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# ASSESSMENT OF THE LEVEL OF AWARENESS OF HOUSEHOLDS AND INSTITUTIONS ON THE IMPACTS OF PREMATURE END-OF-LIFE VEHICLES IN NAIROBI CITY COUNTY, KENYA

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## ABSTRACT

Over the years, Kenya has recorded an increase in the volumes of vehicles shipped into the country. Some of these vehicles end up being premature end-of-life vehicles (ELVs) mainly due to road accidents. These premature ELVS are poorly managed mostly parked in police station yards, garages, and some residential estates causing public health and environmental harm thus undermining achievement of sustainable development. There have been scattered efforts on their management through policies and legislation such as the Environmental Management and Coordination Act, 1999; the umbrella law on environment which is both generic and unable to sufficiently address premature ELVs. This paper provides findings from a study whose objective was to assess the level of awareness of households, public and private institutions on the impact of poor management of premature ELVs on social concerns, public health, and the environment; and implores on the need for responsive policy and legal frameworks. To this end, structured questionnaires were administered to a total of 170 households in Nairobi County while key informant interviews (n=88) were conducted in relevant government agencies viz. policy making institutions; regulators and enforcement agencies; and, garages, salvage companies, and insurance firms. A Likert scale (1-5), with 1 being totally unaware and 5 highly aware was used to gauge the level of awareness. The mean level of awareness was 3.87 and most respondents were above this level of knowledge about social impacts such as degradation of the aesthetic values associated with poorly managed premature ELVs. However, another majority was below the average awareness level of 3.87 on awareness of the environmental and public health impacts associated with poor management of the premature ELVs. The results of this study indicate the need for enhanced awareness programs and development of policy and legal frameworks for effective management of premature ELVs in Kenya.

**Keywords**: Premature end-of-life vehicle, Awareness level, ELV management, Nairobi City County, sustainable development

## INTRODUCTION

Premature end-of-life vehicles (ELVs) are automobiles that have reached their end of useful lives before their average life span due to damage from accidents and therefore not able to be used on the roads.[1]ELVs consist of large numbers of vehicles already deregistered in European Union (EU) countries and shipped to non-EU countries for re-use as used cars or treatment.[2] Kenya is a major importer of vehicles from Asia and

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1 Shameen Ahmed, Shamsuddin Ahmed, Hasan Rezaul Shumon and Abdul M. Quader, 'End-of-Life Vehicles (ELVs) Management and Future Transformation in Malaysia,' (2014) 9(918) J. Appl. Sci. Agric. J. Appl. Sci. Agric. <www.aensiweb.com/JASA> accessed 20 February 2021; Joseph. K. Muiruri, 'The Magnitude of Unclaimed End of Life Vehicles and Environmental Implications in Police Stations' Yards: A Case Study of Nairobi, Kenya,' (2014) 3(2) Am. J. Environ. Prot. <https://www.researchgate.net/publication/261395912_The_magnitude_of_unclaimed_end_of> accessed 14 December 2020; Flavius Ioan Rovinaru, Mihiela Daciana Rovaniru and Adina Viorica Rus, 'The Economic and Ecological Impacts of Dismantling End-of-Life Vehicles in Romania,' (2019) 11(6446) Sustainability <https://www.mdpi.com /2071-1050/11/22/6446> accessed 19 April 2021.

2 Massimiliano Mazzanti and Roberto Zoboli 'Economic Instruments and Induced Innovation: The Case of End- of-Life Vehicles European Policies' (2005) 80; Working Papers, pp. 1–49, Fondazione Eni Enrico Mattei<https://ideas.repec.org/p/fem/femwpa/2005.80.html> accessed 16 November 2021; Jürgen Schneider, Brigitte Karigl, Christian Neubauer, Maria Tesar, Judith Oliva and Brigitte Read 'End of Life Vehicles: Legal Aspects, National Practices and Recommendations for Future Successful Approach' (2010) <https://www.google.com/search?q=End+of+life+vehicles%3A+Legal+aspects%2C+national+practices+and+recommendations+for+future+successful+approach&oq=End+of+life+vehicles%3A+Legal+aspects%2C+national+practices+and+recommendations+for+future+successful+approach&aqs=chrome..69i57.10787j0j7&sourceid=chrome&ie=UTF-8> acce ssed 3 July 2021; MuhamadZameri Mat Saman, Norhayati Zakuan and Gordon Blount 'Design for End-of-Life Value Framework for Vehicles Design and Development Process' (2012) 5(3) Journal of Sustainable Development, <https://www.researchgate.net/publication/228449357_Design_ for_End-of-Life_Value_Framework_for_Vehicles_Design_and_Development_Process> accessed 22 November 2021

the EU with minimal assemblies done locally. Most of the imported vehicles are second hand having been used in countries of origin. This demonstrates that most of the vehicles shipped into Kenya will at one point, in the near future reach their end-of-life including premature ELV, and require appropriate management mechanisms.

The increasing number of vehicles in Kenya can be attributed to the expanding economy, and therefore required to support industrial growth. In 2010 and 2018, Kenya reported about 1.3 million and 3.3 million registered motor vehicles respectively which translates to a 30% increase annually.[3] The number of vehicles being purchased both old and new has been increasing over years. In 2014 for instance, the vehicle population was 2,022,955 and this is projected to hit 5,062,366 by 2030. This projection is consistent with the 2019 statistics by Kenya National Bureau of Statistics, which recorded a total of 3,280,934 newly registered vehicles by December 2018.

In 2018, the World Health Organization (WHO) released a global status report indicating that road transport accidents including vehicles had increased to 1.3 million every year with 93% being from low and middle-income countries[4]. While noting that road accidents rank ninth in the global causes of death, the researcher associated the causes in Kenya to test failure, the poor state of the roads, and non-compliance to traffic laws. Between the periods 2016 to 2021 there was a sharp increase in number of road accidents[5]. In 2019, the National Transport and Safety Authority (NTSA) recorded 3572 fatalities, 6938 serious injuries and 5186 slight injuries as at

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[3] Joseph. K. Muguro, Minoru Sasaki, Kojiro Matsushita and Waweru Njeri, 'Trend Analysis and Fatality Causes in Kenyan Roads: A Review of Road Traffic Accident Data Between 2015 and 2020,' (2020) 7( 1 ) Cogent Eng. <https://www.tandfonline .com/action/showCitFormats?doi=10.1080%2F23311916.2020.1797981> accessed 23 De-cember 2020

[4] Ibid.

[5] Jane Ngugi and Dennis Rasto 'Road accidents increase by 17.3 percent in 2021' (Kenya News Agency, 22 December 2021) <https://www.kenyanews.go.ke/road-accidents-increase-by-17-3-percent-this-year/> accessed 4 March 2022

December 2019[6]. In 2020, the total number of road accidents fatalities in the country was 3,707 while in mid-December 2021, a total of 4,347 was recorded being, the highest in five years representing a 17.3 % increase[7]. The increase in accidents is evidence of increasing volumes of premature ELVs, which contribute to environmental pollution and risks to public health as well as social concerns.

