EFFECTIVENESS OF NEWLY INSTALLED WASTE COLLECTION BINS IN MANAGING SOLID WASTE IN MACHAKOS TOWN, KENYA

BY
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THIS DISSERTATION IS SUBMITTED TO THE FACULTY OF SOCIAL SCIENCE IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF A MASTER OF DEVELOPMENT STUDIES (MDS) FROM ST. PAUL'S UNIVERSITY

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DECLARATION

This Dissertation is a product of my own work and is not the result of anything done in collaboration. It has not been previously presented to any other institution. I agree that this dissertation may be available for reference and photocopying, at the discretion of the university

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RECOMMENDATION

This Dissertation has been submitted for examination with my/our approval as university supervisor(s) and I/we confirm that the work was carried out by the student under my/our supervision.

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DEDICATION

I dedicate this dissertation to my able supervisors, Dr. Daniel Muasya and Dr. Nason Vundi for their big hearts that accommodated me throughout the journey; to my family for their financial, moral support and encouragement during this period.

ABSTRACT

Rapid urbanization, population explosion besides economic growth leading to more consumption has resulted into increased generation of solid waste exceeding existing waste management infrastructure. As a result, a substantial percent of this waste is never collected, implying it is dumped openly and this has health and environmental ramifications especially in urban areas such as Machakos town constituency in Kenya. Proximity to Kenya's capital city (Nairobi) and located next to international road network, Machakos town constituency attracts many workers and business people as residents who contribute to massive waste generation exceeding available waste arrangements. Consequently, waste is dumped all over despite newly installed collection bins. To that end, this study sought to evaluate the effectiveness of newly installed waste collections bins in managing solid waste in Machakos town constituency. To achieve this, the present study set out to determine household perception on usage of bins, the extent to which the residents use the newly installed bins, to determine influence of proximity and placement of bins on residential use and to analyze residents' satisfaction with frequency of town pick-ups of bins for waste disposal. The research was anchored on systems, planned behavior, waste management and institutional theories. Descriptive research design that incorporates a quantitative approach was adopted to collect and analyze data. Targeted population included households, SWM staff, county's executive members, civil organizations, sub-county administrators, MCA and local leaders. Closed ended questionnaires were administered to 214 participants who had been sampled through Krejcie and Morgan (1970) table for determining sample size, purposive sampling and census technique. Descriptive and inferential statistics were used to analyze data. Findings were expressed in frequencies, percentages, standard deviation and means and presented in tables and figures. Findings reported low awareness and knowledge, risk of waste, uncollected waste, charged fee influenced perception of bins. Also, households took garbage to bins once a week. Bins were also not positioned in the shortest distance and only stationary bins were installed, bins were too fewer although bins were placed along roads. Additionally, bins were poorly designed with no covers and not fragmented, were unguarded, misused and vandalized. Besides, waste was collected once a week, and occasionally, no emergency pick-up. Overall, a positive and significant correlation between effectiveness of newly installed bins and SWM existed. This study recommends public sensitization campaigns on importance of save waste collection and better waste management to influence positive perception of use of bins. There is need to institute a specific waste collection time based on waste generated. The study recommended that more bins proportionate to waste generated be procured and be evenly distributed. Further, bins be positioned close to households and be placed in sloping gradient towards collection points for convenient dropping of waste. Besides, haul type of bin be introduced in addition to stationary type of bins which should be installed along roads accessible by pick-up trucks. Better designed bins with covers and fragmentation to allow waste separation as well as instituting guarding of bins, are recommended. Finally, frequency of pick-ups of waste should be increased.

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ABBREVIATION AND ACRONYMS

CV:	Contingent Valuation
CBOs:	Community Based Organizations
EPPM:	Extended Parallel Process Model
EU:	European Union
ISWM:	Integrated Solid Waste Management
KAP:	Knowledge Attitude Practice
KNBS:	Kenya National Bureau of Statistics
KUSP:	Kenya Urban Support Programs
LSC	Location Set Recovering
MCL:	Maximum Covering Location
MSW:	Municipal Solid Waste
MSWMS:	Municipal Solid Waste Management Services
MSWR:	Municipal Solid Waste Rules, 2000
NACOSTI:	National Commission for Science, Technology and Innovation
NEMA:	National Environment Management Authority
NGOS:	Non-Governmental Organizations
NMT:	Non-Motorized Transport
SD:	Standard Deviation
SPSS	Statistical Package for Social Sciences
SWM:	Solid Waste Management
SWOT	Strengths, Weaknesses, Opportunities and Threats
TPB:	Theory of Planned Behaviour
UNDP:	United Nations Development Program
UNEP:	United Nations Environmental Programs

DEFINITION OF OPERATIONAL TERMS

Circular Economy: Is regeneration system in which the inputs and outputs of the system (resources and waste, emissions and energy) may be reduced through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling.

Incineration: Waste disposed of via controlled combustion.

Integrated Solid Waste Management Approach: Is the strategic approach to sustainable management of solid wastes covering all sources and all aspects, covering generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency,

Landfill: Waste disposed of via burial at unspecified, sanitary, controlled sites.

Open Dump: Refers to the solid waste disposed of illegally and unplanned without the involvement of environmental protection mechanisms.

Recycled: Waste converted into new materials.

Solid Waste generation: Is defined as waste produced by human beings, animals, and industries and mainly categorized as useless.

Solid waste management: These are those activities or actions required to manage waste from its inception to its final disposal.

Sustainable development: It is the development that meets the needs of the present without compromising the ability to meet their own needs.

Unaccounted: Untraceable waste.

Municipal Solid Waste: This is waste generated by households, and waste of a similar nature generated by commercial and business establishments, industrial and agricultural premises, institutions such as schools and hospitals, public spaces such as parks and streets and construction sites.

Waste characterization: Is the process whereby composition of different solid waste is grouped and analyzed.

Waste Generated Per Capita: The kilograms of waste produced per person.

Waste: These are products that have no further use or value to the person or organization that utilizes or owns it and that it is eventually discarded.

CHAPTER ONE
INTRODUCTION

1.1 Introduction

In a nutshell, chapter one delineates background information, statement of the problem and objectives of the study. As well, research questions, scope of this study and justification of the study. Additionally, the significance and justification of the study are given attention in this initial section of the study. Further, this first part of the current research focuses on the limitations and delimitations of the study before putting emphasis on the operational definitions of terms and chapter summary.

1.2 Background of the Study

Globally, industrialization, urbanization and population explosion continue to contribute to the proliferation of solid waste production with severe socio-economic and environmental effects (Lagerkvist & Dahlén, 2019). Presently, over 11.2 billion tons of global waste with 1.3 kg per capita is generated annually and projected to 3.40 billion tonnes in 2050 and rise by 70 per cent by 2050 (World Health Organization, 2020) (Kumar, Samadder, Kumar & Singh, 2018). Unfortunately, such massive solid waste is not properly disposed with at least 33% mismanaged globally today through open dumping, burning or not being accounted for (Ali, 2017).

Global Waste Management Outlook estimated that at least 2 billion people do not have access to regular waste collection (Modak, Wilson & Velis, 2018). This contravenes Sustainable Development Goal 11, aimed at achieving sustainable cities and communities by 2030 by reducing the per capita environmental impact of cities, in part, through effective waste management (UN, 2019). Significant decreases in waste production through prevention, reduction, recycling and reuse, as well as safe final disposal, will be necessary to achieve this target (Gillespie, 2017).

However, waste management set-up suffers negative economic legislatives, political, technical and operational limitations. Adding pain to injury, the prevailing coronavirus disease 2019 (COVID-19) pandemic has worsened waste management through disruption and abrupt collapse of waste management chains (World Health Organization, 2020). For instance, more effective and sustainable practices such as recycling have been replaced by less effective and environmentally unfriendly like landfills and incineration (United Nations, 2020). As a result, the

quality and efficient institutional as well as organizational structures for solid waste management have been compromised, overwhelmed and constrained. Implicitly, waste mismanagement has increased to unprecedented levels and proportions.

Poor solid waste management is linked to a wide range of medium- and long-term risks including slowing down of economic growth, higher incidence of diseases, environmental degradation and deterioration in quality of life (Ali, 2017). Particularly, release of SW especially serious heavy metals pollution into soil, plants and water bodies compromises economic activities (Lloyd, 2019). Health impacts from improper waste management include infection transmission from bacterial, viral or other disease-causing organisms, physical bodily injury such as cuts, blunt trauma, chemical injury or burns (WHO, 2020).

Non-communicable diseases resulting from long-term exposure to toxic wastes may lead to development of cancers and other permanent, irreversible damage as well as emotional and psychological effects from living in close proximity to an environmentally degraded site (Yusuf & Inambao, 2019). In addition to the negative effects on human health, the release of emissions from decomposition and burning of solid waste also contributes to accumulation of atmospheric greenhouse gases and exacerbation of climate change (Kolekara *et al.*, 2016).

Solid waste is described as any discarded materials that arise from human activities and are not free-flowing including bottles, metals and plastic scrapers, garbage, papers, glasses, and food/animal product, disposable carrying bags, woods, concrete, gravel, oil, rubber, sludge, textiles and or malfunctioned electronic devices (OECD, 2017). They can be classified as domestic, commercial/market, industrial, hospital, or street sweepings.

Furthermore, solid waste management is the process of controlling the production, storage, collection, transportation, processing, and disposal as well as monitoring and regulation of the process of solid wastes (Bezama & Agamuthu, 2019). In many cases, the waste is disposed of at the designated dumpsites, in open spaces, uncompleted buildings, and so on through means such as anaerobic, digestion, landfill (unspecified, sanitary landfill or controlled landfill), open dump, recycling composting and incineration (Letcher & Vallero, 2019).

Although waste production and management vary from country to another, developed and specifically wealthier states tend to produce more waste with mixed management fortunes. For

instance, the United States, with a total population of 321 million, generates 258 million tons per year and per capita of 4.46 kilograms per day, is ranked the biggest generator of waste worldwide. About half of the waste is food and green waste. Waste collection which involves the private sector stands at the rate of 85% with urban areas leading while rural trail at 30% collection (Barabad, *et al.*, 2018).

The main transportation mode for waste is use of trucks which move it to holding center before being taken to final treatment centers. More than half of waste (two-thirds) is disposed of in sanitary landfills of waste is disposed of in landfill with 52.6 million tons disposed through unspecified landfill. Additionally, 27% goes to open dumping while the rest is disposed of through recycling and composting among others. Landfills in the United States are regulated by each state's environmental agency, which in turn, follows the guidelines set by the United States Environmental Protection Agency (EPA) (Kaza *et al.*, 2018).

The UK generated 221.0 million tons of total waste in 2016, with England responsible for 85% of the UK total. These include increased recycling, composting, anaerobic digestion and the use of thermal treatment facilities to recover energy from waste (Eurostat, 2017). In terms of treatment, a total of 214.3 million tons was processed through various means. Notably, recycling and other recovery emerged the most common final waste treatment type in the UK processing 104.04 million tons represented by 48.5% with 2017 statistics reporting 70.0% of UK packaging waste was either recycled or recovered (United Nations Economic Commission for Europe, 2017).

In addition, 7.5 million tons was processed through incineration with energy recovery, incineration alone accounted for 5.7 million tons and backfilling handled 16.8 million tons. Further, landfill treated 52.3 million tons, 28.2 million tons went through land treatment and release into water bodies (Reike, Vermeulen & Witjes, 2018). Still, UK disposed of some waste through exportation in excess of 611,000 million packaging plastics to other countries with China receiving the bulk (Fiksel & Lal, 2018**)**.

Germany is the third largest producer of waste in the EU, generating 51,046,000 million for 618 kg per person (Steuer, Ramusch & Salhofer, 2018). On collection, materials are separately deposited into differently coloured bins and sorted using infrared detector before is recycled by

producers, private, or public sector agencies. With the best recycling rate (56.1%) in the world, Germany no longer deposits untreated waste at the banned landfill sites as almost half (47%) is recycled, 17% subjected to composting and 35% to incineration while 1.86 million is unaccounted for. However, high recycling rate creates waste shortage compelling waste importation from England, Ireland, Italy, and Switzerland which residents disapprove as moral betrayal of their long-cherished recycling culture besides stinking imported waste. Also, waste is sometimes piled up in one spot for weeks before being moved (Kumar, Holuszko & Espinosa, 2017).

As one of the leading producers of solid waste not only in Latin America but in the world, Mexico generates 1.16kg per capita daily. At 85%, waste collection coverage is quite high compared with global trends and most waste collection systems are on a door-to-door basis. The country composts more than 10 percent of the waste, recycles about 4.5 percent of the waste and 21 million tons accounting for 27% is diverted to open dumping (Ikhlayel, 2018).

Landfill gas collection has emerged as the main mechanism of recovering energy from waste in this country. The main transportation mode for waste is trucks which take the waste to a transfer station or other site before final disposal. The stations may be intended either to transfer waste to larger trucks or to increase efficiency of materials recovery. These stations may be formal or informal recycling centers where waste pickers sort materials for recycling (Reyna-Bensusan, Wilson & Smith, 2018).

In 2016, 79,889,010 tons of solid waste was generated with an average of 161,400 tons waste in Brazil per day (Carvalho, Tavares & Lins, 2018). Like Mexico and USA, solid waste collection rate is high at 80% which is transported via trucks to various treatment centers. In relation to treatment, 59% is disposed in landfills, 19.9% dumped in soil without any treatment, 3.4% was treated and recovered in sorting, composting and recycling units and 17.7% is not accounted for (Silva *et al.,* 2019).

Famed as the highly industrious and most populous nation globally with 18.75 percent of global population, China is the second-largest producer of waste amounting to 228.02M tons with 2.14 kg per capita daily accounting for over 15 percent of the global solid waste volume. By the end of 2019, 200 large and medium-sized cities in China produced 1.55 billion tons of general

industrial solid waste and 46.403 million tons of industrial hazardous waste (Wang, Dong & Yin, 2018).

Until January 2018 when the ban the import of 24 grades of solid waste including mixed paper and plastics was instituted, it was the leading importer of over one million tons waste. To address increased waste, a "zero waste city" which includes 100% recycling of municipal solid waste and 100% recovery of all resources from waste materials. Under this program around 90% of the waste is collected on a door-to-door basis. The informal sector is active in collection with up to an estimated 200,000 active waste pickers in Beijing (Chen, 2018).

In relation to treatment, over 64% in sanitary landfills besides recycling, controlled landfill and composting as well as import restrictions. Unfortunately, much of the country's waste still ends up in landfills, and some of it flows down rivers into the ocean (UN, 2018). Landfills contribute the most to the impact potentials mainly due to methane emissions. However, China's recent ban on recyclable waste could impact countries that have not established their own processing facilities and have not established their own local end use markets.

In India, the volume of waste is projected to increase from 64-72 million tonnes at present to 125 million tonnes by 2031. Waste management rules in India are based on the principles of sustainable development, precaution and polluter pays. Of the solid waste produced only 43 million tons (MT) of the waste is collected through public and private entities. Only 45% is actually treated with than 50% remains untreated thrown on the designated landfills, sewage and water bodies due to the lack of efficient waste management system (Singh, Thind & John, 2018). Consequently, the leaching of heavy metals in the water imposes serious health risks to humans. Heavy metal concentration of the soil samples at various depths ranges from 3.78 mg kg^{-1} to 0.59 mg kg^{-1} at a depth of 2.5 to 5.5 m, with concentration higher in the top soil up to a depth of 5.5 m (sandy clay layer) (Yang, Xia, Thompson, Flower, 2017).

Waste management services and infrastructure are unable to keep pace with the over 95 million inhabitants in Egypt. Egypt produces 50k-60k tonnes of solid waste per day, totaling 22 million tonnes annually (Vaccari, Vinti &Tudor, 2018). Only around 60 per cent of the waste produced is actually collected at the moment implying about 40% is unaccounted for. Of the 60% collected, a mere 5% is properly disposed of and 2.5% is recycled while over 60% (84 million

tons) waste is disposed of through open dumping in canals, rivers, streets or open areas without any preventive measures to reduce the impact on the environment (Fahim, El-Gazzer & Elgohary, 2017).

A small portion of organic waste is fed to animals. Waste management is exclusively run by the private sector. However, the private sector has failed in waste management with as many as 15 companies closing down since 2013. The private sector could not find a way around structural problems in the industry, including the lack of a nationwide collection infrastructure and a market that is no longer conducive to the byproducts of recycling (El-Salam & Abu-Zuid, 2015).

In Nigeria, 30,614,830 is generated annually with over 40% disposed through open dumping and 20% is never accounted for (Aderoju, Dias & Gonçalves, 2018). Waste collection systems such as communal container (bin) collection with bins being few, vandalized and dilapidated and emptying is never done for weeks. While no official data available, it is clear that uncontrolled dumping is a common mechanism to get rid of waste.

In Lagos there are about 5000 illegal dump sites (Sesan, 2018). Increased waste production due to over population and rapid urbanization have overwhelm urban facilities with slums characterized with insufficient and lacked major services are most affected. Apparently, slum areas have informal waste management arrangement while middle- and upper-class areas have formal waste management system. The state and local government agencies tasked with responsibility for delivering waste management services receive little financing from the state or local government budgets (Ihedioha, Ukoha & Ekere, 2017).

