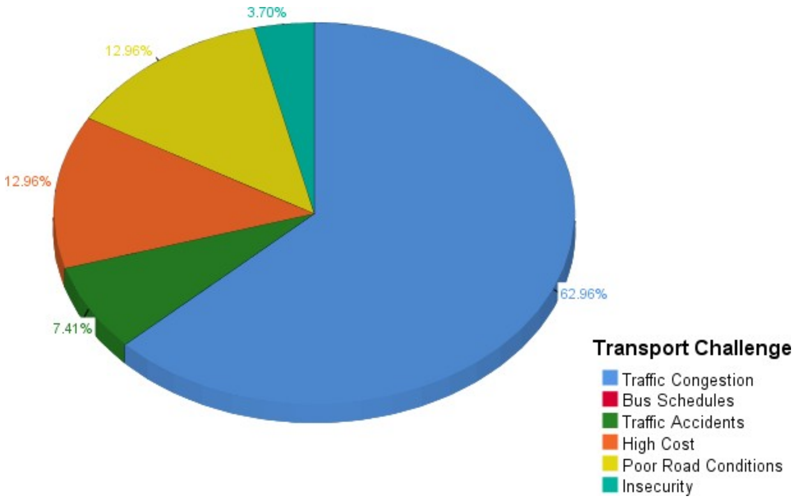


**Figure 5: Challenges Facing Transportation in the Study Area.**

Restrictions on car use have also been implemented to solve transportation challenges. This includes restrictions in terms of road layouts, minimum speeds and less parking space availability. Policies such as deliberate curl-de-sacs, turning restriction, one way street networks and extensive car free zones have been useful in discouraging traffic through city centres (Black et al., 2021). German has got one of the lowest speed limits of about 19 miles per hour or less, road narrowing, raised intersection, crosswalks and speed humps. In residential areas in German there exist even stringent policies on car speed limits requiring cars to travel at 'walking speed' that is 4 miles per hour. This are referred to as traffic calming.

Tax incentives can also be used to encourage the purchase and use of more fuel efficient and less polluting cars (Black et al., 2021; Buehler et al., 2009).

The restrictions on car use to lower negative impacts on automobile use cannot be successful on its own. It calls for integration of various mode of public transportation at the metropolitan, regional and national level to make public transport convenient and attractive. It calls for the provision of transit services and schedules to coordinate all public transportation aspects, ticketing and fare structures. There is also need to integrate walking and cycling amenities such as extensive bike parking services at bus stops. It should be made possible for passengers to use one ticket for their entire travel trip throughout a metropolitan area regardless of the number of transit modes used (Broaddus, 2010).

The following figure illustrates survey findings on the residents' view on the introduction of high-capacity vehicles as a way of dealing with transportation challenges. The findings showed that 87.5% of the respondents welcomed the idea of introduction of mass transit vehicles while 12.5% were against the introduction of high-capacity vehicles. It should be noted that high-capacity vehicles not only lower the carbon footprint but also generates more revenue to offset the operating costs. It thus needs to be targeted as one of the major ways to improve sustainability.

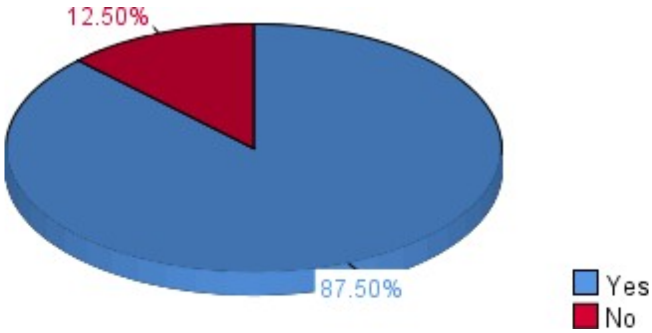


**Figure 6: Support for High-Capacity Vehicles.**

Green transport infrastructure cannot be achieved without promoting safety and convenience for walking and cycling. Besides the provision of multiple options to transit possibilities, they should be safe for use by both motorists, cyclists and pedestrians. The findings on the road conditions in the study area according interviewed residents of Eldoret Municipality are as illustrated below. The findings show that 70.91% feel the roads in a fair condition, 27.27% feel they are good while 1.82% reported that the roads were in bad conditions.