The Sustainable Development Goals (SDGs) 14 on life below water and 15 on life on land envisage protection and sustainable use of water resources and terrestrial ecosystems. As such any human related activity should gear towards protection and sustainability of such ecosystems. However, the current management of premature ELVs has not observed the requirements of SDGs 14 and 15. The recognition of premature ELV as waste stream for purposes of management with both environmental and economic benefits has not been forthcoming despite the increase in the number of premature ELVs. The national commitment is encouraging however, the holistic approach to meeting the SDGs is lacking. The focus on certain aspects of the sustainable development pillars (economic, social and environmental) rather than a holistic approach may undermine the efforts and compromise the achievement of the SDGs. Given appropriate recovery, recycling and disposal practices, the value chain of premature ELVs can address the environmental, social and economic pillars of sustainable development. While premature ELVs have the potential for both environmental and economic benefits, this aspect is not fully explored in Kenya. Reduced overexploitation of natural resources to provide raw materials for the automotive industry through dismantling and recovery of spare parts and safe disposal can provide net gains to the environment. The establishment of a regulated market for spare parts contributes to Gross Domestic Product of the country and opens up job

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[6] United Nations 'Promoting Safer and Cleaner Used Vehicles for Africa' (2020) FIA Region I, <https://www.fiaregion1.com/promoting-safer-and-cleaner-used-vehicles-for-africa/>accessed 27 May 2021

[7] Jane Ngugi and Dennis Rasto 'Road accidents increase by 17.3 percent in 2021' (Kenya News Agency, 22 December 2021) <https://www.kenyanews.go.ke/road-accidents-increase-by-17-3-percent-this-year/> accessed 4 March 2022

opportunities. In a study on the economic and ecological impacts of dismantling ELVs in Romania, it was established that ELVs have many different materials of valuable resources like ferrous metals (71%), nonferrous (7%), plastics (8%), glass (3%), fluids (2%), rubber (5%) and others (4%). Another study also established that ELVs could be valuable resources either in form of spare parts or materials for the automotive industry[8]. ELVs provide important secondary raw materials such as metals and other useful materials that if recovered, can be reused or recycled and fed back into the economy thus closing the sustainable resource circulation loop contributing to a reduced demand of virgin raw materials[9]. If left in parking lots as is currently the practice, they cause environmental and public health-related challenges such as heavy metal pollution, soil and water pollution among others due to exposure and inappropriate recovery methods. These are confirmed by various studies that established that poorly managed premature ELVs release fluids, disturb water flows, soil and water pollution, leaching of heavy metals and polychlorinated biphenyls (PCBs) as well as habitat for vermin[10];[11];[12]. The increasing volumes of the premature ELVs and their impact on the environment and

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[8] Mélanie Despeisse, Yusake Kishita, Masaru Nakano and Michael Barwood, 'Towards a circular economy for end-of-life vehicles: A comparative study UK – Japan' (2015) 29, 668 – 673 Elsevier <https://www.sciencedirect.com/science/article/pii/S2212827115003522> accessed 21 April 2021

[9] Nitish Arora, Shilpi Kapur Bakshi and Souvik Bhattacharjya,' Framework for sustainable management of end-of-life vehicles management in India' (2018) 21, 79–97 J. Mater. Cycles Waste Manag. https://link.springer.com/article/10.1007/s10163-018-0771-0accessed 28 June 2021

[10] Joseph. K. Muiruri, 'The Magnitude of Unclaimed End of Life Vehicles and Environmental Implications in Police Stations' Yards: A Case Study of Nairobi, Kenya,' (2014) 3(2) Am. J. Environ. Prot. <https://www.researchgate.net/publication/261395912_The_magnitude_of_unclaimed_end_of> accessed 14 December 2020

[11] Shinichi Sakai, Hideto Yoshida, Jiro Hiratsuka, Carlo Vandecasteele, Regina Kohlmeyer, Vera Susanne Rotter, Fabrizio Passarini, Alessandro Santini, Maria Peeler, Jinhui Li, Gil-Jong Oh, Ngo Kim Chi, Lawin Bastian, Stephen Moore, Natsuko Kajiwara, Hidetaka Takigami, TakaakiItai, Shin Takahashi, Shinsuke Tanabe, Keijiro Tomoda, Takashi Hirakawa, Yasuhiro Hira, Misuzu Asari, and Junya Yano, 'An International Comparative Study of End-of-Life Vehicle Recycling Systems,'(2014) 16(1) J. Mater. Cycles Waste Manag. <https://link.springer.com/article/10.1007/s10163-013-0173-2> accessed 7 January 2021

[12] Vladimir Simic, 'End-of-life vehicle recycling - a review of the state-of-the-art', (2013) 20(2) Teh. Vjesn. <https://www.researchgate.net/publication/279914203_End-of-life_vehicle_recycling-A_review_of_the_state-of-the-art> accessed 7 October 2021

public health introduce an important debate of ensuring environmentally sound and safe disposal of premature ELVs. Effective management of the premature ELVs can only be feasible if the relevant government agencies and the public are aware of impacts related to end-of-life vehicles and appropriate reforms are put in place including policy and legal frameworks.

Effective management of premature ELVs has been realized in developed countries unlike developing ones largely attributed to failure of the policy and legal frameworks. Japan has the highest vehicle population globally at 1 vehicle for every 1.7 people[13]. In view of the limited space for landfilling, Japan has the Japanese Automobile Recycling Law.57 since January 2005 for ELVs whether natural or premature. Most important is the requirement for the recycling fee, which is paid for at the time of purchase. In addition, the recycling fee is paid for older vehicles during the mandatory vehicle inspection. The legislation ensures that both manufacturers and importers are responsible for the recycling and proper disposal of three designated materials – fluorocarbons, airbags and automobile shredder residue (ASR).[14] As an economic incentive, a vehicle that is more recyclable fetches lower recycling fee with the fee made refundable to the manufacturers and importers after ensuring proper disposal of the ELV. This has led to commendable progress in Japan with recovery and recycling being reported at 99% while energy recovery rate of ASR at 93.3% in 2011[15]. EU member states have been successful in managing ELVs due to proactive policy and legal frameworks. The European Union directive 2000/53/EC on ELV management applies the Extended Producer Responsibility (EPR) applying the principle of subsidiarity and polluter pays principle. EPR requires the generator of the wastes to manage them, which in this case are the manufacturers of the vehicles that finally become ELV wastes. This approach has

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[13] Canadian Environment Law Association, 'Improving Management of End of Life Vehicles in Canada'<https://cela.ca/wp-content/uploads/2019/07/784.ELV-April-2011.pdf> accessed 16 November 2021

[14] Ibid.

[15] Jiro Hiratsuka, Naomi Sato and Hideto Yoshida, 'Current status and future perspectives in end-of-life vehicle recycling in Japan' (2014) 16(1) J Mater Cycles Waste Manag. https://www.researchgate.net/publication/257485788_Current_status_and_future_perspectives_in_end of-life_vehicle_recycling_in_Japan> accessed 8 July 2021

been successful in ELV management among the EU member countries.