In DRC Congo, there is very limited data on waste management. Largely, there is a breakdown of government services because of war or economic crisis, waste management services are often the first to suffer. Informal waste collection happens in all cities to a greater or lesser extent. Almost all (98%) waste collection services are provided by the informal workers. City authorities are unable to continue with UN's installed waste collection bins. Open burning is frequently used as a way of dealing with undisposed waste, especially in areas where waste collection is non-existent (Awuah, 2018).

South Africans generate roughly 56.5 million tons of solid waste per year. Of this 56.6 million of tons of waste, a maximum of 38.6% is recycled or recovered for other uses, whilst at least 90% is landfilled or dumped. Every single person of our total population of 57 million generates up to 2,5 kilograms of waste per day, on average (Oelofse, Nahman & Godfrey, 2018). There is inequality in the waste management services that are delivered in different areas. The middle-class areas generally have a formal system of collection with trucks, while many of the poorer areas have a more informal service, or a service that has been contracted out, or a very erratic and inadequate service from the municipality.

The legacy of apartheid has resulted in an inequitable service which municipalities have not managed to overcome; increasing numbers of people coming to the cities and living in informal housing; lack of prioritisation of waste delivery services by municipalities; and a general lack of institutional capacity by municipalities to deal with waste services. Out of 1 203 general waste landfills sites, only 524 are actually registered. Even those that are properly registered are generally not properly managed according to the required regulatory standard (Hettiarachchi, Meegoda & Ryu, 2018).

In Ethiopia, 1,830,848 metric tons were generated in 2019 with 3,503,253 projected for 2020. Addis Ababa Solid Waste Management Agency manages waste collection in the capital city. The collection rate is as low as 25% (Abebe, 2018). However, over one million tons is dumped in open and unaccounted for due to low capacity attributed to low funding among other factors. As a result of the low financial capacity and communal garbage storage situated far from the residences caused low service coverage that compelled the residences to dump their garbage illegal is the cause for environmental impact disease in the city remains higher.

The fees received from households and commercial enterprises for waste management services covered about half the costs of actually delivering the service. Today most of the city environment impact diseases comprising more than 70% are caused by environmental problems of water, air, and land pollution (Mohammed & Elias, 2017). In March 2017 part of the landfill at Repi collapsed, killing 113 of the informal waste workers 500 working at the landfill in addition to exposing communities around the landfill to great health risks of contaminates water.

With a population of 2,132,686 people, Rwanda, the cleanest cities in Africa, is leading in East Africa community in solid waste management and had been used as a bench-mark point in performance of solid waste (Ferronato et al., 2019). About 4,384,969 million tons of waste is produced yearly and 638 tons per day which translated to per capita generation of 0.57kg/day, or 205kg/year. Bins strategically stationed are used to collect waste which is treated through landfill, recycling and composting. There is only one disposal site run by the city of Kigali which also controls treatment, a modern sanitary landfill, a recycling centre and two small private compost facilities. Currently, waste is managed by the Ministry of Local Government, with the participation of private companies which are only in charge of waste collection.

In Tanzania 20, 276,995 million tons of waste is generated annually with 80 to 90% of this not collected (Nyampundu, Mwegoha & Millanzi, 2020). To collect waste, common containers (waste bins) are provided at dedicated points within neighborhoods for households to drop-off their solid waste. Trash collection vehicles then pick up these containers and empty off the trash at designated disposal spots and return the containers to their original locations. However, this trash collection method is fronted with several difficulties most of the time leading to uncollected.

Thus, there is overflow of waste, ground dumping at collection sites, and at unauthorized spaces. Dar es Salaam is an example of a city where the privatization of waste services has led to good coverage in the city area, while poorer neighbourhoods are left out as private providers. Although famed as a model in controlled landfill, only 27% of the mere 10% – 20% collected waste is treated through landfill mainly with little recycling and rest relegated to open dumping (OECD, 2017).

Like most countries in Africa, Kenya lacks proper waste collection, transportation and disposal systems with less than 50% of the population has collection service (NEMA, 2015). The amount of solid waste generated per year and day in Kenya is currently 8 million tonnes and 22,000 tons respectively with 0.5 kg per capital and is predicted to double by 2030 (World Bank, 2019). Of the 22,000 generated daily, 45 per cent of waste goes uncollected. In the informal settlements, the situation is compounded by lack of ownership of the garbage and lack of collection points and many inhabitants of such areas opt to through their garbage to nearby rivers, drainages, roadsides or undesignated areas.

Statistical data from National Environment Management Authority (NEMA) in the National Waste Management Strategy indicates that 37 percent of waste generated is not collected in Nakuru, 35 per cent in Mombasa and 45 per cent in Eldoret with Kisumu being unknown. The same report cites a study done in Nairobi that shows that 30-40 per cent of the waste produced is not collected. Poor solid waste management (SWM) has negative health impacts, including the proliferation of infectious and non-communicable diseases. It also contributes to environmental degradation and greenhouse gas emissions.

Finally, to the local context of the current, Machakos town constituency is one of the 8 constituencies namely Masinga, Yatta, Kangundo, Matungulu, Kathiani, Mavoko and Mwala which form Machakos county. The sub-county has a population of 168,255 people with 340 households (KNBS, 2019). Machakos town constituency which hosts the capital centre of Machakos County, is cosmopolitan and is located 63 kilometers southeast of Nairobi. Due to its proximity to Nairobi City and being served by two major highways (Mombasa Road and Namanga Road), Machakos town constituency acts as a dormitory for the daily commuters working in Nairobi, Kajiado and Kiambu counties. Such rapid population in addition to industrialization, urbanization and economic growth, have contributed to increased industrial, commercial, clinical/medical and domestic waste generation at 204 tons daily sub-passing the sub-county ecological footprint (KNBS, 2019).

Commercial sector generates the highest quantities at 56.83 percent of total solid waste with residential sector generating the least, 7.62 percent, the per capita solid waste being 1.265kgs higher than the average 1.203kgs found in other counties (KNBS, 2019). Unfortunately, insufficient budget allocation, unqualified personnel and inadequate policy frameworks setbacks saw 32% of the waste find its way to open dumping and 14% is not accounted for. Despite having designated bins for dumping or designated dumpsite at Mitheu, many residents dump their waste by the road sides, uncompleted buildings or anywhere. This has resulted into adverse environmental, public health and economic repercussions.

Other than being managed to be environmentally friendly, solid waste could be economically viable especially in job creation and wealth creation activities such as being converted into reusable products and energy production (Prieto-Sandoval, Jaca & Ormazabal, 2018). These

could impact the health and environment positively hence a milestone to sustainable development. To that end, new approaches with well-tailored programs such as the Integrated Solid Waste Management Approach (ISWMA) which embraced energy generation were designed. This included incorporation of Community Based Organizations (CBOs) and private companies in the solid waste activities.

The most notable waste management strategy is the Kenya Urban Support Program (KUSP) supported by the World Bank (2018). Under this program, waste management policy framework was designed culminating into the procurement and installation of 400 large waste bins, 6 skip loaders and 2 compacting trucks in three municipalities of Machakos, Mavoko and Tala/Kangundo. Also, drainage facilities in the 3 municipalities were constructed. Likewise, Integrated Solar Street lighting System was installed besides building Non-Motorized Transport system (NMT), walkways, parking bays and connecting roads in the 3 municipalities to enhance waste management (Ministry of Environment and Natural Resources and UNDP, 2018). However, effectiveness of this new waste management program is already experiencing teething issues such as uncollected garbage, rampant dumping among others and so on. This is what motivated the current study to evaluate the implementation of the waste bin collection program.

1.3 Statement of the Problem

Despite the recently installed 400 waste collection bins by World Bank's sponsored Kenya Urban Support Program (KUSP), only 30% of solid waste generated daily is taken to bins and only 10% of the collected is picked up for disposal (UNDP, 2018). The Star Newspaper of September 29, 2019, the Environment Executive during a public clean-up exercise of dumped solid waste in Machakos town, complained of continued waste open dumbing, the bus park, markets, streets, estates and walk path and uncollected waste bins overflowing and stinking. Separately, residents' protests in Nguluni in Matungulu, Tala, and Mavoko over the same are evident (Ndonye, 2018).

In its annual report, where it rated Machakos town environmental safety requirements compliance level at 60%, NEMA (2018) citing several complaints received, warned the county over increased pollution. This was validated by Ministry of Environment in collaboration with ministry of health (2018) linked eruption of communicable diseases such as malaria, cholera, typhoid/paratyphoid, pneumonia with risk polluted environmental (Leeabai *et al.*, 2019).

In spite of these issues, there is no scholarly evidence on the success level of the newly installed bins in Machakos town. (Mutua 2017; Eboso, 2016; Ndonye, 2018 and Kiio & Nyang'au, 2019); examined the effectiveness sanitation policy, solid waste recycling and stakeholders' role in solid waste management and asbestos waste disposal respectively. It is these conceptual and contextual gaps the current study attempted to address by investigating the effectiveness of the newly installed waste collection bins in solid waste management in Machakos town.

1.4 General Objective

The general objective of this study was to determine the effectiveness of the newly installed solid waste collection bins within Machakos town.

1.5 Specific objectives of the study:

i) To determine households' perceptions on use of bins as a strategy for residential solid waste management.

ii) To find out extent to which the residents use the new installed bins

iii) To determine influence of proximity and placement of bins on residential use.

iv) To analyze resident's satisfaction with the frequency of town pick-ups of the bins for waste disposal.

1.6 Research Questions

i) What were households' perceptions on use of bins as a strategy for residential solid waste management?

ii) To what extend were residents using the newly installed bins?

iii) What was the influence of proximity and placement of bins on residential use?

iv) What were the residents' satisfaction ratings with the frequency of town pick-ups of the filled bins for waste disposal?

1.7 Justification of the Study

Based on the current study, the national and county government should identify gaps as well as impediments to waste management implementation and engage better solid waste management generation reduction, collection and treatment strategies. Likewise, policy makers could maximize the findings as important data for evidence-based interventions on solid waste management. Similarly, civil society organizations involved in solid waste management should utilize the findings to deepen their understanding of challenges facing solid waste management to enable the advocate for better policies, procedures and practices among the communities and providers of solid waste services. Equally, the findings should give health professionals and environmental advocates in-depth understanding of solid waste management to establish guidelines that would help in reducing solid waste generation. To scholars and academicians, the study should expand the existing strands of literature in this area and as a point of reference or reference for further research.

1.8 Scope of the Study

The study was confined in Mjini, Kariobangi, Eastleigh as well as Muthini. These estates are located in Machakos Central and Muvuti/Kiima Kimwe which form Machakos town. The four estates were targeted because they had newly installed waste collection bins, had reported cases of uncollected waste and representative of slums, lower and middle-income households and produced highest amount of solid waste daily or annually. The choice of the study area was due to the fact that very little study in this area had been done in this region. As well, this area was suitable to generate required data due to its location in the highly urbanized part of the county associated with high solid waste production and management issues.

For anyone to qualify participating, he or she must have been staying in the three estates for not less than five years and a beneficiary of the collection bins. Descriptive research design was adopted because it enabled reporting of the situation as found on the ground without interfering or manipulating. Overall, the research design brought out the correlation between the dependent and independent variables. Further, the results were generalized to the other parts of the county that shared similar features and dynamics.

1.9 Assumptions of the Study

This study was based on assumptions that the increase in population in Machakos town had automatically translated to more consumption under the prevailing market conditions. Also, it is

assumed respondents provided required information willingly and truthfully. Too, the study assumes that urban areas in the two wards had waste collection bins installed. Further, the study assumes that waste collection bins were effective in solid management in the two wards. Another assumption was that the results gathered from the respondents were genuine and that they would guide the county government to improve waste management.

1.10 Limitations of the Study

First and foremost, limiting the study to the middle management, supervisory staff and support staff while ignoring top management, might have denied the study of crucial strategic and policy issues exclusively under the domain of senior executive. In the same vein, excluding ordinary community civilians who are direct beneficiaries of waste management, might have denied the study real time information on the effectiveness of the waste collection bins. The study was purely on social behavior and characteristics of people hence respondents might have filled questionnaire for the sake of it besides failure to return questionnaires.

Besides, 181 was a very sample to have been a true representation of the targeted population. By focusing on solid waste management in Machakos town having unique dynamics and features, findings might not be generalized to other urban areas and rural areas with unique characteristics. Also, a lot of bureaucracy slowed down obtaining of secondary data hence it was time consuming. Focusing on waste collection bins was so narrow and one aspect that may have ignored other critical factors that may have affected solid waste management.

1.11 Chapter Summary

This chapter discussed the background information on solid waste management using funnel approach that include global perspective, regional context, national outlook and local context where the current study was based. Additionally, statement problem motivating and warranting the study as well as research objectives. Further, research questions, scope of the study and significance of the study were delineated. The chapter concluded with emphasis on limitations and delimitations study before finalizing with assumptions of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section of the study covers the theoretical or hypothetical and observational point of view of the relationship between effectiveness of collection bins and solid waste management. Equally, empirical audits on the relationship effectiveness of collection bins and solid waste management through logical structure and outline of writing that helped in shaping the thesis is accentuated. Also given attention is the conceptualization of study concepts or constructs through a pictorial model explaining relationships between variables. Further, summary of the studies reviewed is underscored as well as distinguishing the conceptual, contextual and methodological research gaps.

2.2 Theoretical Literature Review

This area contains the different theoretical or hypothetical establishments for this survey. The present thesis planned to receive a wide scope of theory viewpoints. To this end, the survey mulled over systems theory, theory of planned behaviour, waste management and institutional theories. These theoretical establishments were considered the most suitable in developing study variables.

2.2.1. Systems Theory

This theory analysed interrelationship between parts in order to understand the outcome. The theory was founded by Ludwig Von Bertalanffy (1968) and later developed by Ross Ashby (1964). It was based on key assumptions such as observation, determination and inter-dependence. The main purpose of the theory was to emphasis power of the observer in relation to the systems that he/she interacted with. It was also geared towards creating unifying principle through integration of science, nature and social systems.

Von (1968) stated that a system is a complicated interrelated entity that interacted with its environment and that it kept evolving depending on the prevailing conditions and this connectivity between the entities make a complete component. In the field of social sciences, it is articulated by Forder in 1976 as it is meant to inter link behavior aspects, self-determination and free interactions in human beings during their social interactions. The theory could investigate

any group of elements that worked together for a common purpose. Characterized by human behavioral traits as in most cases human beings thought and acted as a group. This meant that they could react positively or negatively depending on the issues at hand.

More researchers and theorists applied the concept of Systems Theory in their work. Klang *et al.*, (2011) stated that many organizations were unable to retain employees because they failed to identify the factors that contributed to their satisfaction. The study insisted that a variety of features such as working conditions for employees, good policies, economic and environmental factors are key in any waste management system analysis. Poor implementation of policies on solid waste and poor financing adversely affected people's attitude towards solid waste and this led to heaps of waste emanating from the societies (Anwar *et al.,* 2014; Orhorhoro *et al.,* 2017a).

Development of a holistic environment, social interaction, good structures and policies interlinked all the stakeholders in the solid waste management. The theory emphasizes the need to observe and analyse all the aspects that contributed to an individual's behavior as it was influence by a variety of factors that work together as a system. It is also applicable where contextual understanding of behavior leads to the most appropriate practice interventions.

The relevance of this theory to the current study is evident and significant particularly in as it explains the prevailing households' perceptions on use of bins. First, households start using the bins, new social interaction is created unknowingly. In the course of utilizing the collection bins, they are able to discover whether collection bins can accommodate all the waste and whether the deposited waste is collected or left uncollected for days or weeks. This implies there exist ineffective structures and implementation of policies on solid waste and poor financing adversely affected people's attitude towards solid waste. Such poor service of uncollected stinking heaps of waste overflowing and spilling all over certainly creates negative perception about the newly installed collection bins. Such perception is shared through social interaction created during interaction during the use of the bins.

A disadvantage of systems theory suggests all variables have some equality in the extend of impact and control over the business environment conditions. We know this not to be the case as some variables are bound to have a greater impact and degree of control when compared to other variables. Never the less, circumstances can change and hence it is quite possible that what was

once considered irrelevant can as quickly become a major force and vice versa. Dealing with so many variables may not be possible and is often a criticism in the application of systems theory.

Determining strategies and the importance or otherwise of numerous variables given the degree of uncertainty in which organizations now operate is not a simple task. One must question as to whether systems theory can actually capture the complexity of interactions and inter-relationships that exists, whether formally or informally. Dealing with such information will require a consistent re-evaluation of the desired business objectives of the organisation to ensure that are still in line with the market forces and trends, both current and future. If the organisation is constantly adapting and or reacting to such influences this may have unforeseen implications in other areas within the organisation that could be detrimental to it is overall success.