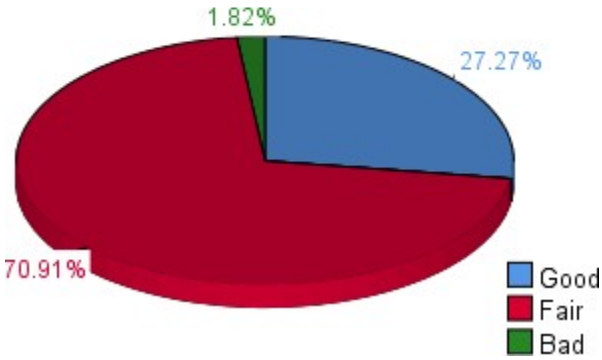


**Figure 7: Road Conditions.**

The study went ahead to assess the availability of bicycle lanes and pedestrian walkways through survey where the findings as shown in the figures below. The findings on the availability of bicycle lanes in estates show that only 33.93% of the respondents reported to have bicycle lanes in the estate as opposed to 66.07% who did have this infrastructure.

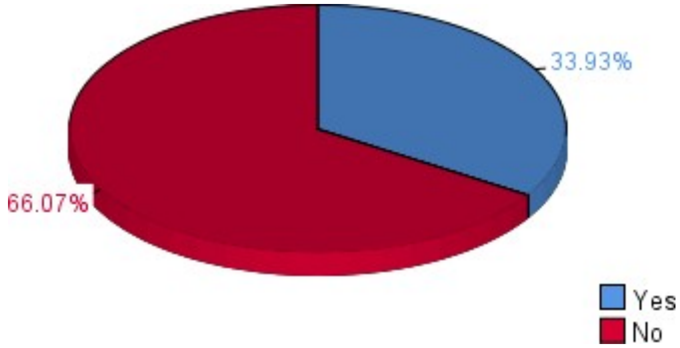


**Figure 8: Presence of Bicycle lanes in Estate.**

Majority of the respondents 85.71% reported to have pedestrian walkways in the estate unlike 14.29% who reported to be missing this infrastructure in the estates.

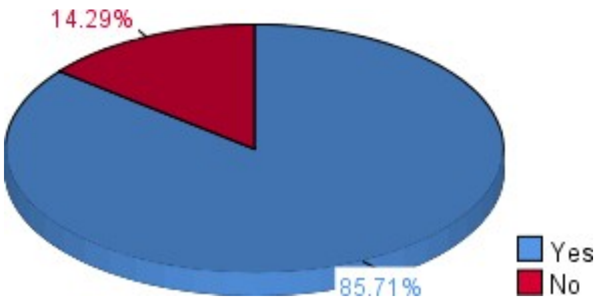


**Figure 9: Presence of Pedestrian walkways.**

It is essential that pedestrian walkways and bicycle lanes be provided so as to lower cyclist and pedestrian fatality and injury rates. The improvement of the safety of these modes of transport who make them attractive and thus lowering the generation of greenhouse gases as they are clean modes of transport (Buehler et al., 2021). In a metropolitan area, it is fundamental that cyclist and pedestrian be to cover the entire trip from origin to destination on either completely separate lanes or lightly travelled traffic calmed residential streets. There should be the provision of car free zones mainly for pedestrian use. This also calls for higher density development with greater mixes of land use to make average trips short easier for walking and cycling. This can be done through policies such as land use planning, zoning regulations among others (Cepeliauskaite et al., 2021).

## CONCLUSION

Green urban transportation system can be realized only through an integrated approach in the implementation of transportation policy. It is unethical and difficult to restrain car use and make it unaffordable without providing feasible and convenient alternatives to car use. The implementation of restrictive policies on car use must be second to the provision of high-quality public transportation systems as well as secure and opportune walking and cycling facilities. There is also need to create public awareness on the alternative green transportation such as walking and cycling. Further, transportation changes to achieve a green transportation system should be accompanied with well-coordinated changes in land use policies. The public should be informed of the benefits of the new policies. Nevertheless, the policies should be implemented in a stepwise manner.

## RECOMMENDATION

a) Congestion pricing, higher fuel taxes and vehicle fees are some of the cost related ways of promoting fuel efficiency and more environmentally friendly cars. Such kinds of policies are essential for promoting public transportation, walking and cycling.

b) Deliberate measures to improve transport infrastructure on continuous basis to keep up with demand as well as trends

c) There is need to integrate transit, cycling and walking as alternatives to the car. For car-restrictive measures to hold, safer, convenient and cheaper alternatives to cars should be made available for the public to use.

d) There is need for public information and education to influence travel behaviour. These campaigns are essential in making clear policy benefits and the final positive impact.

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