Similarly, a study on "Treatment of End of Life Vehicles in Brazil: Challenges and Opportunities" established that Brazil lacks regulations to guide management of ELVs.[16] The study noted the growing demand for new vehicles and need to dispose of the end of life vehicles but there is generally diminishing land that cannot accommodate such needs. Brazil is ranked the eighth largest vehicle fleet in the world behind only the United States, Japan, Germany, Italy, France, United Kingdom and Mexico[17]. The author noted that in Sao Paulo for instance, 500 vehicles per year are abandoned on the streets with an average of 407 daily removal of broken cars due to lack of maintenance and the already compromised allocated sites for waste management approximated at 61%[18]. The poor management of the ELVs due to their direct exposure to weather lead to leakage of fluids into soil and water causing more pollution.

The country has no regulations that guide disposal of ELVs neither specialized companies that undertake recovery, recycling, reuse and appropriate disposal of non-recoverable parts of the ELVs. The practice entails dumping of ELVs directly on the soil leaving them indefinitely while exposed to weather thereby contribution to soil and water pollution. In cases where there is any form of recovery, it is undertaken by illegal and small sized facilities that remain environmentally passive. The practices of such facilities contribute to more harm to the environment. The facilities operate without any environmental permits and process low volumes of ELVs[19]. In addition, these facilities do not keep a detailed inventory of their recovered products and materials and lack technically trained personnel or equipment to ensure decontamination, proper dismantling and recovery.

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[16] Joacquim Jose Filho 'Treatment of End of Life Vehicles in Brazil: Challenges and Opportunities'(2012) 21st SAE Brasil International Congress and Exhibition <https://www.sae.org/publications/technical-papers/content/2012-36-0217/> accessed 16 March 2022

[17] Ibid.

[18] Ibid.

[19] Ibid.

In Kenya, the current policy framework in the country for management of premature ELVs is inadequate for achievement of environmental and economic benefits. Sessional Paper No. 10 of 2013 on the National Environment Policy (NEP), which has identified waste management as a problem fails to recognize premature ELV as a waste stream whose management is even complex and requiring government's attention. It considers electronic, clinical and military wastes but fails to recognize the premature ELV as waste category. In addition, the NEP, 2013 while noting toxic and hazardous substances from agricultural and industrial sectors, fails to note potential decay and leakage of motor fluids from the premature ELVs. The Draft National Automotive Policy of 2019 has been developed to support achievement of the government's Big Four Agenda specifically to steer the domestic automotive industry and enhance Kenya's competitiveness in the sector. This policy has focused on production and marketing but fails to take cognizance of the end of life of the vehicles and how to sustainably manage them.

The Environmental Management and Coordination Act, 1999 and Environmental Management and Coordination (Waste Management) Regulations of 2006 have focused on hazardous wastes and scrap metals without identifying premature ELVs as a major source of hazardous wastes and the scrap metals that require a unique approach in its management. The Waste Management Regulations of 2006 focuses on other waste streams and not premature ELVs. The regulations articulate provisions for industrial wastes, toxic and hazardous wastes and substances, radioactive and biomedical wastes but not premature ELV wastes. The draft waste tyre regulations has also failed to acknowledge the complexity of premature ELVs and its wastes. EMCA, 1999 being the overarching law on environment is generic and has not been successful in effective management of premature ELVs despite the disjointed efforts by the players in the industry. In any case, where the legal framework exists, it should be relevant and fit-for-purpose and be able to address challenges of poor management of premature ELVs; it should be stringent and be able to provide for clear recourse for any violation within the ELV value chain; and it should give clear mandates to the regulator, be enforceable and be able to deter non-compliance.

This article aims to assess the level of awareness of Nairobi's citizenry and government institutions on the presence and impacts of premature ELVs on the environment, public health, and social concerns. The study further addressed weaknesses in policy and legal regimes that have weakened effective management of premature ELVs in Kenya and how poor management of premature ELVs impairs the gains made so far in sustainable development. The article is divided into four major sections. After this introduction, section 2 outlines the methodology used to conduct the study and in specific detailing the study area, population under study, research design, data collection and analysis. Section 3 presents the findings of the study as guided by the study objectives. Section 4 outlines strategic proposals on premature ELVs and section 5 is the concluding section. It provides the appropriate approaches to deal with the gaps that informed the study.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

This study was carried out in Nairobi City County (NCC) of Kenya where the service industry is the most vibrant sector contributing to 59.2 percent of Nairobi's GDP[20]. The transport sector, which is a component of the service industry, is the largest source of premature ELVs with vehicles being the most commonly used mode of transport. This is largely possible because of a high percentage of motorable roads and affordability by the resident population as well as inadequate alternative means of transport for instance trains and other feasible modes of transport. Most of the vehicles within the County are mainly public service vehicles with a reasonable percentage being private vehicles belonging to institutions and individuals. The County has a total of 35 police stations with a total of 12 police stations mandated to handle traffic-related issues. It also hosts several garages, most of which are of small scale and operated by motor vehicle technicians who have learned their trade through on-job training practice. A few of the garages such as Automotive Association (AA) appointed garages and medium scale garages are owned by motor vehicle

[20] Nairobi City County, County Integrated Development Plan, 2018–2022, (2018)

assembly companies with professionally trained motor vehicle technicians. Nairobi City County like any other city has a fast-growing population and the number of vehicles on the roads continues to grow. Scarcity of spaces for parking and storage for ELVs cannot support the indefinite storage of vehicles. Inadequate parking space coupled with inadequate policy and legal frameworks thus providing an environment of poor management of premature ELVs.

## 2.2 Data Collection

The study used primary data collected from various categories of respondents including households and institutions. These were supplemented by observations and secondary data. Primary data from households were collected using semi-structured questionnaires from April to June 2020. The questionnaire constituted both rating scale and open-ended questions. This format of developing the questionnaire neutralizes the biases of single data sources[21] and was developed to allow the respondents to provide information on any knowledge of premature ELVs including existing management mechanisms being used in the County. Stratified sampling was employed in dividing the whole study area with the strata being levels of income (high, medium, and low). The fifteen estates, which were picked for the study from the three strata, were as follows; High-income residential estates being Runda, Kileleshwa, Nyayo Embakasi, Ngong, and South C; middle-income residential estates being Race Course, South B, Buruburu, Utawala, Fedha, and Kariokor; and low-income residential estates being Kasarani, Umoja, Lucky Summer, and Kariobangi. Systematic random sampling was then employed in the selection of households. In areas with a high concentration of households, the questionnaire was administered in every 10$^{th}$ household, while in sparsely populated areas, the questionnaire was administered in every 15$^{th}$ household.

In addition to household surveys, key informant interviews for various groups namely; policy-making institutions, regulation

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[21] Bernard C.K.Choi and Anita W. P. Pak, 'A Catalog of Biases in Questionnaires' (2005) 2(1), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1323316/> accessed 8 January 2021

and enforcement agencies, garages, salvage companies, and insurance firms were also conducted during this period. The selected key informants engaged during the study were either relevant agencies on issues related to premature ELVs or those directly affected due to the nature of their operations. Simple random sampling through an online number generator was employed in the selection of insurance firms, police stations, garages, and salvage companies to which structured key informant interviews were administered. Interviews were conducted with 88 key informants from various institutions. These institutions were categorized by work they do namely; a) policy-making institutions being Ministry of Environment and Forestry and State Department of Transport; b) regulators i.e. National Environment Management Authority (NEMA), National Transport and Safety Authority (NTSA), Directorate of Occupational Safety and Health Services (DOSHS), County Government of Nairobi (Environment, Transport and Planning departments), and Traffic Police Department, and *Matatu* Owners Association (a privately registered organization that regulates public service vehicles in Kenya). A reconnaissance survey was undertaken to establish the total number of police stations in Nairobi County from which nine (9) of the selected 12 were interviewed. The choice of the 12 was due to long time experience in handling premature ELVs. These police stations also provide parking yards for premature ELVs.