2.2.2. Theory of Planned Behavior (TPB)

TPB was articulated by Ajzen (2012) and emerged as a framework for understanding, predicting and changing human societal behavior. According to this theory, it is argued that intentions were behavioral traits which closely related to one's attitudes or perception of phenomena. It was used to predict an individual's intention to engage in a certain behavior at a specific time and place, linking one's beliefs and behavior. This theory emphasized that behaviour emanated from one's attitude and intensions. It suggested that three main variables listed as, one's attitude towards behavior, subjective norms and perceived behavioral control influenced one's intension and thus behaviour itself (Ajzen, 2012). The theory further predicts and explains exceptional behaviour in a wide variety of context.

Studies have been done in support of this theory because of its ability to predict intentions showing that changes in behavior could bring changes in one's behavior. These behavioral traits were then reflected in one's attitude. It was clear that intentions could be used to predict behavior although this was not a proof of the preceding behavior (Webb & Sheeran, 2006). Another previous study indicated that transient populations in a sustainable building disposed of waste more accurately when compared to those in a non-sustainable building (Brothers, Krantz *et al.*, 1994). This was an indication that buildings that were built to communicate atmosphere of sustainability could influence waste disposal. In such environment, main collection was done in the kitchen and this waste was picked regularly. Apinhapath (2014) emphasized on community

mapping as the most effective tool for understanding a community better. He stressed that people's attitude and cooperation was vital in solid waste managed.

Many studies also confirmed that intentions could significantly influence one's attitudes as notions in mind triggered one's actions. It was notable that people could plan to manage waste positively or negatively. Mostly waste was collected without being sorted at the source which ended up putting reusable, recyclables and unwanted waste together. Segregation and disposal of waste in bins at designated areas was all in residents' perceptions. Different counties generated different solid waste which mainly comprised metals, plastics, wood, paper and many more so need for separation. Small towns were keen on solid waste management compared to big cities where population rates had escalated and affected resident's attitudes. It was therefore clear that it was possible to guess the areas where waste would be managed better than others in our estates.

This theory is very relevant to the present study as it develops and qualifies the second research objective on the extent residents use the newly installed bins. The theory helps understand and predict that the level of utilizing newly installed waste collection bins is predicated on effective functionality of newly installed collection bins as well as the effectiveness of awareness and sensitization campaigns on importance of the collection bins. These two elements influence residents' attitude towards collection bins.

If the usage of the collection bins is favorable as well as advocacy efforts on importance of the newly installed collection bins are accepted, they influence and control residents to perceive bins positively which changes their behaviour and creates intentions to start depositing waste in the newly installed collection bins. As such created perception which influences and controls one to change behaviour towards the bins. Therefore, using newly installed collections bins becomes a norm which promotes solid waste management.

Therefore, TPB provides a theoretical framework for systematically identifying the factors which influence the use of newly installed waste collection bins decision. TPB also allowed individuals who have positive attitudes, and think that there is adequate normative support, and perceive that they can easily engage in the activity, should have strong intentions to perform the behavior of utilizing newly installed waste collection bins in Machakos County.

There has been no shortage of criticism towards the TPB. It assumes the person has acquired the opportunities and resources to be successful in performing the desired behavior, regardless of the intention. It does not account for other variables that factor into behavioral intention and motivation, such as fear, threat, mood, or past experience. While it does consider normative influences, it still does not take into account environmental or economic factors that may influence a person's intention to perform a behavior. It assumes that behavior is the result of a linear decision-making process, and does not consider that it can change over time. While the added construct of perceived behavioral control was an important addition to the theory, it doesn't say anything about actual control over behavior. The time frame between "intent" and "behavioral action" is not addressed by the theory.

The main focus of criticism has been the limited predictive validity of the TPB. Reviews show clearly that the majority of variability in observed behaviour is not accounted for by measures of the TPB. In particular, the problem of 'inclined abstainers', individuals who form an intention and subsequently fail to act, has been a recognized limitation of the TPB that remains unaddressed by the theory (Orbell & Sheeran, 1998). While we agree with these criticisms, we suggest focusing the debate on two additional aspects of the application of theory: validity and utility.

2.2.3. Waste Management Theory

Waste management theory was pioneered by Pongracz (2004) and (Pongracz *et al.*, 2006). It is founded on expectations that waste management is meant to prevent waste causing harm to human health and environment. The theory implies that waste is defined by the products that constitute it. The theory is used with others that are closely related with environment. Key objective of this theory is to protect environment through effective solid waste management techniques, protect health, and also prevention of pollution. It also analysed a holistic view of the aims of waste management.

This theory also takes into account all solid waste activities from inception to final disposal as unmanaged waste has become a factor for propagation of innumerable ailments (Kumar *et al.*, 2009). There are many activities that result into waste generation and how the waste is handled, collected and disposed of posed a great risk to the environment and public health (Mohammed &

Eyasu 2017). According to Mckinney et al. (1986), waste is a result of the inefficiency of a set system while Pongracz (2006) considered waste as something that has to be extracted to achieve efficiency. It is notable that key to SWM is reduction of waste at source Tromans (2001).

The implication of the theory in this research is to give answers to conceptual questions through explanation of what waste was and its characterization and concept. It was also to be used as a guide for choosing other waste management options as well as provision of a foundation for integration of solid waste. The theory helps in predicting the results in the use of waste management activities, setting and implementing right policies that impact positively on solid waste management.

Undeniably, the waste management theory reverberates appropriately with the third research objective that set out to assess the influence of proximity and placement of bins to beneficiaries' residents or houses. This theory stresses the protection of environment through effective solid waste management techniques right from inception to final disposal. One of the core effective solid waste management techniques is strategically installing waste collection bins close to residents' houses.

If sorting starts at source whereby one has a bin for separate items, then work would be easy when disposing of as efficiency and effectiveness of waste management started at source. This eventually reduces the amounts that are meant for disposal thereby paving way for, re-using, recycling and composting translating to clean environment which impacts health positively.

Despite many benefits of the waste management theory, one major shortcoming is its prescription of remedy or model that is assumed applicable to all contexts. Different countries and cities present unique economic, social and political characteristics which need particular or specific waste management model. Certain countries' cultures, economy, social set up as well as political system might not provide platform for waste management theory's model. By suggesting a uniform framework or system, waste management theory sets up many countries and cities for failure in managing waste from start to the end.

2.3. 4 Institutional Theory

Institutional theory originates from the research literature on institutional sociology of DiMaggio and Powell (1983), Meyer and Rowan (1977) and Scott (1987). To understand institutional theory, it is crucial to differentiate between an institution and an organization. An organization is a player, while institutions are the rules of the game. Thus, actors can combine logics, highlight contradictions, and otherwise reinterpret and mobilize meanings and practices to drive institutional change.

This theory posits that institutions are a set of norms and values that shape and control behaviour of people. Institutional decisions are based upon a set pattern of cultural values, norms, and behaviors under the influence of an external environment (Gualandris & Kalchschmidt, 2014). Institutional theory is used to understand different types of external factors that force any institution to initiate or adopt any new practice. Institutional theory highlights three kinds of isomorphic pressures, where coercive pressures are a set of formal or informal pressures from influential entities to abide by the law, or even societal expectations (DeGrosbois, 2016).

Therefore, institutional theory can help provide an explanation for institutional decisions and activities. Social structures are both imposed on and upheld by the actors' behaviour. One cognitively oriented view is that a given institution is encoded into an actor through a socialization process. When internalized, it transforms to a script (patterned behavior). When (or if) the actor behaves according to the script, the institution is enacted. In this manner, institutions are continuously (re-)produced (Berthod, Grothe-Hammer & Sydow, 2017).

Institutional theory resonates well with the current study by developing the fourth research objective that sought to determine residents' satisfaction of frequency of town pick-ups of the bins. Social structures are both imposed on and upheld by the actors' behaviour. This theory shows how pressure from external environment such as residents, government regulators, environmentalists force solid waste management personnel to operate under set of patterns of norms and values. Such code of conduct compels waste management personnel to comply with prescribed waste management practices, policies and procedures which lead to change which in this case is proper collection, treating and disposing of waste. As a result, residents or households have their waste they generate and deposit at the bins collected timely, treated and disposed of as required by law. When residents get satisfied, waste management program (the institution) is sustained or continue to operate.

Institutional theory has long been critiqued for neglecting or under theorizing agency. For instance, institutional theory fails to account for the reality of purposive, interest-driven, and conflictual behavior evident in institutions. Recent work ion institutional entrepreneurship has demonstrated a range of field, organization, and individual-level factors that enable individual actors to change institutions contrary to tenets of this theory (Nasrin, Rasiah, Baskaran & Masud, 2017).

2.3 Empirical Literature Review

To understand the effectiveness of the newly installed waste collection bins on waste management, this section of the study examines global, regional and national perspectives in comparison with local context of the present study. Essentially, this assists in getting insights on the issue under investigation with core aim of identifying gaps the current study attempted to address. Basically, empirical audit is discussed thematically in tandem with the four study constructs.

2.3.1 Households' Perception on use of Bins as a Strategy for Residential Solid Waste Management

Barloa *et al.,* (2016), carried out a study on the effect of knowledge on attitudes, perception of 2528 Polytechnic university student in the Philippines. The focus of the study was on university students and aimed at investigating how prevailing environment influenced their knowledge and attitude for their practices of solid waste management. Using the knowledge attitude-practice (KAP) model (Barloa *et al.,* 2016), authors showed that the students' awareness and knowledge were correlated with their perception positively. Nevertheless, the rate of practices was relatively low even though the level of knowledge and attitude were high.

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Echegaray and Hansstein (2017) adopted a survey design administering structured questionnaires on 120 randomly sampled residents of a low-income residential area in Buenos Iris in Brazil to assess the intention-behavior gap in electronic waste management. Subjecting collected data on multiple regression and Contingent Valuation Method, it was established that perception of risk is a factor in changing attitudes, and a risk is considered greater when the hazard is involuntary and uncontrollable, not natural, and cannot be compensated for by any benefits. It further observed that citizens' attitudes to use bins are influenced not only by impacts. Also, negative perception is a product of credibility loss in waste managers due to backfiring decisions and processes such as uncollected overflowing, stinking waste bins.

Sukholthaman, Chanvarasuth and Sharp (2017) investigated consecutive linkage between physical impacts to beliefs, attitudes and utilization of bins in waste collection in Bangkok, Thailand. Applying a qualitative approach, an open-ended interview with 10 purposively sampled longest-staying resident in 10 estates was conducted and data analyzed using content analysis technique. The study classified impacts into two categories namely physical and non-physical with the former including health risks, nuisances, and environmental change, and these in turn generate non-physical impacts, which are categorized into economic (e.g. property value decrease), social (community image loss), and political (e.g. lack of fairness) impacts. Findings indicated that a minor physical impact may trigger a very strong negative attitude to an SWM facility. Also established was that fears about physical impacts are usually exaggerated by residents and do not correspond to actual damage, and non-physical impacts affect attitudes as strongly as physical ones. In terms of physical impacts, pollution causes psychological stress and fear of health risks.

Mandevere and Steven (2018) investigated the effectiveness of the strategies employed by the City of Harare in household solid waste management. The study was conducted in Harare's low, medium and high-density income suburbs. To achieve this, the study adopted a mixed method approach involving triangulation of qualitative and quantitative designs structured questionnaires, interviews, observations and focus group discussions. Findings revealed that cost of waste collection services and low community participation in SWM triggered negative perception of bins influenced perception of bins in Harare.

2.3.2 Residents Usage of Installed Bins

Adopting a qualitative approach, McAllister (2015) investigated factors influencing use of solid-waste collection bins Utah State University students. Basing on students' records, an online interview with 8 final year students randomly sampled in the environment department was conducted. Analyzing qualitative data using content analysis, the results demonstrated that lack of fixed schedule resulted into taking waste only occasionally influenced the willingness to utilize waste collection containers installed at strategic locations. Moreover, he observed that infrastructural and technological constraints would greatly influence individuals' perception and practices (McAllister, 2015).

Santoso and Farizal (2019) conducted a study on community participation in household waste management in DKI Jakarta and Depok in Indonesia. The purpose of this study is to find out the frequency of collecting household waste. An Exploratory research design which employed partial least square (PLS)'s two models namely inner and outer models in the Structural equation modeling (SEM). This research is based on the Theory of Planned Behavior (TPB) which considers several factors such as attitudes, subjective norms, and behavioral controls to influence someone to make intentions in behavior and expand the TPB conceptual model to overcome gaps. The results of this study came from a survey with 301 respondents in two locations namely DKI Jakarta and Depok. The results of this study indicate that attitudinal factors have the most significant influence on the low frequency of households in disposing waste at collection points. However, other factors such as demographics, subjective norms and perceptions of behavioral control do not have a significant effect.

Abbasi *et al.,* (2020) carried out the scale development and psychometric evaluation of behaviors and beliefs associated with frequency of visiting waste collection points to drop household among female students in Isfahan University of Medical Sciences, Iran. This methodological research was performed on 386 female students residing in the dormitories of Isfahan University of Medical Sciences, Iran, during June to August 2019. The primary version of the questionnaire was developed in a preliminary study in EPPM (extended parallel process model) framework to measure the EPPM perceptual and behavioral variables and perceived barriers among students. EPPM results demonstrated that the change in attitude, intention, and behaviors such as frequency of waste collection is higher in terms of perceiving the related efficacy of recommended behaviors and good management.

A study was conducted in Bawku municipality of Ghana, aimed to determine waste collection effectiveness on household frequency of participating in waste management (Douti *et al.,* 2017). The research found that the respondents involved in the study did not show any positive attitude in frequent sending of waste to collection points due to improper management and lack of communication. This also provoked the view that waste management was the sole responsibility of the local authorities and thus, people were not expected to contribute for sub-standard service (Douti *et al*., 2017). As a result, the role and contribution of the public to frequently dispose waste at transition centers was not viewed as important by the citizens.

2.3.3 Proximity and Placement of Bins for Residential Use

Towolioe (2019) assessed the relationship between strategic position of community waste collection points and waste management by identifying failure factors based on unit analysis in Makassar City, Indonesia. The study adopted a shortest service location (SSL) model for allocating collection points and compared the results obtained with those of two other models: Location set covering (LSC) and maximum covering location (MCL). They obtained the data of the study area from 1/5000 aerial photographs and geographical information system (GIS) data (ArcView 3.0) and used CPLEX 6.5 (optimization software) in their study. They reported that SSL model shortens the walking distance by 10% in comparison to LSC and MCL models.

Van der Werf, Seabrook and Gilliland (2018), carried out a study to determine the effectiveness of collection mechanism on waste recycling behavior in the garbage stream of South Ontario, Canada households. To achieve the research objectives, a convergent parallel mixed-method design was adopted. For quantitative data collection, random sampling of 341 households was used to answer questionnaires. Semi-structured interviews were conducted with 12 participants based on exhaustive results of the qualitative data. Descriptive and inferential statistical analyses of chi square and logistic regression were used in the analysis of quantitative data. On the other hand, qualitative data was analysed using a thematic approach supported by strength-weaknesses-opportunities-threats (SWOT) analysis. The study established that strategic positioning of collection bins close to residential places greatly changed recycling behavior.

Amasuomo, Tuoyo and Hasnain (2015) conducted a study on the public perception of local government waste collection for sustainable waste management at the household level in Lagos, Nigeria. The study adopted multiple regression on quantitative data obtained from 400 urban dwellers sampled through stratified and simple random sampling. The study established that failure to place bins closer to point of consumption led to unwillingness of the community to participate in waste collection program. Further, it was indicated that local governments could have successfully implemented the 3Rs had it been adequately supported by households by continuously encouraging the community to perform the 3Rs, and not throw their garbage indiscriminately as well as not to make vacant lots as garbage disposal area.

Manga, Oru and Ngwabie (2019) sought to determine the willingness to pay and strategic placement of bins for an improved solid waste management collection system among the

inhabitants of Mamfe, Cameroon. A total of 371 households were interviewed and data analysis to identify the determinants of perception and willingness to pay values was performed using multiple regression models (Probit & Tobit) and Contingent Valuation Method. The study established that most of the respondents (85.1%) showed a positive attitude towards the willingness to pay for an improved solid waste management collection system because collection bins were strategically installed at a convenient location.

Starovoytova and Namango (2018) conducted a cross-sectional study design employing case-study of the-social-perception on solid-waste-management (SWM) on perceptions, attitudes, and practices of students and vendors of solid waste management at Moi University campus in Eldoret. Document-analysis of over 250 published-materials, a-structured-questionnaire on a sample-size of 374, for students, and an-interview of 37 vendors was executed. Using a Discrete-Choice Experiment-technique, the-study revealed, that both students and vendors have-recognized improperly positioning of bins far away from student hostels as a major SWM problem at-the-campus and as such students do not currently pay for WM-services rendered to them, but would be willing to pay, only for drastically-improved SWM-services.

2.3.4 Resident's Satisfaction with Frequency of Town Pick-Ups of the Bins or Waste Disposal

Tian *et al.,* (2019) examined the effects of government publicity, consumer attitudes, subjective norms, perceived behavioral control and consumer knowledge on consumers' willingness to classify waste in the process of waste management in China's four cities namely Shanghai, Xi'an, Mianyang, and Shenyang. The study utilized descriptive approach where closed ended questionnaires were directly administered to 260 citizen sampled through random street interception.

