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Formalization of Informal Waste Pickers for Sustainable Solid Waste Management in Mombasa County, Kenya

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Abstract

Kenya's Sustainable Waste Management Policy (2021) envisions a transition toward a circular economy and the adoption of a zero-waste principle to achieve long-term sustainability in the waste management sector. A key strategy within this framework is the formalization of the informal waste sector, particularly waste pickers who collect and sort recyclable materials as a means of livelihood. However, limited empirical data exists on the socio-economic characteristics, challenges, and integration potential of these workers. This study, based at Mwakirunge dumpsite in Mombasa County, examined these aspects to inform inclusive waste governance and support sustainable waste management policy implementation.

A descriptive cross-sectional survey using explanatory mixed methods was conducted in the months of August 2024 and February 2025. Quantitative data were collected from 157 randomly selected waste pickers through structured questionnaires, while qualitative data were collected through focus group discussions with waste pickers, and key informant interviews with the municipality officials and itinerant waste buyers.

The average age of respondents was 36 years, males comprised 59%. Mean years of experience was 10, primarily due to lack of alternative employment (80.77%). The majority lacked formal education (38.22%) and earned less than $4 per day (41.40%). Satisfaction with working conditions was low, with frequent exposure to hazards like airborne pollutants (mean=4.87) and sharp objects (mean=4.89). Tiredness (75%) and occasional diarrhoea (73.72%) were common health issues. Socially, most felt insecure (69.87%), unsupported by the municipality (69.23%), stigmatized (58.97%) and faced violence (52.26%). Economically, they lack cleaning facilities (87.18%), face competition (78.21%), and possess limited pricing control (56.41%). Despite the majority (91.7%) knowing the benefits of using personal protective equipment, almost 70% never used them always. This study found out that majority (91%) expressed readiness to be formalized, with the expectations of increased income (91.1%) and improved working conditions (72.3%). Lack of identification cards by waste pickers was identified as a key barrier to beginning any formalization process. Those who were hesitant (9%) said that they preferred working alone (42.86%).

The findings of this study provide a strong empirical basis for initiating inclusive formalization efforts as part of broader waste management reforms in the county of Mombasa and Kenya as a whole.

Keywords: Formalization, Sustainable Solid Waste Management, Informal Waste Pickers, Mwakirunge Dumpsite, Mombasa

CHAPTER 1: INTRODUCTION

1.1 Background

The rapid pace of urbanization especially in Africa has contributed to a sharp rise in waste generation, largely driven by increasing urban consumption patterns [1]. According to the World Bank report (2018), global waste is projected to grow by more than 70% from 2020 levels to approximately 4 billion tonnes by 2050 [2, 3, 4]. This surge in waste poses serious challenges for both developed and developing nations, with cities in the developing countries particularly affected most due to limited resources, strained waste management systems, and inadequate landfill capacities [5]. Inefficient waste management often leads to the accumulation of uncollected waste, illegal dumping, and the open burning of refuse [3, 4]. These practices are often associated with negative impacts on the environment through constant emission of greenhouse gases and other toxins that severely impact human health as well as contributing to negative climate changes [6].

Many economies have started to shift towards circular economy (CE), which emphasizes reducing resource consumption, repairing products and material recycling in the efforts to protect and preserve the environment [7]. To achieve this, developed countries like Europe, Japan and United States are already using strategies that emphasize on turning waste into resources, sound waste material cycle society and sustainable material management, respectively [8, 9, 10]. However, developing countries continue to face challenges with sustainable waste management due to incapabilities of the sectors involved, both formal and informal [11, 12]. This has led to the emergence and dominance of informal waste sectors especially the waste pickers taking over most of the waste collection and recovery activities in these regions [11, 13, 14].

Informal waste pickers' involvement in waste management is very critical yet their roles in addressing the challenges of waste management are often overlooked [15]. Globally, millions of people engage in waste picking and recycling activities, recovering valuable materials such as plastics, metals, paper, and clothes from streets, landfills and dumpsites with the main aim of earning a living [16, 17, 18]. Their involvement helps in waste reduction, resource recovery, and environmental protection, while operating without recognition or support from formal systems [15].