Secondary data was then used to supplement primary data. Its collection entailed a detailed review of both published and unpublished data relating to ELV management from developed and developing countries including Kenya. However, not many studies on ELVs have been done in the country. The information obtained provided insights into technical, technological, and policy, legal as well as institutional frameworks that are pivotal in the effective management of premature ELVs. A total of 258 key informants and household members were interviewed in five categories namely households 170 (66%), Salvage and garage facilities 62 (24%), regulation & enforcement 15 (3%), insurance 9 (3%), policy-making institutions 2 (1%), and Majority of the respondents were males 198 (77%) while females were 60 (23%), as illustrated in Figure 5, Appendix.

### 2.3 Data Analysis

Collected data were entered into an MS Excel spreadsheet for cleaning and preparation. The statistical package used (SPSS V.26)[22] was used to analyze the data. The key focus on households and key informants was their understanding of premature ELVs and their level of awareness on management of premature ELVs within the study area. Socio-demographic data particularly gender analysis and duration of stay for households as well as years of experience for key informants were obtained from the respondents. To test the statistical significance of the opinions of the key informants on their awareness of premature ELVs and their impacts, Analysis of Variance (ANOVA) test was conducted. A G-test of independence was conducted to test the statistical significance of the awareness level of institutions and households on the existing management mechanisms for premature ELVs. The variable with a probability value $p$ of less than 0.05 was considered significant and informed findings and conclusions that should support effective management of premature ELVs including policy actions.

## 3. RESULTS AND DISCUSSION

### 3.1 Awareness Level of Households on Existence of Premature ELVs

Results from the household survey indicated a high level of awareness of what premature ELVs were across all the 15 residential estates within Nairobi City County (see Figure 6, Appendix), with 91% (154) of respondents indicating that they knew what a premature ELV is. Similarly, 95% (161) of respondents indicated that they have some premature ELVs within their residential estates in Nairobi. However, only 9% (16) possessed a premature ELV within the Estates (Figure 1) but the majority of the households (94%) have seen or spotted a premature ELV at one point.

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[22] Darren George and Paul Mallery, IBM SPSS Statistics 26 Step by Step; A Simple Guide and Reference (16th edn, 2020)

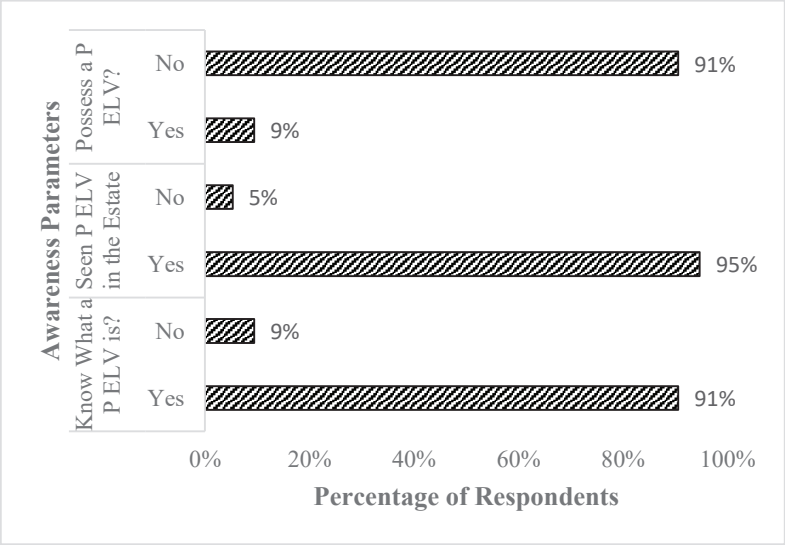


Figure 1: Awareness Level of Households on Existence of Premature ELVs

Most of the respondents were from medium and high-income residential estates such as South B, Buruburu, Utawala, Racecourse, Kariokor and Kileleshwa, South C, Nyayo Embakasi, Runda respectively were well aware of what premature ELVs are. In their responses, they defined premature ELVs as vehicles that have reached their end of useful life due to accidents and written-off. On the other side, several of the respondents from low-income residential estates such as Kariobangi and Lucky Summer were not well aware of premature ELVs. This outcome can be attributed to the economic status of a household as having a role to play in ownership thus defining awareness level on premature ELVs. Most of the households from low-income residential estates do not own vehicles as such limiting their exposure and knowledge on premature ELVs; while households with high levels of income have a higher potential of vehicle ownership. This is corroborated by previous studies done which indicate that level of income has a direct relationship to vehicle ownership[23;24].

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[23] Vijayalakshmi S and Krishna Raj, 'Income and Vehicular Growth in India : A Time Series Econometric Analysis', (2019) Working Papers 439, Institute for Social and

Households with high levels of income have a higher potential for vehicle ownership. Another separate study established that the level of income determines the choice of residence, thus most of the respondents from high and middle-income residential estates are those considered to have a stable income and can own a vehicle which further makes their level of awareness on premature ELVs high unlike in the low-income residential estates.

Households from middle-income residential estates such as Kariokor, Fedha, Buruburu, and Race Course (Figure 2) are indicated as having the highest possession of premature ELVs where open spaces act as storage for premature ELVs. In addition, these residential estates are surrounded by many illegally established garages where premature ELVs are indefinitely packed. The establishment of these garages can largely be attributed to inadequate enforcement requirements of urban planning. Low-income residential estates (Kasarani, Lucky Summer, Kariobangi, and Umoja) also have a good number of premature ELVs. These residential estates are largely characterized by poor enforcement of planning requirements where most open spaces are turned into dumping zones.