The sample consisted of 59 were in Shanghai, 59 in Xi'an, 57 in Mianyang and 61 in Shenyang. Utilizing structural equation modeling, hierarchical regression, the findings show that households were dissatisfied with the delay in collection of waste residents deposited in the collection bins. Overflowing, accumulated and stinking waste collection containers had a significant negative impact on consumer attitudes, subjective norms, and perceived behavioral control.

Choon *et al.,* (2017) adopted a survey approach with closed-ended questionnaires sent directly to 400 respondents in the Klang Valley in Kuala Lumpur, Malaysia to assess the satisfaction and awareness of households about various issues of solid waste management. To assess the household level of satisfaction and awareness on solid waste management services and facilities, frequency analysis and factor analysis were employed. The core criterion that determined the household's satisfaction on solid waste management services and facilities was subsequently executed. Logistic regression was used to determine the strength of the association between factors. This study revealed that the majority of the respondents were dissatisfied with their waste management services particularly uncollected waste collection bins left unattended for weeks.

Babaei *et al.,* (2015) aimed to determine the effect of waste management practices including collection, recycling, waste separating at source, solid waste reduction and community satisfaction in Iran. Adopting the knowledge attitude-practice (KAP) model (Barloa *et al.,* 2016), the findings demonstrated that waste management practices were correlated with community satisfaction level. They concluded that the public attitude and willingness towards solid waste management participation was predicated on the satisfaction level of the prevailing governance effectiveness. However, the findings demonstrated that their knowledge and practice levels were inadequate and that might have compromised their findings despite the public attitude and satisfaction level eventually. (Babaei *et al.,* 2015).

Boateng *et al.,* (2019) steered a study on households' willingness to pay for improved solid waste management services in four major metropolitan cities in Ghana. A cross-sectional multicenter approach using structured questionnaire on sample size of 1,536 from four regional capitals of Accra, Kumasi, Takoradi, and Tamale in Ghana using single proportion formula by Cochran. Data was analyzed with the help of the contingent valuation (CV) method. The study observed that satisfaction with the four regional governments' collection system was the reason for the households' willingness to accept use of collection bins and subsequent intention to pay for SWM services in the four metropolitan cities.

Hassan *et al.,* (2018) carried out a study on the assessment of beneficiary satisfaction with community based solid waste management service in reference to Okoa Maisha Project in Mnarani Village in Kilifi County, Kenya. Systematic random sampling method was used to

select 290 respondents from an approximate target population of 800 households. The first household was selected at random and every 4th household was interviewed until the total number of 290 households was reached. A semi structure questionnaire was used to collect data from respondents. Findings show waste was collected the after long intervals with waste totally neglected and never collected in other estates. The Chi-square test documented respondents' low satisfaction level of both frequency of waste collection from households and the behaviour of the waste collection crew towards residents.

2.4 Conceptual Framework

The conceptual framework is an illustrative diagram represents the variables of the study that express how the various variables relate. Basically, household perception of bins, appropriate usage of bins, proximity/placement of bins and resident's satisfaction with bins are independent variables. The dependent variable consisted of the effective use of the new bins while governance institutions and structures are intervening variables. Essentially, good or positive household perception of bins is positive, appropriate usage of bins and proximity/placement of bins strategically favours residents as well as residents satisfaction with frequent collection of waste from the new bins in addition to good governance institutions and structures will result into the newly installed bins being rated as effective and when the opposite happens or is true, the reverse is true.

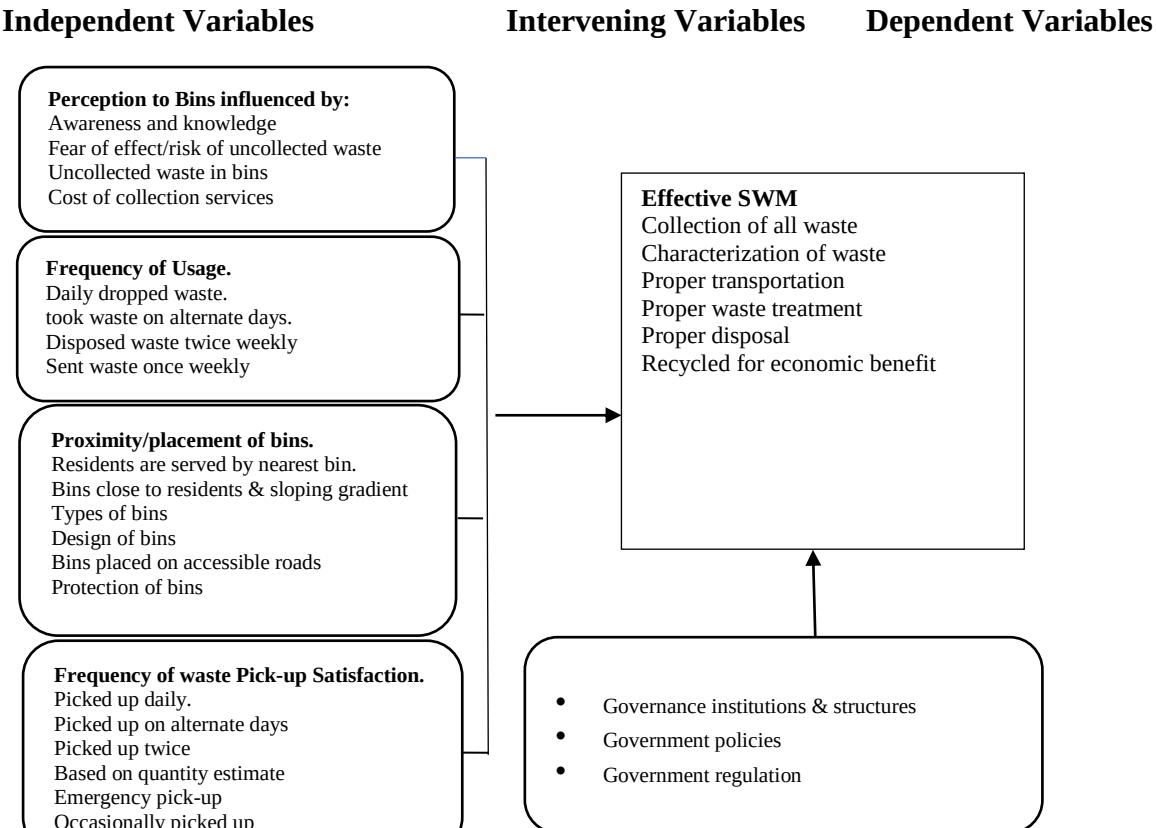


Figure 2.1: Conceptual Framework

Author (2020)

The conceptual model in Figure 2.1 hypotheses the relationship between the independent and depend variables; association between effectiveness of newly installed bins and solid waste management. In this study, independent variables include households' perception of newly installed bins, extend at which bins are utilized, proximity of bins to residences of beneficiaries and satisfaction level of frequency picking up of the waste in the bins. The dependent variable is effective solid waste management which is conceptualized as collection, characterization, transportation, treatment, disposal and recycled of waste.

Perception of bins was determined by awareness and knowledge, fear of effect/risk of uncollected waste, uncollected waste in bins and cost of collection services charged on households. The sub-theme of frequency of usage consisted dropping waste at the collection points (bins) daily, alternate days, twice weekly and once weekly. Proxies including residents being served by nearest bin, bins close to residents and sloping gradient, types of bins, design of bins, bins placed on accessible roads and protection of bins from vandalism and abuse measured proximity/placement of bins. Further, satisfaction level of frequency of waste pick-up from bins was quantified by daily, alternate, twice, once or occasional picking up of waste or picked based quantity estimate and emergency pick-up. Hypothetically, the behaviour of independent variable determine the behaviour of the dependent variable. For instance, in the event households' perception of newly installed bins is positive, increased utilization of bins, bins are placed close to residences of beneficiaries and satisfaction level of frequency picking up of the waste is very high, there will be effectiveness in waste management and the opposite is true.

2.5 Research Gap

Largely, studies reviewed above, examined households' perception, usage, positioning and disposal satisfaction with bins. Conceptually, most studies reviewed demonstrated that perception, attitude and knowledge of waste management were correlated with issues such as utilization of waste collection bins. On second research objective, studies showed that residents' usage of bins, was based on attitudinal factors such as benefits, impacts of waste and credibility

of waste managers, decisions and processes, indicated that a minor physical impact may trigger a very strong negative attitude to an SWM facility. Further, reviewed studies observed increased use of bins that were strategically positioned close to households' residences as well as high satisfaction rates with high frequency of collection of waste from installed bins.

However, studies presented mixed findings denoting negative or positive relationships on each of the four themes (objectives) the study examined. Also, reviewed literature either focused on broad or narrow aspects of waste management aspects. Evidently, findings of studies demonstrated contradictions and inconsistences in this field implying empirical inconclusiveness, a conceptual gap this study attempted to address. Still, most studies focused on broad waste management aspects which starved same studies of relevant insights achieved by narrowing to specific areas such as utilization of bins, a conceptual gap the current study sought to address. Few studies conducted in Kenya and especially in Machakos County dwelt on many thematic areas except the area the current study focused on.

Contextually, most studies reviewed in this area were conducted in foreign countries especially from the developed world. Further, studies reviewed adopted unsuitable methodologies such as small sample size especially qualitative ones which had representation implications on the findings evolved. Evidently, the studies reviewed demonstrated conceptual, contextual and methodological research gaps which the current study sought to address. Hence, this area of study should be encouraged, especially, in Machakos town constituency to ensure effective and sustainable SWM.

2.6 Chapter Summary

This gave attention to the theories that helped in understanding the relationship between effectiveness of collection bins and solid waste management. Equally, empirical audits on the relationship effectiveness of collection bins and solid waste management through logical structure and outline of writing that helped in shaping the thesis has been emphasized. Also given attention is the conceptualization of study concepts or constructs through a pictorial model explaining relationships between variables. Further, summary analysis of major studies reviewed is done to identify their shortcomings in terms of research site, design, target population, sample, data collection techniques, major findings that this study attempted to address as well as identifying the conceptual, contextual and methodological research gaps.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter described the methods that were used in the research. These included the area of study, research design, target population, sample size and sampling procedure. Others were the research instruments used for data collection, validity and reliability of the instruments, data collection procedures, data analysis techniques, research ethics and chapter summary.

3.2 Research Design

The study used descriptive survey design that incorporated quantitative approach. This facilitated a smooth coordination of the various entities covered in the chapter. The design described the attitudes of the target population in relation to their actions towards the topic. It also allowed a big sample to be used hence determination of the relationship between the present condition and the previous one. The design also took a short period of time in accomplishment of the mission.

3.3 Brief Overview of Study Area

The study was conducted in Mjini, Kariobangi, Eastleigh as well as Muthini estates in Machakos town constituency, Machakos county. The county has a rapid population which stands at 1,421,932 and a density of 240/km2 (610/sq. mi). The gender representations are as follows: males are 710,707, females 711,191 (Kenya Population and Housing Census, 2019). The study was done in Machakos town, the county headquarters, with a population of 168,255 people.

Machakos, also known as Masaku, is located at lower Eastern region of East Kenya, 63 kilometers Southeast of Nairobi. It borders Nairobi and Kiambu to the west, Embu to the North and Kitui to the East. Makueni is to the South, Kajiado to the South-West and Murang'a and Kirinyaga to the North-West. There are several universities such as Machakos University, St Paul's University, SEKU and colleges such as KIM, MIT and Uwezo. The county also had many medical facilities such as Level 5, Shalom Community Hospital, Machakos Doctors Plaza and Bishop Kioko Hospital, Bristol Part, just to mention but a few.

More industries were also coming up within the Machakos Industrial Area that is located behind Muthini Estate. Most of them handled wood and metal products that also increased the solid waste. The town also has a stadium known as 'Kenyatta Stadium' which is located next to the

county offices in town. Just like the other counties before devolvement, Machakos town was facing many challenges in solid waste management. There were designated areas in town and within the estates where waste would be dumped illegally either at the far edge in the estates or by the road sides. Waste would eventually be scooped by the pickers, put it in the trucks then transport to the designated dumpsite at Mitheu.

The idea of better solid waste services was hatched when the county government entered into a Memorandum of Understanding (MOU) with the World Bank to finance its solid waste activities in 2010. Good amount of money was donated to the county that saw the rehabilitation of infrastructure in Swahili and Kariobangi informal settlements. Two CBOs were also set up for each estate for recycling purposes. The Swahili village, (Mjini Estate) is the slum of Machakos town and comprised mainly Muslims while Kariobangi is characterized by low income residents from other faiths.

The birth of the bins in the county came with the grant of 1 billion shillings which was advanced to the county through another MOU in 2018/19 fiscal year. The MOU was meant for infrastructure development and expansion of the three municipalities, that is Machakos town, Mavoko and Kangundo. This saw the county purchase 400 bins, 6 skip loaders, compactors, 4 trucks and 3 tractors. The compactor was able to compact five to six bins into one small load. The county also had two designated dumpsites that is, Mitheu in Machakos and Athi in Mavoko municipality. Machakos town municipality had 3 skip loaders; 150 bins, 2 trucks and 1 tractor. Waste here was not segregated apart from the MOH where incineration of hazardous substances was done.

The specific area of study was Machakos town. The study majored on households from four estates which were: Mjini (Swahili), Kariobangi, Eastleigh and Muthini. The key informants were officers from the department of SWM. There were more than 40 bins that were sufficiently distributed within the Municipality. Sensitization of the new bins was done to the residents as well as a pilot exercise. It involved officers from Directorate, local administrators and Nyumba Kumi heads. The bins were then placed at the same points which had been illegally designated for waste previously and the rest placed strategically within the areas that generated more waste – along the streets.

These bins are made of high-quality metal and monitoring was done to ensure that they were not mishandled by the residents. Collection of waste was determined by waste flow. In case of breakage of a bin, it was repaired in time. Characterization here was mainly food waste, pampers bottles, wood and packaging paper. The residents were very happy with the new move which had seen cleanliness of the town improve drastically. However, there were a few notable challenges with these bins. Some residents burnt waste in them hence weakening them and they were also prone to vandalism, as they were made of quality metal which could be used as scrap metal. Lastly, some landlords and tenants did not approve of their placement near their residential areas.

3.4 Target Population

The study targeted Mjini, Kariobangi, Eastleigh and Muthini estates in Machakos town sub-county that has a population of 168,255 (KNBS, 2019). Specifically, the study targeted household heads, SWM staff, County Executive Members for Environment Management, Housing, Physical Planning, Public Health, Social Services, Inspectorate Services and Public Works departments, civil organizations Executive Directors working in sub-county at the time this study was conducted. Further, the sub-county administrator, ward administrator, the Member of County Assembly, Chief, Assistant Chiefs as well as village elders for the site the study was conducted.

These individuals were targeted because they were directly or indirectly involved in SWM they hence understood the practices and philosophy of SWM therefore deemed suitable to provide required information. These estates were targeted due to their close proximity to the Machakos town center which exhibits highest tendencies of uncollected waste in bins, overflowing bins and waste littered in bus parks, pavement, estates, streets, roads among others. Besides, the estates had highest number of newly installed bins.

3.5 Sample Size and Sampling Procedure

To sample household heads, Krejcie and Morgan (1970) table for determining sample size for a finite population as presented in Table 3.1 was adopted. For this-study, confidence-level of 95%, and margin-error of 5% were adopted.

Table 3.1: Table for Determining Sample Size for a Finite Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.
Source: Krejcie & Morgan, 1970

The Table is constructed using the following formula for determining sample size:

Formula for determining sample size

$$s = X^2NP(1-P) + d^2(N-1) + X^2P(1-P)$$

s = required sample size.

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).

N = the population size.

P = the population proportion (assumed to be .50 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (.05).

Source: Krejcie & Morgan, 1970

NOTE: There is no need of using the formula since the table of determining sample size has all the provisions you require to arrive at your sample size

At the time of the present study, there were 340 households in Mjini, Kariobangi, Eastleigh and Muthini estates. According to Table 3.1, Krejcie and Morgan (1970) suggest a definite population of 340 should have a sample of 181 respondents for proper representation and generalization of the findings to the target population. Therefore, a sample size of 181 households from the four estates namely Mjini, Kariobangi, Eastleigh and Muthini was adopted for the present study as indicated in Table 3.2.

To sample SWM staff, a census technique was used as recommended by Verme and Gigliarano (2019) who suggest that a small target population of less than 500 subjects should not be sampled but select every member or subject to participate in the study. At time of the study, there was 1 WMS manager, one technical officer, 8 supervisors, 1 skip loaders and 2 drivers. Therefore, 1 WMS manager, one technical officer, 8 supervisors, 1 skip loaders and 2 drivers totaling to 13 personnel were selected to participate in the study as indicated in Table 3.2.

With express understanding that each of the designations or positions of County Executive Members for Environment Management, Housing, Physical Planning, Public Health, Social Services, Inspectorate Services and Public Works, sub-county administrator, ward administrator, Member of County Assembly, NGO Executive Director, village elder, Assistant Chief and Chief are held by a single person at a time, purposing sampling technique was employed and one individual of these categories was considered for the study.