An informal economy monitoring study (IEMS) in 2013 reported that waste pickers actually know their importance in waste management chain [19]. Nevertheless, waste pickers often work in precarious conditions, face social exclusion and harassment, and lack access to health, legal, and economic protections [17]. The fact that their activities in waste management remain unregulated leaves them vulnerable to exploitation by intermediaries or itinerant waste buyers who broker deals with recycling companies [20, 21]. Their association with waste and the poor conditions they work in often lead to social exclusion and stigma [11, 15, 20, 21]. As a result, they face significant health risks, including respiratory problems, muscle-related injuries, and digestive illnesses caused by continuous exposure to harmful substances and hazardous waste [11, 20].

Studies have revealed diverse sociodemographic and economic characteristics and factors to waste picking in different regions in terms of age, education level, marital status, poverty levels among others [14, 22, 23, 24, 25, 26, 27, 28]. A global review of human waste picking by Morais et al (2022) cited that waste pickers are generally faced with stigma from social exclusion, poor working and living conditions due to increased exposure to health and safety risks, poverty among others [17].

As the shift towards a circular economy gains global attention, the idea of integrating informal waste pickers (IWPs) into formal systems has become increasingly prominent in developing countries. This formalization is seen as a means to improve their living and working conditions, boost waste management effectiveness, and foster greater social inclusion [29, 30, 31].

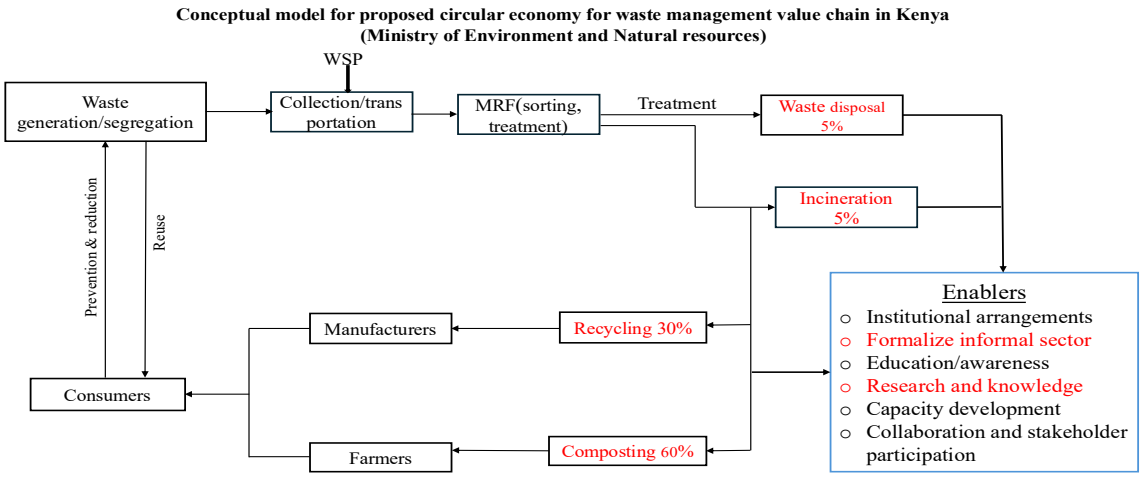
Case studies from Asia and Latin America show that formalizing waste pickers improves their working conditions and recognition, while also enhancing the efficiency and sustainability of waste management in line with circular economy goals [11]. For instance, over 90% of e-waste in India is recycled by the informal sector [32], and similar trends are noted in China [33] and Brazil [34].

These successes have informed global advocacy for the formalization of informal waste sectors which has been viewed as a pathway to achieving Sustainable Development Goals (SDGs) related to health, decent work, urban sustainability, and environmental protection [16, 35]. Contrastingly, the concept of formalization of informal waste pickers remains underexplored in the continent of Africa, Kenya included. As such, waste pickers in these regions experience rejections and harassments and work without any recognition as an important stakeholder in the waste management systems [18].

1.2 Scope of the study

Kenya's Sustainable Waste Management Policy of 2022 (figure 1) sets out a transformative vision for the country's waste sector by promoting the transition to a circular economy and the implementation of a zero-waste principle. A central pillar of this policy is the formalization of the informal waste sector, which comprises a significant number of individuals mainly waste pickers who rely on collecting and selling recyclable materials for survival. Despite their essential contribution to resource recovery and landfill diversion in Kenya, informal waste pickers are frequently excluded from official waste management frameworks and policies.