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Economic Change <http://www.isec.ac.in/WP%20439%20-Vijayalakshmi%20S%20and%20Krishnaraj%20-%20Final.pdf> accessed 7 October 2021

[24] Ben Clark, Kiron Chatterjee and Steve Melia 'Changes in level of household car ownership: the role of life events and spatial context,'(2016) 43(4) Transportation, <https://link.springer.com/article/10.1007/s11116-015-9589-y#citeas> accessed 7 October 2021

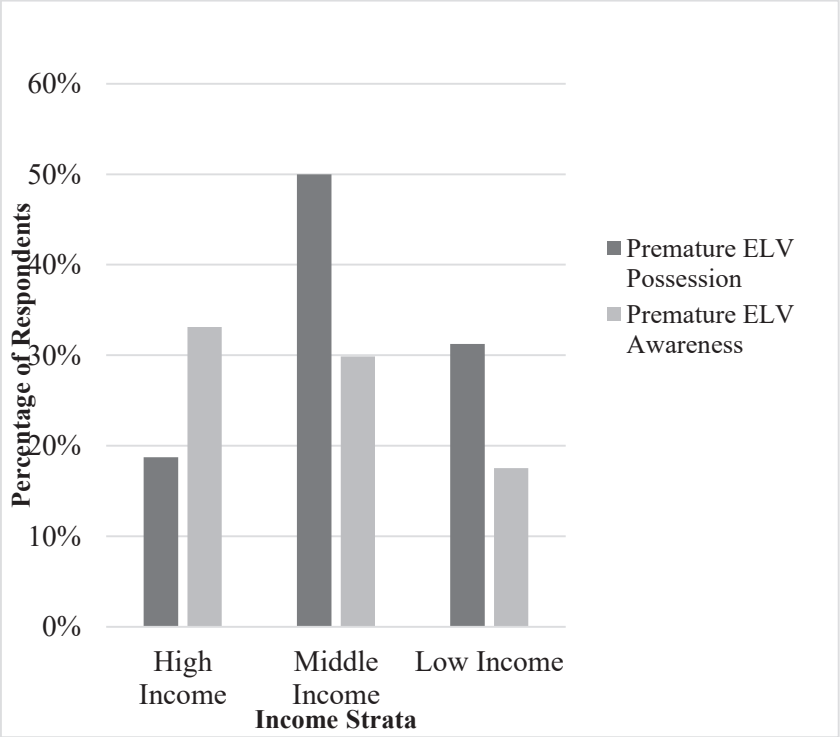


Figure 2: Possession and Awareness Level on Premature ELVs per Income Strata

Further, the households are not expected to undertake any response measure on disposal of premature ELVs in their possession. The inaction is attributed to inadequate awareness of the environmental and public health impacts of premature ELVs (Figure 3) as well as inadequate information on management options within Nairobi County. High-income estates such as Kileleshwa, Runda, and Nyayo Estate have highly controlled plans with organized management structures that regulate any undertakings in such estates. This largely reduces unnecessary dumping of premature ELVs within high-income residential estates.

Results also show that education level is also linked to the level of awareness of premature ELVs. There is a positive correlation between the level of education and environmental awareness. Philippsen et al., in 2017 corroborated this finding where they established that individuals with good levels of education have

better understanding of environmental issues and therefore are more concerned about the quality of the environment and often practice environmentally responsible behaviour[25]. Further, a similar proposition was established by studies conducted in Columbia, Iran, and Malaysia on level of education and environmental awareness, which established that a higher level of education gives a greater impetus on environmental awareness[26;27]. Public participation is a major factor in the management of "ELVS as it ensures social awareness and social acceptance, and owners of ELVs should be encouraged to withdraw their end-of-life vehicles from the traffic[28]."

This conclusion from the detailed review conducted by Karagoz, et al., has corroborated the finding from this study that there is a need for public awareness on premature ELV management. The awareness of the public provides social acceptance that would support any government initiatives geared towards the effective management of premature ELVs. Another study conducted on the end-of-life passenger vehicles in China established that there is a need for heightened awareness for both policy-makers and vehicle manufacturers to generate more incentives to promote sustainable development pathways for the ELVs including resource recovery[29]. These

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[25] Juliana StriederPhilippsen. Fabio Angeoletto and Rosangela G. Santana., 'Education level and income are important for good environmental awareness: A case study from south Brazil,' (2017) 27(1) Ecol. Austral, <https://www.researchgate .net/publication/313820841> accessed 18 June 2021

[26] Hans-Erik Edsand and Tobias Broich, 'The Impact of Environmental Education on Environmental and Renewable Energy Technology Awareness : Empirical Evidence from Colombia' (2020) 18(4), <https://eric.ed.gov/?id=EJ1247246> accessed 7 October 2021

[27] Yi Du, Xiaoyan Wang, Daniele Brombai, Angela Moriggi, Andrew Sharpley and Shujiang Pang 'Changes in environmental awareness and its connection to local environmental management in water conservation zones: The case of Beijing, China' (2018) 10(6) Sustain. Switz., <https://www.mdpi.com/2071-1050/10/6/2087> accessed 7 October 2021

[28] Selman Karagoz, Nezir Aydin and Vladimir Simic, 'End - of - Life Vehicle Management : A Comprehensive Review' (2019) 22 J. Mater. Cycles Waste Manag. <https://link.springer.com/article/10.1007/s10163-019-00945-y> accessed 2 March 2021

[29] Yang Li, Kiyoshi Fujikawa, Junbo Wang, Xin Li, Yiyi Ju and Chenyi Chen 'Thepoten-tial and trend of end-of-life passenger vehicles recycling in China' (2020), 12 (4) Sustain. Switz., <https://www.mdpi.com/2071-1050/12/4/1455/pdf> accessed 7 October 2021

findings give a strong impetus to the Kenyan government to initiate awareness programs targeting relevant agencies and the players in the premature ELV cycle to ensure sustainable management of this category of ELVs. Awareness about certain environmental issues usually exacerbates pro-environmental attitudes and behaviors that may help in the establishment of appropriate environmental policies and laws as well as educational programs that promote good environmental management practices[30;31]. An author established that when the public is environmentally aware to a large extent, they tend to have higher requirements for environmental quality[32]. When people are more aware of the environmental issue in this case being poor management of premature ELVs, there is a strong consideration and push of appropriate policies and legal frameworks that can tackle the environmental problem. The appropriateness can be determined by some elements such as stringency (legally binding for all forms of violations along the ELV value chain), consistency (same principle to enforcement and must and be similar to all violators), relevance (fit-for-purpose) and compliance (clear mandate for regulator to enforce).

### 3.2 Awareness Level on Environmental and Social Impacts of Premature ELVs

The key informants interviewed had served in the various sectors or institutions for an average of 7.3 years, with insurance, regulation and enforcement, salvage, and garage sectors having the longest-serving informants; while household respondents had an average residence period of 8.3 years in the respective estates (Figure 7, Appendix). This indicated that the respondents and key informants had adequate experience in

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[30] Juliana StriederPhilippsen. Fabio Angeoletto and Rosangela G. Santana, 'Education level and income are important for good environmental awareness: A case study from south Brazil,' (2017) 27(1) Ecol. Austral, <https://www.researchgate.net /publication-/313820841> accessed 18 June 2021

[31] Z. Aminrad, S. Z. B. Sayed Zakariya, A. Samad Hadi, and Mahyar. Sakari, 'Relationship between awareness, knowledge and attitudes towards environmental education among secondary school students in Malaysia' (2013), 22(9) World Appl. Sci. J., <https://www.idosi.org/wasj/wasj22(9)13/15.pdf> accessed 12 May 2021

[32] Meng-Meng Geng and Ling-Yun He 'Environmental Regulation, Environmental Awareness andEnvironmental Governance Satisfaction' 2021, 13(5) Sustainability <https://www.mdpi.com/2071-1050/13/7/3960>accessed 3 March 2022

their field of expertise or area of residence with the capacity to provide reliable information on premature ELVs in Kenya.