Therefore, the final sample size consisted of 181 household heads, one WMS manager, technical officer, 8 supervisors, 1 skip loaders, 2 drivers, one (1) Environment Management Executive Member, one (1) Public Health Executive Member, one (1) Housing Executive Member, one (1) Physical Planning Executive Member, one (1) Inspection of services Executive Member, one (1) Public works Executive Member, 3 village elders, one (1) assistant chief, one (1) Chief, 6 Civil organizations Executive Directors, one (1) Member of County Assembly, one (1) Sub-county administrator and one (1) Ward administrator. To that end, this summed up to a final sample size of 214 prospective respondents who qualified to participate in the study as shown in Table 3.2.

Table 3.2 Sample Size Distribution

Sample Stratum	**Category unit**	**Total Category Distribution**
Household heads	181	181
WMS manager, technical officer, 8 supervisors, 1 skip loaders, 2 drivers	13 personnel	13
Environment Management Executive Member	1 x 1 CEM	1
Public Health Executive Member	1 x 1 CEM	1
Housing Executive Member	1 x 1 CEM	1
Physical Planning Executive Member	1 x 1 CEM	1
Inspection of services Executive Member	1 x 1 CEM	1
Public works Executive Member	1 x 1 CEM	1
Village Elders	1 x 3 villages	3

Assistant Chief	1 x 1 AC	1
Chief	1 x 1 Chief	1
Civil organizations Executive Directors	1 x 6 ED	6
Member of County Assembly	1 x 1 MCA	1
Sub-county administrator	1 x 1 SCA	1
Ward administrator	1 x 1 WA	1
Total		**214**

Source: (Author, 2020).

3.6 Data Collection Instruments

The researcher used both primary and secondary data. Secondary data was collected by reviewing reports from Government books, periodicals, journals, newspapers and magazines on waste management practices in Kenya and other countries. Primary data was collected using structured questionnaires with questions designed to ensure consistency with the study objectives and research questions. These tools were administered by researcher and research assistants to ensure accuracy and completeness. A 5-point Likert scale was used for more expansive responses to capture information.

The questionnaire was structured thematically in accordance with the study variables. Accordingly, Section A focused on demographic data of the respondents and Section B had question items on the first objective that sought to examine households' perception of the use of bins. In addition, Section C dwelt on the second study objective on usage of bins while Section D gave attention to objective three that was about proximity positioning of bins. Further, Section E concentrated on households' satisfaction level with collection of waste in the bins.

3.7 Pilot Study

A pilot study was performed in Athi River town to in order to ascertain the reliability of the questionnaire. Athi River town, being an urban area, had similar waste management issues like those of Machakos town constituency. Likewise, Athi River town proximity to Machakos town constituency made it logistically convenient for pilot study. This took place before the actual data gathering. A pilot test exercise is meant to detect and correct any probable error in the questionnaire (Yazan, 2016). For the current, 10 participants represented by 5% of the sample size (214) in accordance to Yazan's (2016) desired percentage of 1-10% for a pilot study. The participants involved in the pilot study but they did not participate in the actual survey as they were located outside of the study area.

3.7.1 Validity

For accuracy and precision, the content of the draft questionnaire was shared with thesis supervisors, experts in environmental management, experts in solid waste management and the researcher's peers to review and make suggestions. Their comments were incorporated in fine-tuning the final tool. Internal validity was controlled by recruiting research assistants to ensure that the questionnaires were effectively answered. The researcher trained research assistants and pre-tested them to ensure that they were valid.

3.7.2 Validity and Reliability

Reliability is correctness and relevance of the study tools to give similar results once several tests are done. Data generated from the pilot study conducted in Athi River town to test reliability. The Cronbach's Alpha Coefficient is a metric for reliability (Polit, 2014). The measure determines how consistent a questionnaire is. The value of the coefficient is from 0 to 1; where a high value is a significant alpha and 0.7 is considered a minimum alpha whereas anything below that value is dropped. For this task, Alpha coefficient of 0.87 was generated which was high enough to qualify the questionnaire reliable for the study.

3.8 Data Collection Procedure

Well-structured questionnaires capturing perceptions, attitudes, usage, proximity, placement and satisfaction with frequency of pick-ups of bins by residents were used. These were given to households in the estates on different days. The research assistants gave out the questionnaires to respondents through drop-and-pick method and gave them an ample time of two days to fill and return them to a designated place. The interviewees then filled them and thereafter the research assistants picked them.

3.9 Data Analysis Techniques

Qualitative data was entered in excel and analyzed for themes. Quantitative data was analysed using descriptive and inferential statistics in order to determine frequencies and percentages. The frequencies and percentages were presented in graphs while inferential statistics were presented in chi-square. Descriptive and inferential statistics which comprised frequencies, percentages and graphs were used to test significance and associations. Data was analysed by use of Statistical Package for Social Sciences (SPSS).

The gathered data was cleaned, verified and coded before entered into SPSS software version 21 where inferential as well as descriptive techniques were utilized for data analysis. To determine first objective, second, third and fourth objectives that sought to examine households' perceptions on the use of bins, usage of bins, proximity positioning of bins and households' satisfaction level with collection of waste in the bins respectively, descriptive statistics was applied. To determine the relationship between usage of bins and their effectiveness, multiple regression of the inferential statistics was used. The data was processed in percentages and frequencies. A 5-point Likert scale was also used as it facilitates statistical analysis. Charts and diagrams were used to present the data.

To conduct the regression analysis the following model was adopted;

$Y= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e$

Where;

Y = Solid Waste management

β_0= Constant defines value of performance without inclusion of independent variables.

β_1 - β_4 = Beta regression co-efficient of variables; measured the rate of change of dependent variable as a function of changes in the predictor variable.

X_1 = Perceptions on the use of bins

X_2 – Usage of bins.

X_3 – Proximity & placement of bins.

X_4 – Waste collection satisfaction level

e – Error term reflecting (other factors that influence economic development). Error term that represents the total variance that is not unexplained by the variables above. Findings were expressed in frequencies and percentages as well as means and standard deviations before being presented in tables and figures.

3.10 Ethical Consideration

The respondents who participated in the survey were asked to voluntarily and freely consent to the interview. They were also to be provided with the real disclosure of the purpose of the study and were be assured of anonymity and confidentiality right from the onset to the end of the interview. The researcher sought university clearance letter from the Post Graduate Directorate, NACOSTI, and also from the relevant local administration.

3.11 Chapter Summary

This chapter focused on the methods that were used in collecting data and analyzing the data as well as presentation of the findings of the study. Basically, research design, the target population and sample size determination as well as sampling procedure, were discussed. Similarly, data collection instruments, validity and reliability, were considered. Further described were data collection procedure, data analysis and ethical issues of the study.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION, PRESENTATION AND DISCUSSION

This chapter presents the data analysis, interpretation and presentation and discussion of findings. This entails separation of data into constituent elements and examining separately in relation to the whole more than just examining what has been collected in order to make deduction and inference. The returned questionnaires which formed the basis for the analysis presented in this chapter, were then verified, coded and tallied according to the research objectives.

Thereafter, they were quantitatively through descriptive and inferential statistics of SPSS (Scientific Package for Social Sciences) version 21. Regression was applied for verification, level as well as significance of the effectiveness of newly installed bins on SWM. In each sub-section, responses of all categories of respondents were analyzed and reported. An interpretation of the analysis was made to attach significance and offer explanations to the findings and make inferences. Presentation of findings was expressed in frequencies, percentages, standard deviations and means before presented in form of tables and charts.

4.1 Descriptive Findings

4.1.1 Response Rate

This part sought to establish the response rate. The results were presented in Table 4.1 below.

	Frequency	Per cent
Responded	210	94.6
Not returned	12	5.4
Total	**222**	**100**

Source: Author (2020)

From Table 4.1, the total number of questionnaires that were distributed to participants was 222; however, 210 questionnaires representing 94.6% were dully filled and returned while 12 questionnaires representing 5.4% were not returned. According to Yin (2014), a response rate below 40% is unreliable, a response rate of 40%-50% is poor, a response rate of 50%-60% is acceptable for analysis and reporting, a response rate of 60%-70% is good and a response rate of 70%-80% is very good while response of over 80% is excellent. Accordingly, from the response, it can be concluded that the response rate of 94.6% was excellent thus giving credence to the findings.

4.2 Demographic Findings

This part sought to establish demographic characteristics of respondents which comprise age, gender, education level of respondent as well as family size. Also discussed included kilograms of waste generated weekly per house (kg/house), type and weight of waste generated, examples of waste produced and respective weight in the estates of Mjini, Kariobangi and Eastleigh as well as Muthini in Machakos town constituency.

Further, estates where respondents stayed, number of storeys in the houses each lived in, duration of stay in the estates as well as their occupation were given attention. The sample used for this study had these demographic attributes that are presented in the tables and figures expressed in frequency, percentages, standard deviation and mean. Further, brief explanatory notes, comments and implications of the statistics in the tables and figures are appended after each table and figure.

4.2.1 Age

Age is a very key demographic feature that bears on the research findings hence this part sought to determine the age of individual respondents from Mjini, Kariobangi and Eastleigh as well as Muthini estates in Machakos town constituency. Respondents were asked to indicate their age. The results are as presented in Table 4.2.

Table 4.2 Respondents' Age

Age Bracket	Frequency	Percent
Between 18-25	6	2.9
Between 26-30	7	3.3
Between 31-40	83	39.5
Between 41-50	114	54.3

Total	210	100.0

Source: Author (2020).

According to the findings of the study as indicated in Table 4.2, majority of the respondents were aged between 41-50 who added up to 114 and represented by 54.3%, followed by those aged between 31-40 at 39.5% years. Further, those aged between 26 - 30 years were 3.3% while those between 18-25 years were 2.9%. This gives an implication that respondents at the county are old enough to provide the required information.

4.2.2 Respondents' Gender

Gender equality is an important consideration in almost all spheres of any institution. As a result, it was necessary for the study to establish the gender distribution at the county among the respondents as indicated in Table 4.3

Table 4.3 Gender Distribution

Gender	Frequency	Percent
Male	161	76.7
Female	49	23.3
Total	210	100

Source: Author (2020).

The statistics in Table 4.3 above indicate that 76.7% represented male respondents while females stood at 23.3% while 0.8% declined to indicate their gender. To that end, the there is no gender equity, implying that there is no adherence to the constitutional provision which stipulates that no gender should exceed a third in a group composition. Accordingly, response is gender insensitive as there is no balanced gender representation. Institutions or associations which are gender sensitive tend to make balanced decisions. This could be explained by the fact that some jobs such as SWM have traditionally been a male-dominated field.

4.2.3 Respondents' Highest Education Level

It is conventionally argued that education is key to economic, social and political transformation such as sustainable development largely possible through environmentally promotion practices such as waste reduction. Therefore, it was essential to establish the highest level of education qualifications of the respondents. Respondents were asked to indicate their highest education level. The results are as presented in the Table 4.4.

Table 4.4 Highest Education Level

	Education Level	Frequency	Percent
Educational	Secondary & below	60	28.6
Level	TEVs	100	47

	Diploma	38	18
	Bachelor's Degree	10	5
	Post-graduate	2	1.0
	Total	**210**	**100.0**

Source: Author (2020)

Statistics in the table above indicate the highest number of respondents represented by 47% had TEVs as highest education level. This was distantly followed by 28.6% with secondary and below educational level. On the other hand, 1% had post-graduate level of qualification. The interpretation is that majority of the respondents were fairly educated to provide required data that needed relative literacy. Also, the 5% and 1% respondents of bachelor's degree and post-graduate level respectively, were adequately qualified to provide the strategic and tactical information required. However, low education levels work against sustainable development predicated on more knowledge and awareness of waste reduction philosophy and practices only possible with increased education levels.

4.2.4 Respondents' Family size

Size of a household is relevant in the current study due to its role in the generation of solid waste. As such, the respondents were asked to provide number of bonafide members of their families whose results are as represented in Table 4.5.

Table 4.5 Household Size

Variable	Value & Label	Frequency	Valid Percent
	1. One & below	66	31.4
	2. Between 2-4	107	56.2
Family size	**3**. Between 5-7	30	14
	4. Between 8-10	7	3.3
	5. Over 10	5	2.1
Total		210	100.0

Source: Author (2020).

According to the results shown above, out of the 210 respondents who had returned their questionnaires, 56.2% had a household between 6-10 members while 2.1% had over 10 family members. The interpretation is that most families had few family sizes implying amount of solid waste generated by most families is minimal. This is a positive trend towards reduction of solid waste towards many global, regional and local sustainable development agenda.

4.2.5 Weekly Waste Generation per Household (kg)

It was imperative to determine the quantity of weekly waste generated in kg per house as presented in Table 4.6.

Table 4.6 Weekly Waste Generation (kg/house)

Variable		Frequency	Valid Percent
Family size	**1**. Below 1kg	63	30
	2. Between 1-3kg	110	52
	3. Between 4-6kg	20	10
	4. Between 5-7kg	10	5
	5. Between 7-10	5	2.5
	6. Over 10kg	2	1
Total		210	100.0

Source: Author (2020).

Statistics in Table 4.6 present varied weekly generated per household quantified in kilograms. Notably, a total of 110 respondents represented by 52%, produced between 1 to 3 kilograms of solid waste per house. Also evident is 2 respondents accounting for 1% that generated over 10 kilograms per household. The implication is that majority of the families account for diminished waste production which augurs well with waste management goals for improved health, environment and sustainable development.

4.2.6 Respondents' Estate of Residence

To determine effectiveness of newly installed bins, it was necessary to obtain required from households hailing from the site of the study in addition to a long span stay. As such, respondents were asked to state their estate of residence as presented in the in Table 4.7.

Table 4.7 Respondents' Estate of Residence

	Age Bracket	Frequency	Percent
Estate of Residence	**1.** Mjini	102	48
	2. Kariobangi	58	28
	3. Eastleigh	33	16
	4. Muthini	17	8
	Total	210	100.0

Source: Author (2020).

From Table 4.7, majority of the respondents represented by 48%, resided to Mjini Estate. This large population is attributed to its lowest cost of housing by the virtue of exhibiting informal settlement characteristics. Kariobangi with 28% of households comes next which is occupied by relatively low-income households although it is not classified as a slum like Mjini. Eastleigh is third in terms of population of 16% of the total respondents. Muthini accounting for the smallest number of residents, is categorized as an expensive estate to stay in due to high cost of housing among others.

4.2.7 Households' Distance to the Newly Installed Bins (meters)

Being the first stage in the process of management of waste implies the success of the subsequent stages largely depends on waste collection. In that regard, premium should be placed on waste collection if the entire waste management process has to accomplish the set goals. One of the key determinants of effective waste collection is the optimum proximity and placement of the waste collection containers to the target beneficiaries or primary consumers. This is the motivation of this part to determine how far the newly installed are from the target users as summarized in Table 4.8.

Table 4.8 Respondents' Distance to the Newly Installed Bins

Variable	Values	Frequency	Percent
Distance to the Bin	1. Below 100 meters	10	5
	2. Between 100-300 meters	8	4
	3. Between 300-500 meters	14	6
	4. Over 500 meters	178	85
	Total	210	100.0

Source: Author (2020).

For effective waste management, bins should be positioned in shortest distance for convenience walking to the waste collection point (bin) to drop household garbage. This predicated on the finding in Table 4.6 that report most of the households (85%) generate less than 3kg of household waste which is light enough to walk and drop it in the bin. Ironically, majority of households represented by 85% as indicated in Table 4.8 are located 500 meter and above from the bin as opposed to 10% whose houses are below 100 meters from the newly installed bins. Optimal proximity and placement of bins instrumental in solid waste management.

4.3 Descriptive Findings of Key Study Variables

Basically, descriptive findings, as the key word implies, is reporting things as they are without manipulating or interfering in order to design commensurate and appropriate interventions. These findings in this section are presented thematically according to the stated research objectives. These variables include households' perception on use of bins, extent of the use of bins by households, proximity and placement of bins, the satisfaction level with frequency pick-ups of the bins for waste disposal.

4.3.1 Households' Perception on use of bins

This part sought to establish how household perceived the use of newly installed bins in Mjini, Kariobangi and Eastleigh as well as Muthini estates in Machakos town constituency. The results are summarized and presented in the Table 4.9.

Table 4.9 Households' Perception on use of bins

	Variable		5	4	3	2	1	SD	M
1	Low awareness and knowledge influence perception of bins	F	1	5	11	115	78	0.706	1.74
		%	0.5	2.4	5.2	54.8	37.1		
2	Perception of risk (health risks) is a factor in changing attitudes towards bins	F	6	5	18	116	65	0.862	1.91
		%	2.9	2.4	8.6	55.2	31.0		
3	Low community participation in SWM trigger negative perception of bins	F	2	3	19	95	91	0.767	1.71
		%	1.0	1.4	9.0	45.2	43.3		
4	Overflowing, accumulated and stinking uncollected waste bins create negative perception	F	3	13	17	97	80	0.908	1.87
		%	1.4	6.2	8.1	46.2	38.1		
5	Cost of waste collection services influence perception of bins	F	3	13	17	97	80	0.793	1.73
		%	1.4	6.2	8.1	46.2	38.1		

** 5= Strongly Disagree, 4=Disagree, 3= Not Sure, 2=Agree and 1=Strongly Agree. F=Frequency; SD=Standard Deviation; M=Mean*

Source: Author (2020).