Figure 1: National Sustainable Waste management Policy in Kenya, 2021 (NEMA, 2021).



Existing literature in the Kenyan context remains limited regarding the characteristics of waste pickers, the occupational and social challenges they face, and their readiness to be formalized or integrated into

municipal systems. This study focused on Mwakirunge dumpsite in Mombasa County, Kenya's second-largest city and a regional hub for urban migration and waste generation. By examining the demographic profiles, working conditions, and attitudes of waste pickers toward formalization, the study sought to fill a critical knowledge gap. The findings are intended to inform the design of inclusive, socially just, and environmentally sustainable waste management strategies that align with Kenya's national policy framework and international commitments, including Sustainable Development Goals (SDGs) 3 (health), 8 (decent work and economic growth), 11 (sustainable cities and communities), and 13 (climate action) among others. The research specifically sought to answer the following questions:

1. What are the sociodemographic characteristics of informal waste pickers at Mwakirunge dumpsite?
2. What are the perceptions and attitudes of waste pickers at Mwakirunge dumpsite towards the challenges they face?
3. Are they willing to be formalized?

CHAPTER 2: LITERATURE REVIEW

2.1 Background

Waste refers to materials and substances produced because of human daily production and consumption activities, which usually undergo processes like resource recovery, recycling, reclamation or even direct reuse [37]. Generally, something is regarded as a waste when it has no more value to the individual user (38). Municipal Solid Waste (MSW) refers to different types of wastes generated from different sources like households, public spaces, streets, shops, offices, hospitals among others [4, 37]. Municipal Solid Waste Management (MSWM) refers to the implementation of the functional elements of solid waste management which includes the collection, transportation, treatment, and disposal of MSW. It incorporates both formal actors (such as municipal authorities and private companies) and informal sectors (like waste pickers) in managing these functional elements [37]. The effective implementation of MSWM is vital for public health, environmental sustainability, and supports the transition toward a circular economy through practices like waste prevention and recycling [38].

According to Seadon (2010), sustainable waste management refers to a structured and adaptive system of handling waste that is environmentally sound, economically feasible, and socially inclusive. Such systems are designed to respond to changing conditions and incorporate strategies that emphasize minimizing wastes sent to landfills by promoting reduction, reuse, recycling, and recovery [39]. In the urban contexts of developing countries, where informal waste pickers contribute significantly to waste recovery and material circulation, integrating them into formal waste systems is vital to realize waste management sustainability. Sustainable waste management not only supports the transition to a circular economy but also contributes to climate change mitigation by reducing greenhouse gas emissions associated with poor disposal practices [39]. Moreover, it aligns with global sustainability goals, particularly Sustainable Development Goal 11 on sustainable cities and communities, and SDG 13 on climate action, by fostering inclusive, low-carbon, and resilient urban waste systems [3].

Solid waste management systems in developed countries have undergone significant transformation, emphasizing four key pillars: transitioning from landfilling to material recycling and energy recovery, enforcing stricter environmental regulations for waste treatment facilities, shifting public perceptions around improper disposal practices, and implementing policy reforms such as the "polluter pays" principle [38]. For instance, in Europe, recycling is the dominant strategy, while in the United States, both recycling and energy recovery are widely practiced [38]. In Japan, according to Japan Environmental Agency report

(2022), more than 70% of solid waste is incinerated, about 6% is landfilled, and the remainder is recycled supported by well-established source separation at the household level [3].

In developing countries however, the management of solid wastes is highly unsatisfactory in regards to public health and environmental protection [38]. Poor management of MSW has led to increased scenarios of open dumping and open burning of wastes whose impacts include visual challenges, bad smell and flies, greenhouse gas emissions, soil and air contamination, water pollution, marine litter and spread of vector-borne infectious diseases to humans [41].

The effective waste management is a key component of sustainable development, as it contributes significantly to mitigating the effects of climate change and promoting socio-economic sustainability [42]. Increasingly, countries around the world are adopting circular economy principles, which aim to achieve economic efficiency and growth while minimizing environmental degradation and externalities [43]. As noted by Gall et al., (2020), the circular economy is a model that counters the traditional 'end-of-life' approach by promoting responsible consumption and innovative business strategies. It emphasizes minimizing waste through reduction, reuse, recycling, and recovery practices [44].