**Table 1: ANOVA Results on the Environmental and Social Impacts of Premature ELVs**

| ANOVA | | | | | |
|---|---|---|---|---|---|
| Impacts Score | | | | | |
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 544.812 | 5 | 108.962 | 83.821 | .000 |
| Within Groups | 2004.508 | 1542 | 1.300 | | |
| Total | 2549.320 | 1547 | | | |

On a Likert scale of 1 to 5, with1 being totally not aware and 5 highly aware, the key informants and household respondents ranked six key environmental, public health, and social impacts of premature ELVs significantly different as found out in an analysis of variance (ANOVA) test (F=83.82, df 5, *P*<.000) as shown in Table 1.

The awareness level of respondents on the direct impacts associated with premature ELVs namely; public health risks, heavy metal pollution, soil and water pollution, aesthetic degradation, misuse of valuable spaces, and host for disease vectors received various responses. The average awareness for environmental and social impacts of premature ELVs was 3.87 (~4) meaning that there was general awareness on the impacts. However, there was low awareness of public health risks, water, and soil pollution as impacts of ELVs with an average ranking of not aware to neutral (2-3 rating). Heavy metal pollution as an impact of poorly managed premature ELVs was not well known. However, the key informants and household respondents were most aware of aesthetic degradation of police station yards, space misuse, and host for disease vectors and pests as the major impacts associated with poorly managed

premature ELVs (Figure 3). This indicates that most of the respondents including key informants were more aware of impacts associated with premature ELVs that can easily be visualized but had a low level of awareness of scientific impacts such as heavy metal and water pollution as well as harm to public health. The level of awareness is determined by activities such as awareness programs, management programs on premature ELVs as well policy and legal frameworks in place within a country to facilitate premature ELV management. In Kenya, these have not been undertaken to influence the awareness level of the people. This view is held by other studies conducted in other countries on public knowledge on ELV recovery and specific environmental issues. The studies established that the level of knowledge on specific environmental issues relating to ELV is low[33;34;35]. In addition, the level of knowledge is low in developing countries where there are few activities relating to a specific environmental issue unlike developed countries like the European Union, the United States of America, and Japan.

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[33] Selman Karagoz, Nezir Aydin and Vladimir Simic, 'End - of - Life Vehicle Management : A Comprehensive Review' (2019) 22 J. Mater. Cycles Waste Manag. <https://link.springer.com/article/10.1007/s10163-019-00945-y> accessed 2 March 2021

[34] Nur Aishah Nadzirah Ahmad Nawawi, Muhamad Asri Azizul and Syabillah Sulaiman, 'Study of End-Of Life Vehicle (ELV) Implementation in Malaysia' (2019) 1(1), J.Ind, Eng and Inno, <https://fazpublishing.com/jiei/ index.php/ jiei/article/view/44> accessed 7 October 2021

[35] D.A. Wahab and Z.F. Fadzil, 'Public Community Knowledge on Reuse of End-of-Life Vehicles: A Case Study in an Automotive Industrial City in Malaysia' (2014), 14(3), J. App. Sci.<https://scialert.net/fulltext/?doi=jas.2014.212.220> accessed 1 August 2021

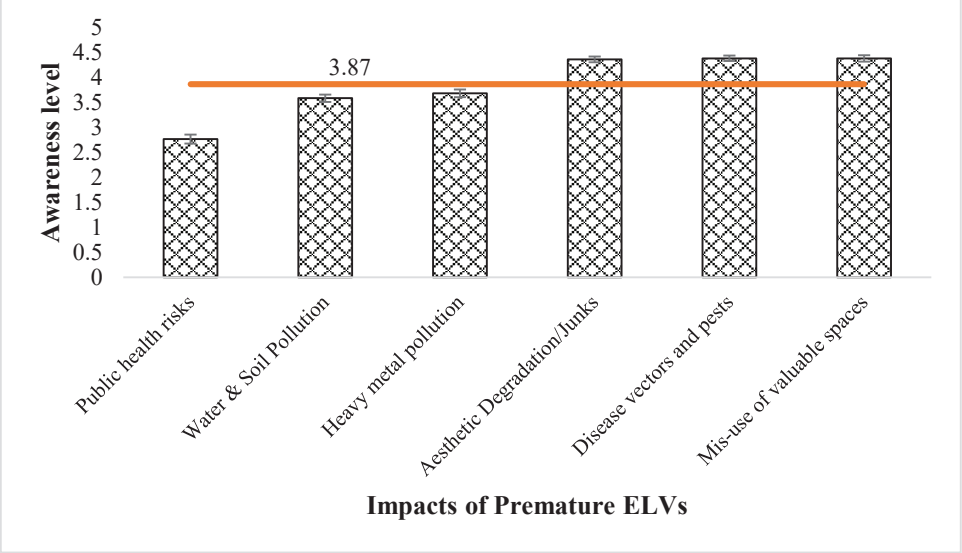


Figure 3: Awareness Level on Environmental and Social Impacts of Premature ELVs

These findings on awareness are supported by a study on unclaimed vehicles in police station yards where some respondents comprising *matatu* (a minibus or similar vehicle used as a public service vehicle in East Africa) industry, insurance companies, and policy- makers acknowledged that the unclaimed ELVs are an eyesore and are breeding grounds for pests and should be considered for proper disposal[36].

### 3.3 Awareness of Existing Management Mechanisms of Premature ELVs

The respondents' awareness level on existing ELV management mechanisms differed significantly across the respondents and gender. Close to 40% of the respondents indicated that premature ELVs in Kenya are mostly sold out to garages for spare parts sourcing, 19% sold out to

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[36] Joseph. K. Muiruri, 'The Magnitude of Unclaimed End of Life Vehicles and Environmental Implications in Police Stations' Yards: A Case Study of Nairobi, Kenya,' (2014) 3(2) Am. J. Environ. Prot.<https://www.researchgate.net/publication/261395912_The_magnitude_of_unclaimed_end_of> accessed 14 December 2020

scrap metal dealers, 14% left out in police yards indefinitely without proper disposal guidelines while 11% is salvaged by insurance companies and sold out. The majority are sold out to garages for spare parts sourcing (40%) as shown in Figure 4 below. Female respondents indicated that 3% of premature ELVs are sold out to vehicle recycling centers for dismantling, sorting, recovery, reuse, and recycling while 6% of the respondents were not aware or they did not know what happens to premature ELVs in Kenya (Figure 4).