Manifestly, the statistics in Table 4.9, demonstratively, variables in this thematic area demonstrated that the prevailing circumstances influenced the perception of the usage of newly installed bins. For instance, 115 respondents represented by 54.8% with SD and M of 0.706 and 1.74, respectively indicated that low awareness and knowledge influenced perception on usage of bins. A further 116 respondents represented by 55.2% with SD and M of 0.862 and 1.91 respectively agreed that perception of risk (health risks) is a factor in changing attitudes towards usage of bins.

Equally, 45.2% with SD and M of 0.767 and 1.71 respectively, opined that low community participation in SWM triggered negative perception of bins. Similarly, 46.2% with SD and M of 0.908 and 1.87 respectively, indicated that overflowing, accumulated and stinking uncollected waste bins created negative perception. Alike, 46.2% with SD and M of 0.793 and 1.73 respectively, were of the view that the cost of waste collection services influenced perception of bins in Mjini, Kariobangi and Eastleigh as well as Muthini estates in Machakos town constituency.

4.3.2 Extent of the use of Bins by Households

The part sought to determine the extent of the use of newly installed bins in Mjini, Kariobangi and Eastleigh as well as Muthini estates in Machakos town constituency. As such, respondents were asked to rate how often newly installed bins were utilized by households in the four estates of Mjini, Kariobangi and Eastleigh as well as Muthini. The findings were as summarized and presented in Table 4.10.

Table 4.10 Extent of Households use of newly installed bins (n = 210)

Variable		5	4	3	2	1	SD	M

Households do not take waste to newly installed bins daily	F		1	10	94	105	0.610	1.56
	%		0.5	4.8	44.8	50.0		
Households do not dispose waste to the bins on alternate days	F	1	5	11	115	78	0.706	1.74
	%	0.5	2.4	5.2	54.8	37.1		
Residents do not drop garbage to the bins twice in a week	F	6	5	18	116	65	0.862	1.91
	%	2.9	2.4	8.6	55.2	31.0		
Households take garbage to bins once a week	F	2	3	19	95	91	0.767	1.71
	%	1.0	1.4	9.0	45.2	43.3		
Households only drop waste occasionally on the day they are able to pay due to high	F	3	13	17	97	80	0.908	1.87
	%	1.4	6.2	8.1	46.2	38.1		
Households have no fixed schedule and drop waste only sporadically	F	1	4	15	101	89	0.726	1.70
	%	0.5	1.9	7.1	48.1	42.4		

** 5= Strongly Disagree, 4=Disagree, 3= Not Sure, 2=Agree and 1=Strongly Agree. F=Frequency; SD=Standard Deviation; M=Mean*

Source: Author (2020).

Manifestly, the statistics in Table 4.7 report that 50% of the respondents with a standard deviation of 0.610 and a mean of 1.56 strongly agreed that households did not take waste to newly installed bins daily. Additionally, 115 respondents represented by 54.8% with standard deviation and mean of 0.706 and 1.74, respectively indicated that residents did not drop garbage to the bins twice in a week. A further 116 respondents represented by 55.2% with standard deviation and mean of 0.862 and 1.91 respectively agreed that households did not dispose waste to the bins on alternate days.

As well, 45.2% with standard deviation and mean of 0.767 and 1.71 respectively, indicated that households took garbage to bins once a week. Besides, 46.2% respondents with standard deviation and mean of 0.908 and 1.87 respectively, specified that households only dropped waste on the day they were able to pay due to high. Finally, 48.1% with SD and M of 0.726 and 1.70 respectively, revealed that households had no fixed schedule and dropped waste only sporadically.

4.3.3 Proximity and Placement of Bins

This objective sough to determine the influence of proximity and placement of newly installed bins on the residents of in Mjini, Kariobangi and Eastleigh as well as Muthini estates in Machakos town constituency. Accordingly, respondents were asked to rate the appropriateness and convenience of the placement and positioning of the newly installed bins in in Mjini, Kariobangi and Eastleigh as well as Muthini estates in Machakos town constituency. The findings are summarized and presented in Table 4.11.

Table 4.11 Proximity and Placement of Bins (n = 210)

Effect		5	4	3	2	1	SD	M
Each demand point is served by its nearest service point	F	4	6	11	91	98	0.847	1.70
	%	1.9	2.9	5.2	43.3	46.7		
Bins are positioned in shortest distance and descending slope for the ease of waste carrying by cart and tricycle pullers	F	1	100	93	5	11	0.627	1.67
	%	0.5	47.6	44.3	2.4	5.2		
Installing only stationary bins and excluding haul type disadvantages physically limited residents and residents dropping large waste	F	1	5	18	96	90	0.727	1.72
	%	0.5	2.4	8.6	45.7	42.9		
Installed bins are too fewer to accommodate generated waste	F	1	5	15	97	92	0.747	1.70
	%	0.5	2.4	7.1	46.2	43.8		
Bins are placed along roads accessible by pick-up trucks	F	3	7	16	86	98	0.854	1.72
	%	1.4	3.3	7.6	41.0	46.7		
Poorly designed bins attract scavenging people, dogs, birds who pose security and health risks at collection points	F		4	24	102	80	0.722	1.77
	%		1.9	11.4	48.6	38.1		
Poor design does not provide for bin fragmentation to waste separation	F		3	14	102	91	0.667	1.66
	%		1.4	6.7	48.6	42		
Unguarded bins turn into abode of scavengers who litter waste and vandalize the bins	F		1	10	94	105	0.610	1.56
	%		0.5	4.8	44.8	50.0		

** 5=Strongly Disagree, 4=Disagree, 3= Not Sure, 2=Agree and 1=Strongly Agree. F=Frequency; SD=Standard Deviation; M=Mean*

Source: Author (2020).

Plainly, the findings document 98 respondents represented by 46.7% with a standard deviation and mean of .847 and 1.70 respectively strongly disagreed that each demand point is served by its nearest service point. Additionally, 47.6% with standard deviation and mean of 0.627 and 1.67 were in disagreement that bins are positioned in shortest distance and descending slope for the ease of waste carrying by cart and tricycle pullers. Also, responses of 45.7% with standard deviation and mean of .727 and 1.72 respectively strongly agreed that installing only stationary bins and excluding haul type disadvantages physically limited residents and residents dropping large waste. Further, 46.7% respondents with standard deviation and mean of .747 and 1.70 respectively strongly agreed that installed bins are too fewer to accommodate generated waste.

More so, 46.7% of the respondents with a standard deviation of 0.854 and a mean of 1.72, agreed that bins are placed along roads accessible by pick-up trucks. Additionally, 48.6% with SD and M of 0.722 and 1.77 respectively, expressed that poorly designed bins attract scavenging people, dogs, birds who pose security and health risks at collection points. A marginal of 48.6% respondents with SD and M of 0.667 and 1.66 respectively, held the opinion that poor design does not provide for bin fragmentation for waste separation. Finally, 50% of respondents with

SD and M of 0.610 and 1.56 respectively, strongly opined that unguarded bins turn into abode of scavengers who litter waste and vandalize the bins.

4.3.4 Satisfaction with Frequency Pick-Ups of the Bins for Waste Disposal

The success and effectiveness of the newly installed bins in waste management is pegged on emptying or picking-up of the waste dropped in the bins in Mjini, Kariobangi and Eastleigh as well as Muthini estates in Machakos town constituency. To gauge and assess the effectiveness of picking-up of the waste for disposal, respondents were asked to indicate their satisfaction level with the frequency pick-ups of the bins for waste disposal using a scale of 1= Very Satisfied; 2= Satisfied; 3= Somewhat Satisfied; 4= Dissatisfied and 5= Very Dissatisfied. Summaries of findings are as shown in Table 4.12.

Table 4.12 Satisfaction with Frequency Pick-Ups of the Bins (n = 210)

Variable		**5**	**4**	**3**	**2**	**1**	**SD**	**M**
Solid waste is not picked up daily	F	1	4	15	94	96	0.734	1.67
	%	0.5	1.9	7.1	44.8	45.7		
Newly installed bins are not emptied twice a week	F	4	4	15	124	63	0.777	1.87
	%	1.9	1.9	7.1	59.0	30.0		
Collected waste is not picked up on alternate days	F	4	4	16	127	59	0.772	1.89
	%	1.9	1.9	7.6	60.5	28.1		
Solid waste is collected once a week	F	1	6	11	78	114	0.761	1.58
	%	0.5	2.9	5.2	37.1	54.3		
Emptying of bins frequency is based on the waste quantity estimate	F	1	2	11	94	98	0.676	1.62
	%	0.5	1.0	5.2	45	47		
There is no emergency pick-up of bins filled before scheduled collection time	F	1	6	12	95	96	0.752	1.67
	%	0.5	2.9	5.7	45.2	45.7		
There is no fixed schedule and waste is picked up only occasionally	F	4	4	15	124	63	0.777	1.87
	%	1.9	1.9	7.1	59.0	30.0		

** 1= Very Satisfied; 2= Satisfied; 3= Somewhat Satisfied; 4= Dissatisfied and 5= Very Dissatisfied; SD=Standard Deviation; M=Mean*

Source: Author (2020).

Expressively, from Table 4.12, 45.7% respondents with standard deviation and mean of .734 and 1.67 respectively, strongly agreed that solid waste is not picked up daily. Next, 59% of the respondents with standard deviation and mean of .777 and 1.87 respectively, agreed that newly installed bins are not emptied twice a week. As well, 60.5% of the respondents a with standard deviation and mean of .772 and 1.89 respectively, agreed that collected waste is not picked up on alternate days.

Additionally, 54.3% respondents with standard deviation and mean of .761 and 1.58 respectively, strongly agreed that solid waste is collected once a week. Further, 47% with standard deviation and mean of .676 and 1.62 respectively, strongly agreed that emptying of bins

frequency is based on the waste quantity estimate. Furthermore, 45.7% of the respondents with standard deviation and mean of .752 and 1.67 respectively strongly agreed that there is no emergency pick-up of bins filled before scheduled collection time. Finally, 59% of the respondents with SD and M of .777 and 1.87 respectively, agreed that there is no fixed schedule and waste is picked up only occasionally. Notably, there is inconsistence in the findings on this aspect of frequency pick-up of solid waste for disposal. The contradiction is likely attributed to the frequent change in collection time schedule as well as poor communication from SWM team.

4.3.5 Inferential Findings: Regression Coefficients.

Multiple regression was utilized to establish the strength of association between effectiveness of newly installed bins and SWM as presented in Table 4.13. R is the correlation coefficient or determination which showed the relationship between the study variables. R squared was used to show how the regression line predicts the estimates of the mean and determine distance from the actual values. In addition, R squared or the coefficient of determination explains the variation in the dependent variable resulting due to change in the dependent variables.

Table 4.13 Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
SWM (Constant)	1.052	1.733		.607	.015
Households' Bin Perception	.298	.558	.315	.053	.006
Households' Bin use Extent	.065	1.415	.050	.046	.042
Bin Proximity and Placement	.506	.770	.552	.658	.049
Waste Collection Frequency Satisfaction	.026	.466	.033	.057	.031

a. Dependent Variable: Solid Waste Management (SWM); Predicators; Households' Bin Perception, Households' Bin use Extent, Bin Proximity and Placement & Waste Collection Frequency Satisfaction Level

Source: Author (2020).

Effectiveness of newly installed bins was predicated by households' bin perception, households' bin use extent, bin proximity and placement, as well as waste collection frequency satisfaction level. The generated regression statistics demonstrate that, if the entire independent variables are held constant, then SWM in Mjini, Kariobangi and Eastleigh as well as Muthini estates in Machakos town Constituency would be 1.052. Additionally, all the predicators are positively and significantly correlated with solid waste management (p=0.015).

On the relationship between households' perception on use of bins and solid waste management (SWM), regression model displays a positive and significant relationship (β= .298, t= 053 and P value of 006). Implicitly, a unit change in households' perception on use of bins would lead to a factor change in solid waste management of Mjini, Kariobangi, Eastleigh and Muthini estates in

Machakos town constituency by a factor of 0.298 when the other variables are held to a constant zero.

Concerning the second research objective on the relationship between the extent of the use of bins by households and solid waste management (SWM), regression model displays a positive and significant relationship (β=.065, t= 046 and P value of 042). Implicitly, a unit change in the extent of the use of bins by households would lead to a factor change in solid waste management of Mjini, Kariobangi, Eastleigh and Muthini estates in Machakos town constituency by a factor of .065 when the other variables are held to a constant zero.

Further, regression coefficients document, the generated regression coefficients display a positive and significant relationship (β= .506, t= .658 and P value of .049) between proximity and placement of bins and solid waste management (SWM). Accordingly, a unit change in proximity and placement of bins would lead to a factor change in solid waste management of Mjini, Kariobangi, Eastleigh and Muthini estates in Machakos town constituency by a factor of .506 when the other variables are held to a constant zero.

Finally, on the relationship between the satisfaction level with frequency pick-ups of the bins for waste disposal and solid waste management (SWM), regression model displays a positive and significant relationship (β= .026, t= .057 and P value of 031). This means that a unit change in the satisfaction level with frequency pick-ups of the bins for waste disposal would lead to a factor change in solid waste management of Mjini, Kariobangi, Eastleigh and Muthini estates in Machakos town constituency by a factor of .026 when the other variables are held to a constant zero.

4.4 Discussion of the Findings

Descriptive and inferential findings on the effectiveness of newly installed bins and solid waste management are delineated in the context of previous studies discussed earlier in this study. Accordingly, the discussion is organized in accordance with the key study constructs evidently stated in the research objectives. Downright, the four study standpoints, households' perception on use of bins, extent of the use of bins by households, influence of proximity and placement of bins on residential, the satisfaction level with frequency pick-ups of the bins for waste disposal.

4.4.1 Households' Perception on use of Bins

On the first research construct that sought to determine the relationship between households' perception on use of bins and solid waste management, descriptive findings reported confirmed that perception had influence on households' usage of bins. On specific proxies of this objective, it was established that low awareness and knowledge influenced perception of bins, that perception of risk (health risks) was a factor in changing attitudes towards bins and that low community participation in SWM triggered negative perception of bins. In addition, overflowing, accumulated and stinking uncollected waste bins created negative perception the same way the cost of waste collection services influenced perception of bins.

Moreover, inferential findings, courtesy of regression model, presented a significant positive relationship between relationship between households' perception on use of bins and solid waste management. Barloa *et al.,* (2016) and Hansstein (2017) were in agreement with this finding that attitude and knowledge were correlated with their practices positively. Further, these reviewed studies observed that perception of risk (health risks) was a factor in changing attitudes towards bins.

Accordingly, a risk is considered greater when the hazard is involuntary and uncontrollable, not natural, and cannot be compensated for by any benefits. It further observed that citizens' attitudes to use bins were influenced not only by impacts, but also by a lack of credibility in waste managers, decision makers, decision processes, and control. Studies added the assertion that low community participation in SWM triggered negative perception of bins. Mandevere and Steven (2018) and Sukholthaman, Chanvarasuth and Sharp (2017), similarly, concurred with this finding.

4.4.2 Extent of the use of bins by Households

On the second study variable stated, descriptive findings observed that households did not take waste to newly installed bins daily besides residents not dropping garbage to the bins twice in a week. Too, households did not dispose waste to the bins on alternate days but households took garbage to bins once a week. However, some indicated that they only dropped waste on the day they were able to pay due to high. Still, it was established that households had no fixed schedule and dropped waste only sporadically. The regression model output, posted a significant positive

relationship between extent to which households dropped waste at designated collection points and solid waste management.

These findings confirm the position held by Santoso and Farizal (2019), Douti *et al.,* 2017) and Abbasi *et al.,* (2020) who reported mixed findings on the extent to which households dropped waste at designated collection points. The studies agreed that households did not take waste to newly installed bins daily, twice in a week, alternate days or once a week. More agreement was on the finding that households only dropped waste on the day they were able to pay due to high, households had no fixed schedule and dropped waste only sporadically.

4.4.3 Proximity and Placement of Bins

Further, descriptive findings on proximity and placement of bins, established that each demand point was not served by its nearest service point. Second finding reported that bins were not positioned in shortest distance and descending slope for the ease of waste carrying by cart and tricycle pullers, installing only stationary bins and excluding haul type disadvantages physically limited residents and residents dropping large waste. Also found out was the finding that the newly installed bins were too fewer to accommodate generated waste as well as newly installed bins being placed along roads accessible by pick-up trucks.