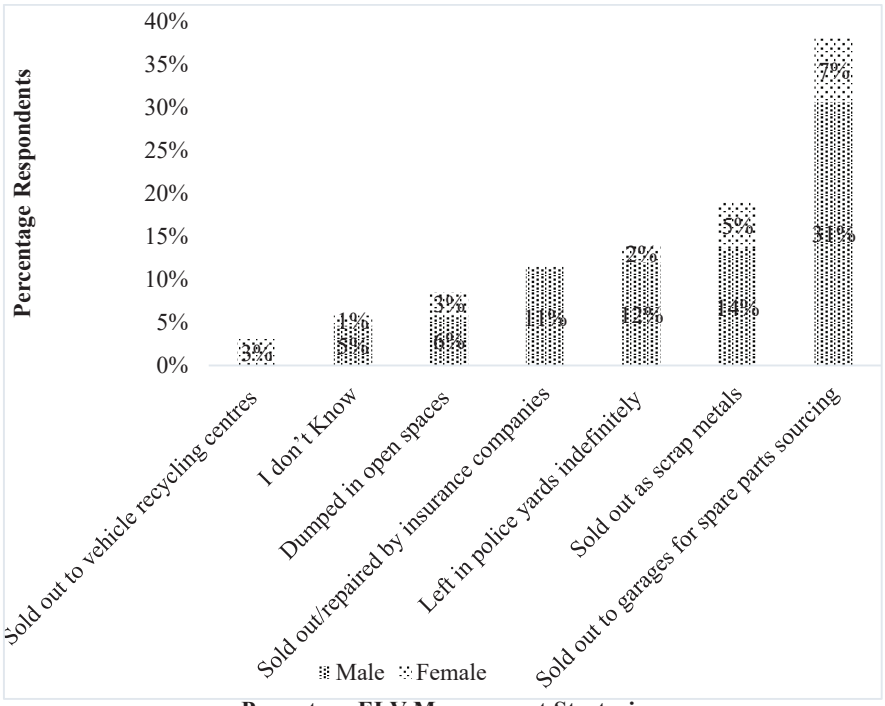


Figure 4: Awareness Level on Existing Management Mechanisms for Premature ELVs in Nairobi City County

While some of these respondents stated that premature ELVs are sold to recycling centers, Kenya has no registered recycling center; and where any recycling is done, it is at a small scale with rather crude operations by salvage companies, garages, and scrap metal dealers who haphazardly dismantle and recover the

reusable parts for resale. The other hazardous substances (engine oils, lubricants, ASR) are never disposed of in an environmentally sound manner, as there are no strong legislative and institutional frameworks focused on the management of this particular waste stream. This finding is substantiated from a study that concluded that management of ELVs in Kenya is not done in an environmentally sound manner and the government should only allow authorized treatment facilities for ELVs to undertake their management[37]. Most of such wastes from the premature ELVs are released into the environment (land and water) or end up being mixed with municipal wastes for disposal in dumpsites.

There was a general agreement among the respondents that these premature ELVs are sold out either to garages, scrap metal dealers among others, which brings their economic value into perspective. Currently, this has not been regulated yet it is the most prevalent. In other countries, governments have encouraged recycling of the ELVs to support the automotive industry[38;39;40;41;42;43;44]. Job opportunity is another economic

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[37] Joseph. K. Muiruri, 'The Magnitude of Unclaimed End of Life Vehicles and Environmental Implications in Police Stations' Yards: A Case Study of Nairobi, Kenya,' (2014) 3(2) Am. J. Environ. Prot.<https://www.researchgate.net/publication /261395912_The_magnitude_of_unclaimed_end_of> accessed 14 December 2020

[38] Yang Li, Kiyoshi Fujikawa, Junbo Wang, Xin Li, Yiyi Ju and Chenyi Chen,'The potential and trend of end-of-life passenger vehicles recycling in China' (2020), 12 (4) Sustain. Switz., <https://www.mdpi.com/2071-1050/12/4/1455/pdf> accessed 7 October 2021

[39] Michael Johnson and M. H. Wang, 'Evaluation policies and automotive recovery options according to the European Union Directive on end-of-life vehicles ( ELV )' (2002), 216(9) J. Automobile Eng., <https://journals.sagepub.com/doi/10.1243 /09544070260340826> accessed 8 October 2021

[40] Federica Cucchiella, Idiano D'Adamo, Paolo Rosa and Sergio Terzi 'Scrap automotive electronics : A mini- review of current management practices' (2016) 34(1) Waste Manag. Res. <https://pubmed.ncbi.nlm.nih.gov/26467318/> accessed 5 June 2021

[41] Zulhaidi MohdJawi, Mohd Hafzi Md Isa, Mohd Syazwan Solah, Aqbal Hafeez Ariffin, Akmalia Shabadin and MohdRasid Osman, 'The future of end-of-life vehicles ( elv ) in Malaysia – A feasibility study among car users in Klang valley' 2017, MATEC Web of Conferences 90<https://www.matec-conferences.org / articles/matecconf/abs /2017/04/matecconf_aigev2017_01038/matecconf_aigev2017_01038.html> accessed 11June 2021

[42] Hsin-Tien Lin, Kenichi Nakajima, EijiYamasue and Keiichi N. Ishihara 'Recycling of End-of-Life Vehicles in Small Islands : The Case of Kinmen, Taiwan' (2018), 10(12) Sus.<https://www.mdpi.com/2071-1050/10/12/4377> accessed 8 October 2021

gain if the government regulates premature ELV management and leapfrogs into the existing sustainable development principles including recovery and recycling of the premature ELVs. Incorporation of the appropriate management approaches of premature ELVs are more feasible with development of appropriate policies and laws for this industry. Such frameworks will incorporate all the necessary strategies including awareness programs, technical and technological needs as well as appropriate economic instruments to facilitate effective management of premature ELVs. Applicability of best practices such as recovery, reuse, recycling in management of premature ELVs support the achievements made so far towards sustainable development. In the United States of America (USA) for instance, the automotive recycling industry has employed over 140,000 people in different parts of the country[45]. The industry also generates $32 billion from sales within the USA and supplies approximately 37% of all ferrous metal to blast furnaces and smelters across the country[46]. A study on the economic and ecological benefits of ELVs established that the spare parts recovered and re-used from ELVs advance ecological and economic good with about 850,000 engines and 1 million transmissions being remanufactured and sold annually in addition to the employment of about 19,000 people[47].

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[43] Linfeng Yu, Ming Chen and Bin Yang, 'Recycling policy and statistical model of end-of-life vehicles in China' (2019) 37(4) Waste Manag. Res.,<https://journals.sagepub.com/doi/10.1177/0734242X19833150> accessed 8 October 2021

[44] Yisong Chen, Zhensen Ding, Jiahui Liu and Jinqiu Ma, 'Life cycle assessment of end-of-life vehicle recycling in China: a comparative study of environmental burden and benefit' (2019), 76(6) Int. J. Environ. Stud.,<https://www.tandfonline.com/doi/abs/10.1080/00207233.2019.1618670> accessed 8 October 2021

[45] Flavius Ioan Rovinaru, Mihiela Daciana Rovinaru and Adina Viorica Rus, 'The Economic and Ecological Impacts of Dismantling End-of-Life Vehicles in Romania,' (2019) 11(6446) *Sustainability* <https://www.mdpi.com/2071-1050/11/22/6446> accessed 19 April 2021

[46] Ibid

[47] Ibid

# 4. RECOMMENDATIONS

## 4.1 Awareness Programs on Premature ELVs

There is a definite need for targeted awareness programs for all players including the relevant government agencies and private sector including the insurance firms and *Matatu* Owners Association as well as the public. Environmental awareness to a certain degree exacerbates the need for better environmental quality. Increased level of awareness on premature ELVs and their social, economic and environmental impacts can trigger the need for policy, legal and institutional actions for effective management of premature ELVs.

## 4.2 Economic Potential of Premature ELVs

The economic value of premature ELVs needs to be appreciated, developed, and regulated to enhance the growth of the automotive industry. Using other countries as examples, such as Malaysia, Taiwan, China, Japan, and European Union among others, there is a need for effective management of premature ELVs for the economic gains associated with it. This can also be considered as an opportunity to leapfrog on policy and legal response for effective management of premature ELVs for environmental gains.

Recovery of reusable parts of premature ELVs exposes dismantlers to risks including heavy metal pollution and other hazardous substances. There is a need to encourage BATs to protect public health and reduce environmental pollution. Additionally, there is a necessity to consider the development of treatment facilities that meet the acceptable standards to undertake the management of premature ELVs in Kenya.

## 4.3 Formulation of Responsive Policy, Legal and Institutional Frameworks

There is an impending need to develop appropriate frameworks to facilitate effective management of premature ELVs. The ongoing recovery, reuse and recycling of premature ELVs' parts are informal and undertaken for economic gains at the cost of environment. Development and implementation of policy and legal frameworks will address the social, economic and environmental impacts of premature ELVs further strengthening efforts made so far in the sustainable development

agenda. Further, it would be noteworthy to identify factors that have undermined partnerships between private sector players and government on supporting initiatives towards management of premature ELVs with feasible options.

## 5. CONCLUSION

This study advances the debate on stakeholders' level of awareness on effective management of premature ELVs. It can be concluded from the study findings that level of awareness on an environmental issue is a key determinant to a response action geared towards addressing the problem. Low level of awareness has hindered appropriate policy, legal and institutional reforms that would otherwise facilitate effective management of premature ELVs. The current policy and legal frameworks have not addressed premature ELVs and their management.

Existing management strategies for premature ELVs are not environmentally sound nor safe for public health. While informally and out of self-innovation, there have been attempts to recover parts of premature ELVs for economic gains, there is no drive for environmental benefits. Furthermore, the existing recovery procedures employed by the players in this industry are not informed by the best acceptable technologies "BATs". The current management practices on premature ELVs have not progressed the efforts towards achievement of sustainable development.

# 6. APPENDIX: SOCIO-DEMOGRAPHICS

## a) Gender Analysis

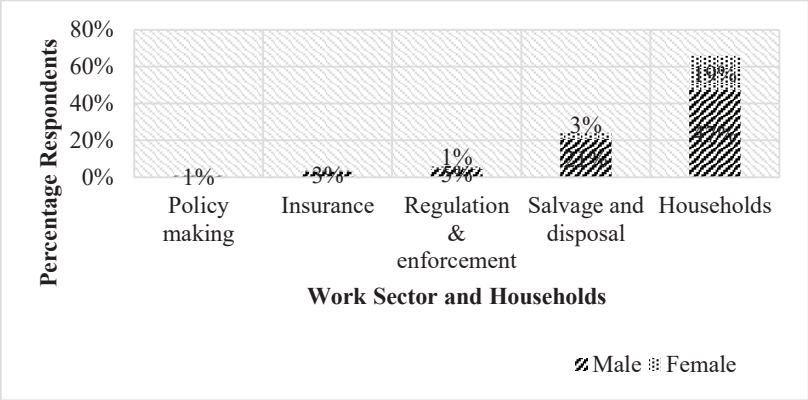


Figure 5: Gender of Respondents per category of the Respondents

## b) Households per Residential Estate in Nairobi

The 170 household respondents were from 15 estates within Nairobi City County. In each residential estate within the defined income strata (low, middle and high-income), 15 households were selected for the interview. The response rate was between 10 to 14 respondents per residential estate as indicated in Figure 6 below. The estates were as follows: High-income residential estates being Runda, Kileleshwa, Nyayo Embakasi, Ngong and South C; middle-income residential estates being Race Course, South B, Buruburu, Utawala, Fedha and Kariokor; and low-income residential estates being Kasarani, Umoja, Lucky Summer and Kariobangi.

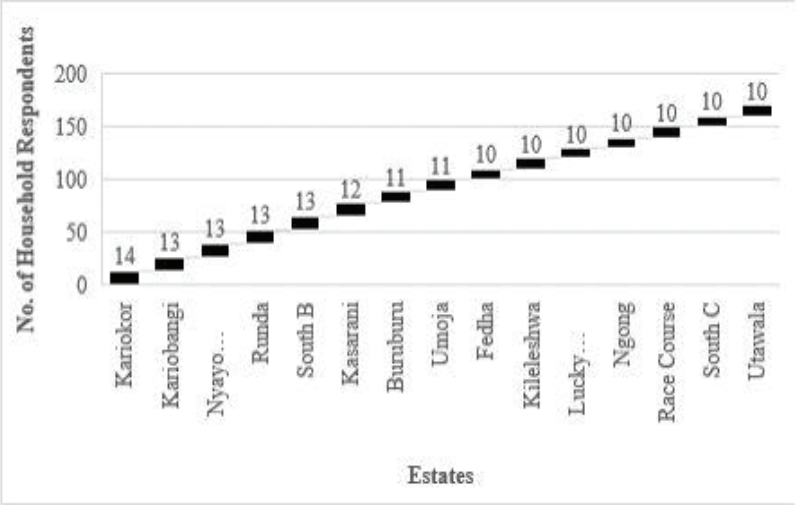


Figure 6: Household Respondents per estate in Nairobi City County

## c) Number of years of service in the sector

The key informants and respondents had resided or served in the various sectors for an average of 7.3 years with insurance, regulation and enforcement, salvage and garage sectors having the longest serving informants as indicated in Figure 7 below. The household respondents had an average residence period of 8.3 years in the respective estates. This indicated that the respondents and key informants had adequate experience in their field expertise or area of residence with capacity to provide reliable information on premature ELVs.

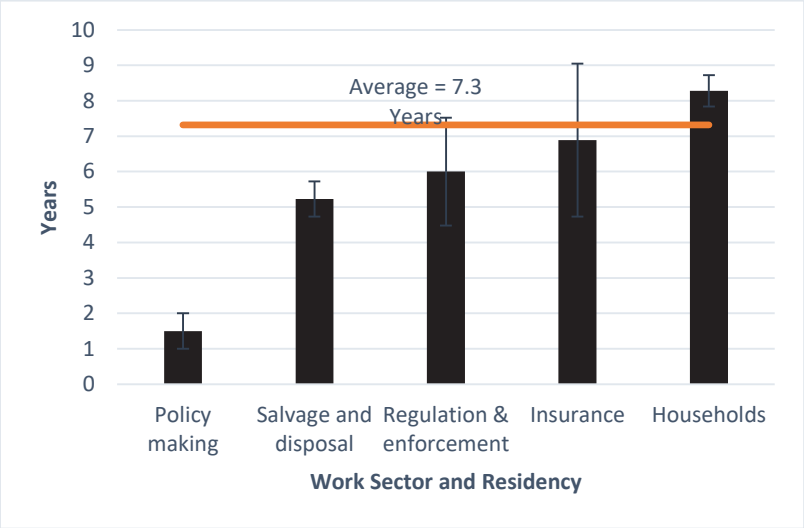


Figure 7: Average number of years in service/residence of the key informants and households in various sectors (Error bars; Std. Er