Likewise, the study established that poorly designed bins attract scavenging people, dogs, birds who pose security and health risks at collection points. Poor design which did not provide for bin fragmentation for waste separation and that unguarded bins turned into abode of scavengers who littered waste and vandalized the newly installed bins. The outcome of inferential technique of regression documented a positive and significant relationship between proximity and placement of bins and solid waste management. This finding is in line with the studies done by Towolioe (2019) as well as Starovoytova and Namango (2018) who reported that short walking distance to drop waste, descending slope, number of bins, installing more types of bins among others, had great bearing on solid waste management.

4.4.4 Satisfaction with Frequency Pick-ups of the Bins for Waste Disposal

In relation to households' level of satisfaction with frequency pick-ups of the bins for waste disposal stated as the final research variable, descriptive statistics posted low satisfaction levels among respondents. For instance, it was revealed that solid waste was not picked up daily, twice

a week nor on alternate days. Equally, emptying of bins frequency was based on the waste quantity estimate, there was no emergency pick-up of bins filled before scheduled collection time as well as no fixed schedule and that waste is picked up only occasionally. On the positive side, solid waste was collected once a week which contradicts the immediate finding. The contradiction is likely attributed to the frequent change in collection time schedule as well as poor communication from SWM team.

A positive and significant correlation between households' level of satisfaction with frequency pick-ups of the bins for waste disposal and SWM was generated by the multiple regression model of the inferential statistics. Tian *et al.*, (2019), Babaei *et al.,* (2015), Boateng, *et al.*, (2019) validated this finding by solidifying it with their findings. Indeed, these studies concur that picking of solid waste at the collection point kept changing from daily, alternate days, twice a week, once weekly, unscheduled emergency pick up to occasional. Possible reasons for such inconsistence in collection scheduling would range from poor communication, inadequate resources, breakdown of trucks to unpaid service charge from households.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Summary of the findings generated, conclusions and the recommendations, are presented in this final section of the study. Largely, intervention measures predicated on the study output, are presented for consideration by interest groups especially policy makers, professionals and practitioners. More so, future studies that can draw reference on the findings here to increase knowledge in this field.

5.2 Summary

Essentially, the study sought to determine whether newly installed bins have any effect on solid waste management in Machakos town constituency in Machakos County. Specifically, the research sought to: evaluate the effect of households' perception on use of bins, determine the effect of the extent of the use of bins by households, to establish the influence of proximity and placement of bins on residential, determine the satisfaction level with frequency pick-ups of the bins for waste disposal on solid waste management in Machakos town constituency.

On the first study variable, the study observes that low awareness and knowledge influenced perception of bins, that perception of risk (health risks) was a factor in changing attitudes towards bins and that low community participation in SWM triggered negative perception of bins. In addition, overflowing, accumulated and stinking uncollected waste bins created negative perception the same way the cost of waste collection services influenced perception of bins. A significant and positive association between the newly installed bins and solid waste management in Machakos town constituency is reported.

In regard to the second research variable, the study reported that households failed taking waste to newly installed bins daily besides residents not dropping garbage to the bins twice in a week.

Too, households did not dispose waste to the bins on alternate days but households took garbage to bins once a week. It is also established that households only dropped waste on the day they were able to pay due to high. Still, it was found out that households had no fixed schedule and dropped waste only sporadically. In answering the stated research question, the study recognized that there is a direct association linking the extent of the use of bins by households and solid waste management.

On the third study variable, it is determined that bins were not positioned in shortest distance and descending slope for the ease of waste carrying by cart and tricycle pullers, installing only stationary bins and excluding haul type disadvantages physically limited residents and residents dropping large waste. Also established is that the newly installed bins were too fewer to accommodate generated waste as well as newly installed bins being placed along roads accessible by pick-up trucks.

Likewise, the study observes that poorly designed bins attract scavenging people, dogs, birds who pose security and health risks at collection points. Poor design which did not provide for bin fragmentation for waste separation and that unguarded bins turned into abode of scavengers who littered waste and vandalized the newly installed bins. Therefore, the third research question was answered by observing that there is a positive and significant relationship between proximity and placement of bins and solid waste management.

Concerning the final research construct, it is revealed that solid waste was not picked up daily, twice a week nor on alternate days. Equally, emptying of bins frequency was based on the waste quantity estimate, there was no emergency pick-up of bins filled before scheduled collection time as well as no fixed schedule and that waste is picked up only occasionally. On the positive side, it is established that solid waste was collected once a week which contradicts the immediate finding. To respond to the research question posed, it is established that a positive and significant correlation between households' level of satisfaction with frequency pick-ups of the bins for waste disposal and SWM exists.

5.3 Conclusions

The findings of the study summarized above, evolved conclusions specified in this section of the final chapter. On the first study variable, the study concludes that low awareness and knowledge influenced perception of bins, that perception of risk (health risks) was a factor in changing

attitudes towards bins and that low community participation in SWM triggered negative perception of bins. In addition, overflowing, accumulated and stinking uncollected waste bins created negative perception the same way the cost of waste collection services influenced perception of bins. A significant and positive association between the newly installed bins and solid waste management in Machakos town constituency is concluded.

In regard to the second research variable, it is concluded that households not taking waste to newly installed bins daily besides residents not dropping garbage to the bins twice in a week. Too, households did not dispose waste to the bins on alternate days but households took garbage to bins once a week. It is also concluded that households only dropped waste on the day they were able to pay due to high. Still, it is concluded that households had no fixed schedule and dropped waste only sporadically. In answering the stated research question, the study concluded that there is a direct association linking the extent of the use of bins by households and solid waste management.

On the third study variable, it is concluded that bins were not positioned in shortest distance and descending slope for the ease of waste carrying by cart and tricycle pullers, installing only stationary bins and excluding haul type disadvantages physically limited residents and residents dropping large waste. Also concluded is that the newly installed bins were too fewer to accommodate generated waste as well as newly installed bins being placed along roads accessible by pick-up trucks.

Likewise, the study concludes that poorly designed bins attract scavenging people, dogs, birds who pose security and health risks at collection points. Poor design which did not provide for bin fragmentation for waste separation and that unguarded bins turned into abode of scavengers who littered waste and vandalized the newly installed bins. Therefore, the third research question was answered by concluding that there is a positive and significant relationship between proximity and placement of bins and solid waste management.

Concerning the final research construct, it is revealed that solid waste was not picked up daily, twice a week nor on alternate days. Equally, emptying of bins frequency was based on the waste quantity estimate, there was no emergency pick-up of bins filled before scheduled collection time as well as no fixed schedule and that waste is picked up only occasionally. On the positive side, it is concluded that solid waste was collected once a week which contradicts the immediate

finding. To respond to the research question posed, it is concluded that a positive and significant correlation between households' level of satisfaction with frequency pick-ups of the bins for waste disposal and SWM exists.

5.4 Recommendations

5.4.1 Recommendations for the Practitioners and Policy Makers

The essence of conducting this study was to fill the identified gaps by generating new empirical evidence to inform policy options to address effectiveness issues arising from newly installed waste collection bins to enhance waste management. To that, pertinent policy interventions are proposed to relevant entities. First, to change perception of household on bins usage, the study recommends that adequate and elaborate public sensitization campaigns on health risks of carelessly and illegally disposal of waste aimed at changing attitudes towards bins as well as enhancing community participation in SWM to influence positive perception of the use of bins. Also, there is need to institute a specific schedule for households to drop their waste

To increase the frequency households, dispose waste in the newly installed bins, an elaborate daily, weekly need should be designed. Moreover, this study is of the opinion adequate bins proportionate to waste generated in the estates should be positioned close to households sloping from homesteads for convenience dropping of waste. Besides, both stationery and haul types of bins be installed along roads accessible by pick-up trucks. Likewise, better designed bins having covers and fragmentation as well as instituting guarding of bins, is recommended. To increase satisfaction levels, frequency schedule of picking-up solid waste from the newly installed bins for disposal be specified on the waste quantity estimate.

5.4.2 Recommendations for Future Study

While the current study delimitated on the collection of waste in relation to effectiveness of the newly installed bins conceptually. However, the study proposes further studies on other processes of data management namely, waste separation for better treatment such as recycling and disposal mechanisms among others in the same context. Contextually, there is also need to focus on other estates outside of Mjini, Kariobangi and Eastleigh as well as Muthini. In terms of methodology, this study encourages a further study using other research designs such as case study. Likewise, adoption of both quantitative and qualitative unlike application of the former in the current study. Additionally, further study using a larger sample size than the 181 utilized in this study.

REFERENCES

Abbasi et al (2020). Development and psychometric evaluation of waste management beliefs and behaviors scale among female students in Isfahan University of Medical Sciences, Iran. *Environmental Health and Preventive Medicine*, *25*(12), 1-12.

Abd El-Salam, M.M., & Abu-Zuid G.I. (2015). Impact of landfill leachate on the groundwater quality: A case study in Egypt. *J. Adv. Res. 6*, 579–586.

Abebe, M. A. (2018). Practice of Waste Payment Collection from Public and the Improving of Its Challenges. *Journal of Waste Recycling*, *3*(2), 10.

Aderoju, O.M., Dias, G.A., & Gonçalves, A.J. (2018). A GIS-based analysis for sanitary landfill sites in Abuja, Nigeria. *Environmental Development Sustainability*, 1–24.

Ali, M., Wang, W., Chaudhry, N., & Geng, Y. (2017). Hospital waste management in developing countries: A mini review. *Waste Manag. Res. 35*, 581–592.

Amasuomo, E., Tuoyo, O. J. A., & Hasnain, S. A. (2015). Analysis of public participation in sustainable waste management practice in Abuja, Nigeria. *Environmental Management and Sustainable Development*, *4*(1), 180.

Anwar, J., Habib, A., Haslenda, H., Saeed, A., & Ramli, M. (2014). Municipal solid waste management and potential revenue from recycling in Malaysia. *Modern Appl. Sci. 8*(4), 37-49.

Awuah, K.G.B. (2018). The Role of Urban Planning in Sub-Saharan Africa Urban Pollution Management. Urban Pollut: *Sci Manag*. 385–395.

Babaei, A. A., Alavi, N., Goudarzi, G., Teymouri, P., Ahmadi, K., & Rafiee, M. (2015). Household recycling knowledge, attitudes and practices towards solid waste management. *Resources, Conservation and Recycling, 102*, 94-100.

Barabad, M.L.M., Jung, W., Versoza, M.E., Lee, Y.I., Choi, K., & Park, D. (2018). Characteristics of particulate matter and volatile organic compound emissions from the combustion of waste vinyl. *Int. J. Environ. Res. Public Health*, *15*, 1390.

Barloa, E. P., Lapie, L. P. & de la Cruz, C. P. P., (2016). Knowledge, attitudes, and practices on solid waste management among undergraduate students in a Philippine state university. *Journal of Environment and Earth Science, 6*(6), 146-53.

Bezama, A., & Agamuthu, P. (2019). Addressing the big issues in waste management. SAGE Publications, Sage UK; London, England.

Boateng, et al (2019). Household willingness to pay for improved solid waste management services in four major metropolitan cities in Ghana. *Journal of Environmental and Public Health*, 1- 9.

Brothers, K. J., Krantz, P. J., Dorothea, C. & Jeniffer, N. F. (1994). Effects of number and location of bins on plastic recycling. *Journal of Applied Behaviour Analysis,* 43, 711-715.

Carvalho, F.M., Tavares, T.M., & Lins, L. (2018). Soil contamination by a lead smelter in Brazil in the view of the local residents. *Int. J. Environ. Res. Public Health*, *15*, 2166.

Chen Y.C. (2018). Effects of urbanization on municipal solid waste composition. *Waste Manag*. 79, 828–836.

Choon, S. W., Tan, S. H., & Chong, L. L. (2017). The perception of households about solid waste management issues in Malaysia. *Environment Development and Sustainability*, 19, 1685-1700.

Douti, N. B., Abanyie, S. K. & Ampofo, S. (2017). Solid waste management. Challenges in urban areas of Ghana: A Case Study of Bawku Municipality. *International Journal of Geosciences, 8(*4), 494-513.

Eboso, S. M. (2016). Factors influencing recycling of solid waste in Machakos County. *Water and Environment Journal*, *25*(4), 504-512.

Echegaray, F., & Hansstein, F. V. (2017). Assessing the intention-behavior gap in electronic waste recycling: the case of Brazil. J Cleaner Prod. 142:180–90.

Eurostat (2017). Waste statistics. Statistical Office of the European Union 2017. Production and treatment of municipal waste in the EU (in kg per person).

Fahim, R. El-Gazzer, R., & Elgohary, M. (2017). Understanding the Dilemma of the Municipal Solid Waste Management System in Alexandria, Egypt.

Ferronato, N., Rada, E.C., Gorritty, Portillo, M.A., Cioca, L.I., Ragazzi, M., Torretta, V. (2019). Introduction of the circular economy within developing regions: A comparative analysis of advantages and opportunities for waste valorization. *J. Environ. Manag*. 230, 366–378.

Ferronato, N., Torretta, V., Ragazzi, M., & Rada, E.C. (2017). Waste mismanagement in developing countries: A case study of environmental contamination. *UPB Sci. Bull. Ser. D Mech. Eng. 79*, 185–196.

Fiksel, J., & Lal, R. (2018). Transforming waste into resources for the Indian economy. *Environ. Dev.*, *26*, 123–128.

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., & Hultink, E.J. (2016). The Circular Economy—A new sustainability paradigm? *J. Clean. Prod.*143, 757–768.

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., & Hultink, E.J. (2017). The Circular Economy—A new sustainability paradigm? *J. Clean. Prod. 143*, 757–768.

Ghisolfi, V., Chaves, G.D.L.D., Siman, R.R., & Xavier, L. H. (2017). System dynamics applied to closed loop supply chains of desktops and laptops in Brazil: A perspective for social inclusion of waste pickers. *Waste Manag. 60*, 14–31.

Gillespie, A. (2017). The long road to sustainability: The past, present, and future of international environmental law and policy. Oxford, U.K.: Oxford University Press.

Godfrey, L., & Oelofse, S. (2017). Historical review of waste management and recycling in South Africa. *In Resources, 6*(57).

Hassan et al. (2018). Assessment of beneficiary satisfaction with community based solid waste management service. A case of Okoa Maisha project in Mnarani Village, Kilifi County, Kenya. *Internal Journal of Scientific Research and Management, 6*(3).

Hettiarachchi, H., Meegoda, J.N., & Ryu, S. (2018). Organic Waste Buyback as a Viable Method to Enhance Sustainable Municipal Solid Waste Management in Developing Countries. *Int. J. Environ. Res. Public Health, 15*, 2483.

Ihedioha, J.N., Ukoha, P.O., & Ekere, N.R. (2017). Ecological and human health risk assessment of heavy metal contamination in soil of a municipal solid waste dump in Uyo, Nigeria. *Environ. Geochem. Health, 39*, 497–515.

Ikhlayel, M. (2018). An integrated approach to establish e-waste management systems for developing countries. *Clean. Prod. 170*, 119–130.

Kaza, S., Yao, L. C., Bhada-T. P., & Van Woerden, F. (2018). *What a Waste 2.0:* A Global Snapshot of Solid Waste Management to 2050. Urban Development. Washington, DC: World Bank.

Kiio, P. M., & Nyang'au, P. S. (2019). Determinants of implementation of asbestos waste disposal projects in Machakos County, Kenya. *International Journal of Entrepreneurship and Project Management, 4*(2), 104-121.

Kilonzo, P. (2019, September 29). Punish violators; Machakos cleans up solid waste in town; Government warns against illegal dumping on roadsides, near river: The Star; 5

KNBS (2019). *KNBS* Census, Kenya National Bureau of Statistics, Nairobi.

Kolekara, K. A., Hazrab, T., & Chakrabartyc, S. N. (2016). A review on prediction of municipal solid waste generation models. Intl Conf. on solid waste Manage. *Procedia Environ. Sci.* 35, 238-244.

Krejcie, R.V., & Morgan, D.W., (1970). Determining sample size for research activities. Educational and psychological measurement.

Kumar, A., Holuszko, M., & Espinosa, D.C.R. (2017). E-waste: An overview on generation, collection, legislation and recycling practices. *Resour. Conserv. Recycl, 122*, 32–42.

Kumar, A., Samadder, S.R., Kumar, N., & Singh, C. (2018). Estimation of the generation rate of different types of plastic wastes and possible revenue recovery from informal recycling. *Waste Manag. 79*, 781–790.

Lagerkvist, A., & Dahlén, L. (2019). *Recovery of Materials and Energy from urban wastes*: A Volume in the Encyclopedia of Sustainability Science and Technology. second ed. Solid waste generation and characterization; 7–20.

Leeabai, N., Suzuki, S., Jiang, Q., Dilixiati, D., &Takahashi, F. (2019). The effects of setting conditions of trash bins on waste collection performance and waste separation behaviors; Distance from walking path, separated setting, and arrangements. *Waste Management*. 94, 58–67.

Letcher, T.M., Vallero, D.A., editors. (2019). Waste: A handbook for management. Academic Press;

Lloyd, J.S. (2019). Expanding safe waste management to public health systems. *The Lancet*. 393:225.

Mandevere, B., & Steven, J. (2018). Household solid waste management: How effective are the strategies used in Harare Zimbabwe? *Journal of Environmental Waste Management and Recycling. 2*(1), 6-22.

Manga, V. E., Oru, T. O., & Ngwabie, M. N. (2019). Household perception and willingness to pay for improved waste management service in Mamfe, Cameroon. *African Journal of Environmental Science and Technology*, *13*(9), 354-364.

McAllister, J. (2015). *Factors influencing solid-waste management in the developing world*. (Unpublished master's thesis). Utah State University, Iran.

Mecheo, O. N., Omondi, P. & Abdirizak, N. (2019). Nature and collection systems of domestic solid wastes in Kisii Town, Kenya. *World Environment Journal.*

Media Congo. (2017). Insalubrity in Kinshasa: The mountains of filth, source of various infections. Rubrique health published.

Ministry of Environment and UNDP (2018). A Circular Economy Solid Waste Management Approach for Urban Areas in Kenya. P. 28.

Modak, P., Wilson, D.C., & Velis, C. (2018). Waste management: Global status. In *Global Waste Management Outlook*; UNEP: Athens, Greece, pp. 51–79.

Mohammed, A., & Elias, E. (2017). Domestic solid waste management & its environmental impacts in Addis Ababa City. *Journal of Environment & Waste Management*, *4*(1), 194-203.

Mutua, J. K. M., Jones F. Agwata, J. F., & Anyango, S. (2017). Effectiveness of sanitation policy instruments in Mavoko Municipality of Machakos County, Kenya. *Cogent Environmental Science*, *3*(1).

Ndonye, C. M. (2018). *Role of stakeholders in successful solid waste management in Machakos County*. (Unpublished master's thesis). KCA University, Nairobi, Kenya.

NEMA (National Environment Management Authority) (2018). National Solid Waste Management Strategy.

Nyampundu, K., Mwegoha, W. J. S. & Millanzi, W.C. (2020). Sustainable solid waste management Measures in Tanzania: An exploratory descriptive case study among vendors at Majengo market in Dodoma City. *BMC Public Health 20*, 1075.

OECD (Organisation for Economic Co-operation and Development). (2017). Municipal Waste (Indicator). OECD Data, OECD, Paris.

Oelofse, S. H., Nahman, A., & Godfrey, L. K. (2018). United Nations Environment Programme; Waste as Resource: Unlocking Opportunities for Africa.

Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular economy. *J. Clean. Prod. 179*, 605–615.

Reike, D., Vermeulen, W. J. V., & Witjes, S. (2018). The circular economy: New or Refurbished as CE 3.0? —Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options. *Resour. Conserv. Recycl*, *135*, 246–264.

Reyna-Bensusan, N., Wilson, D. C., & Smith, S. R. (2018). Uncontrolled burning of solid waste by households in Mexico is a significant contributor to climate change in the country. *Environ. Res*.

Reyna-Bensusan, N., Wilson, D.C., & Smith, S.R. (2018). Uncontrolled burning of solid waste by households in Mexico is a significant contributor to climate change in the country. *Environ. Res. 163*, 280–288.

Romallosa, A., & Kraft, E. (2017)**.** Feasibility of biomass briquette production from municipal waste streams by integrating the informal sector in the Philippines. *Resources*, *6*, 12.

Santoso & Farizal. (2019). Community participation in household waste management: An Exploratory Study in Indonesia. E3S Web of Conferences 125*ICENIS*

Silva, F. C., Shibao, F. Y., Kruglianskas, I., Barbieri, J. C. & Sinisgalli, P. A. (2019). Circular economy: Analysis of the implementation of practices in the Brazilian network. *Revista de Gestao*, *26*(1), 39-60.

Singh, M., Thind, P.S., & John, S. (2018). Health risk assessment of the workers exposed to the heavy metals in e-waste recycling sites of Chandigarh and Ludhiana, Punjab, India. *Chemosphere*, *203*, 426–433.

Starovoytova, D., & Namango, S. (2018). Solid waste management at university campus (Part 4/10): Perceptions, Attitudes, and Practices of students and vendors.

Steuer, B., Ramusch, R., & Salhofer, S.P. (2018). Can Beijing's informal waste recycling sector survive amidst worsening circumstances? *Resour. Conserv. Recycl*, *128*, 59–68.

Suave, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development & circular economy*:* Alternative Concepts for Trans-disciplinary Research. *Environmental Development*, (17), 48-56.

Sukholthaman, P., Chanvarasuth, P., & A. Sharp, A. (2017). Analysis of waste generation variables and people's attitudes towards waste management system: A case of Bangkok, *Thailand Journal Mater Cycles Waste*, *(19)*, 645-656.

Tian et al (2019). Consumer's waste classification intention in China: An extended theory of planned behavior model. *Sustainability*, 11, 1-16.

Torretta, V., Ferronato, N., Katsoyiannis, I.A., Tolkou, A.K., & Airoldi, M. (2017). Novel and conventional technologies for landfill leachates treatment: A review. *Sustain*, *9*, 9.

UN. (2018). *The Sustainable Development Goals Report*; UN: New York, NY, USA.

UNECE (United Nations Economic Commission for Europe). (2017). Environmental Performance Reviews Series No. 46: Tajikistan. UNECE, New York

United Nations (2020). Sustainable Development Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable. Geneva: United Nations.

Vaccari, M., Vinti, G., & Tudor, T. (2018). An Analysis of the Risk Posed by Leachate from Dumpsites in Developing Countries. *Environments, 5*, 99.

Van der Werf, P., Seabrook, J. & Gilliland, J. A. (2018). The food waste in the garbage stream of South Ontario, Canada households. *PLOS one Journal,* (13)13, 6.

Van der Werf, P., Seabrook, J. & Gilliland, J. A. (2018). The food waste in the garbage stream. *Journal of Environment and Earth Science, 8*(7).

World Health Organization (2020). Water, sanitation, hygiene, and waste management for the COVID-19 virus: Interim guidance, Geneva: World Health Organization.

Yang, H., Xia, J., Thompson, J.R., & Flower, R.J. (2017). Urban construction and demolition waste and landfill failure in Shenzhen, China. *Waste Manag. 63*, 393–396.

Yilmaz, O., Kara, B.Y., & Yetis, U. (2017). Hazardous waste management system design under population and environmental impact considerations. *J. Environ. Manag. 203*, 720–731.

Yusuf, A. A., & Inambao, F. L. (2019). *Effects of Cold Start Emissions from Gasoline-fueled engines of light-duty vehicles at low & high ambient temperatures: Recent trends. Case Study. Therm Eng*, (14)100417.

APPENDICES

Appendix I: Introduction Letter

Dear respondent

I am a Masters student at St Paul's University – Machakos Campus. My area of specialization is Community Development.

I am carrying out a research study on the effectiveness of the newly installed solid waste bins in Machakos county and specifically, Machakos town. The information that will be provided in this questionnaire will be highly protected and no one should imagine he or she will be victimized or otherwise. I urge you to cooperate as the information that you provide is part of my requirement for the award of my Masters in Community Development.

Fill free to fill the questionnaires below as I am humbled to have you as part of my team.

Thanks.

Appendix II. Questionnaire

Kindly fill this questionnaire as openly and honestly as possible. This research instrument is designed to solicit for empirical data for the conduct of academic exercise as a semi-requirement for the award of a Master of Development Studies (MDS), St. Paul's University. Please provide the following information as required. Any information, opinion and views provided in this questionnaire will be treated with strict confidentiality and will be used for the purposes of this study only. You are humbly requested not to mention your name or any information anywhere that might reveal your identity. In case you encounter any difficult in the course of filling in this questionnaire, to not hesitate to contact the researcher on cell no +---------- for an instant clarification. Answer all the questions by marking in the appropriate box using a tick (√) or X in the spaces provided.

Section A: Demographic Information

	Variable	**Response**	**Comment/further information**
Gender of respondent	**1.**Male		
	2.Female		
Age of respondent (years)	**1.**25 & Below		
	2.26-35 Years		
	3.36-45 Years		
	4.46 & above		
Education level of respondent	**1.** Secondary & below		
	2. TEVs		
	3. Bachelor's Degree		
	4. Post-graduate		
Family size	**1.** One & below		
	2. Between 2-4		
	3. Between 5-7		
	4. Between 8-10		
	5. Over 10		
Weekly waste generation (kg/house)	**1**. Below 1kg		
	2. Between 1-3kg		
	3. Between 4-6kg		
	4. Between 5-7kg		
	5. Between 7-10		
	6. Over 10kg		
Estate of current residence	**1.** Mjini		
	2. Kariobangi		
	3. Eastleigh		
	4. Muthini		
Distance to the newly installed bins	1. Below 50 meters		
	2. Between 60-100 meters		
	3. Between 110-150 meters		
	4. Over 150 meters		

Section B: Households' Perception on use of bins

To what extent do you agree with the following household's perception statements on use of newly installed bins in your estate? In rating the statements below, indicate your response based on a 5-point scale where: 1= Strongly Agree; 2=Agree; 3= Uncertain; 4= Disagree and 5=Strongly Disagree; (Use a tick (√) to mark the applicable box).

	Variable	**1**	**2**	**3**	**4**	**5**
1	Low awareness and knowledge influence perception of bins					
2	Perception of risk (health risks) is a factor in changing attitudes towards bins					
3	Low community participation in SWM trigger negative perception of bins					
4	Overflowing, accumulated and stinking uncollected waste bins create negative perception					
5	Cost of waste collection services influence perception of bins					

Section C: Extent of the use of bins by households

To what extents do you agree with the following statements on the extent of the use of bins in your estate? In rating the statements below, indicate your response based on a 5-point scale where: 1= Strongly Agree; 2=Agree; 3= Uncertain; 4= Disagree and 5=Strongly Disagree; (Use a tick (√) to mark the applicable box).

	Variable	**1**	**2**	**3**	**4**	**5**
1	Households take waste to newly installed bins daily					
2	Residents drop garbage to the bins twice in a week					
3	Households dispose waste to the bins on alternate days					
4	Households take garbage to bins once a week					
5	Households only drop waste on the day they are able to pay due to high					
6	Households have no fixed schedule and drop waste only sporadically					

Section D: Proximity and Placement of Bins

Kindly rate your level of agreement with the following influence of proximity and placement of bins on residential use in your estate? In rating the statements below, indicate your response based on a 5-point scale where: 1= Strongly Agree; 2=Agree; 3= Uncertain; 4= Disagree and 5=Strongly Disagree; (Use a tick (√) to mark the applicable box).

	Variable	**1**	**2**	**3**	**4**	**5**
1	Each demand point is served by its nearest service point					
2	Bins are positioned in shortest distance and descending slope for the ease of waste carrying by cart and tricycle pullers					

3	Installing only stationary bins and excluding haul type disadvantages physically limited residents and residents dropping large waste					
4	Installed bins are too fewer to accommodate generated waste					
5	Ensure that bins are placed along roads accessible by pick-up trucks					
6	Poorly designed bins attract scavenging people, dogs, birds who pose security and health risks at collection points					
7	Poor design does not provide for bin fragmentation to waste separation					
8	Unguarded bins turn into abode of scavengers who litter waste and vandalize the bins					

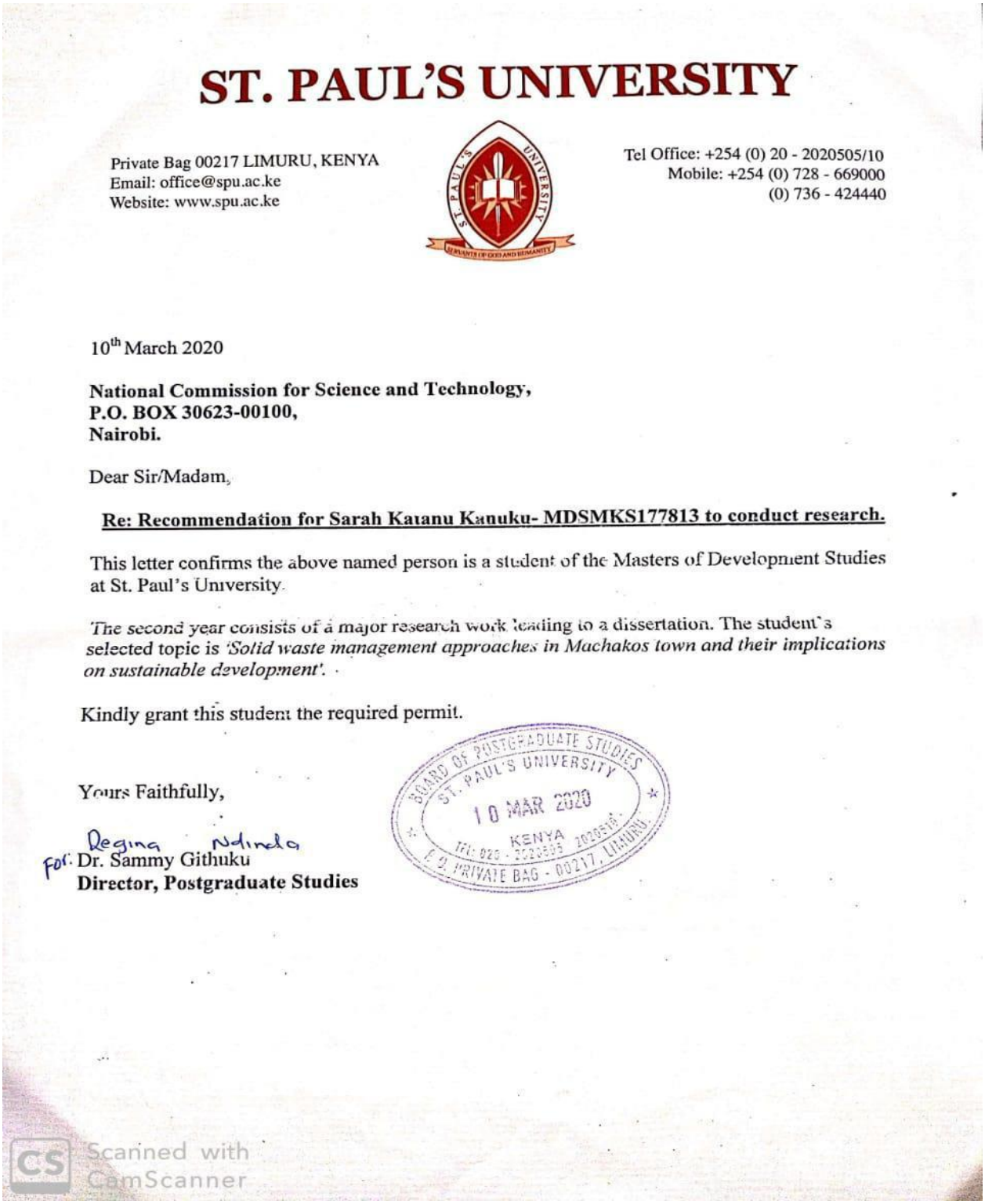
Section E: Satisfaction with frequency pick-ups of the bins for waste disposal

Kindly indicate your satisfaction level with the following indicators of frequency pick-ups of the bins for waste disposal in your estate. In rating the statements below, indicate your response based on a 5-point scale where: 1= Very Satisfied; 2= Satisfied; 3= Somewhat Satisfied; 4= Dissatisfied and 5= Very Dissatisfied; (Use a tick (√) to mark the applicable box).

	Variable	**1**	**2**	**3**	**4**	**5**
1	Solid waste is picked up daily					
2	Newly installed bins are emptied twice a week					
3	Collected waste is picked up on alternate days					
4	Solid waste is collected once a week					
5	Emptying of bins frequency is based on the waste quantity estimate					
6	There is emergency pick-up of bins filled before scheduled collection time					
7	The waste collection schedule is designed as per household need					
8	There is no fixed schedule and waste is picked up only occasionally					

Thank you for taking time to respond.

Appendix III: Research Recommendation Letter



ST. PAUL'S UNIVERSITY

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10th March 2020

National Commission for Science and Technology,
P.O. BOX 30623-00100,
Nairobi.

Dear Sir/Madam,

Re: Recommendation for Sarah Kaianu Kanuku- MDSMKS177813 to conduct research.

This letter confirms the above named person is a student of the Masters of Development Studies at St. Paul's University.

The second year consists of a major research work leading to a dissertation. The student's selected topic is *'Solid waste management approaches in Machakos town and their implications on sustainable development'.*

Kindly grant this student the required permit.

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Yours Faithfully,

Regina Ndinda
For: Dr. Sammy Githuku
Director, Postgraduate Studies

Scanned with CamScanner

Appendix IV: Research License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **245216** Date of Issue: **13/April/2020**

RESEARCH LICENSE



This is to Certify that Ms.. SARAH KATANU KANUKU of St. Paul's University, has been licensed to conduct research in Machakos on the topic: EFFECTIVENESS OF NEWLY INSTALLED WASTE COLLECTION BINS IN MANAGING SOLID WASTER IN MACHAKOS TOWN - KENYA for the period ending : 13/April/2021.

License No: **NACOSTI/P/20/4793**

245216

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code

Appendix V: Sample of installed bins in Machakos County



Appendix VI: A map of Machakos County (Comprehensive Secondary School Atlas 2017)