The connection between waste management and climate change is also critically important, as each influences the other in various ways [45]. Ineffective solid waste practices have been linked to increased emissions of greenhouse gases (GHGs), such as methane and carbon dioxide, which contribute to ozone layer depletion and exacerbate global warming. These pose threats to the environment and the health of the population [46]. Evidence also suggests that poor waste management undermines global climate change mitigation efforts [47]. At the same time, the consequences of climate change such as flooding, wildfires, and other natural disasters can disrupt waste management infrastructure and operations, further affecting the efficiency of waste management systems [45].

2.2 Waste Management in Kenya

Waste management has become increasingly important in Kenya due to rapid urbanization and population growth. This is particular in major cities that continue to struggle with open dumping and burning, highlighting the need for urgent and effective interventions [36]. According to a report by Society for International Development, the vision 2030 aims is to make the country become a middle-class by 2030 with strategies to enhance industrial development and the improvement of the citizens' livelihoods [48]. While waste management remains critical as one of the strategies to achieve this [49], it continues to be a major challenge for county governments in Kenya. Open dumping in the streets and undesignated dumpsites, open burning in dumpsites and uncollected garbage are common, particularly in urban areas and has led to serious social, economic, and environmental issues including flooding (Kerarapon and Ngong, 2018).

Benard (2024) highlighted that Kenya has more than 75 statutes governing environmental management and conservation [51] which are mostly sector-specific including public health, soil and water conservation, air quality, noise control, and land use. Heragu et al., 2017, pointed out that factors such as inadequate political support, incapabilities by the county governments in effectively managing wastes, inadequate planning and poor management structures have for long been attributed to the ineffective waste management in Kenya [52]. In that study, Heragu et al., 2017 further noted that action plans at the Kenyan county levels are poor such that even if waste management targets are addressed at the national level, there is no concrete plan on how to secure the budget for waste management in the counties. The priority policies of political leaders change with each election, and corruption also hinders the effectiveness of the waste management plans and policies developed [52].

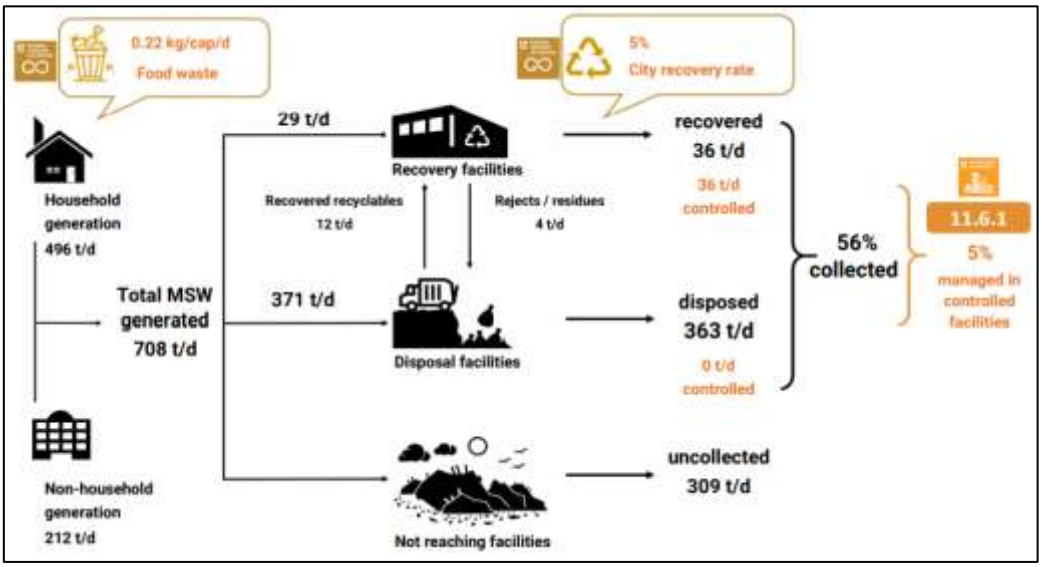
Currently, the Sustainable Waste Management Act enacted in 2021 clarifies the role of all the stakeholders in waste management including the central government, the county governments, the private sector, and citizens in achieving a circular economy in Kenya [36]. The act also advocates for the closure of open dumping sites to enable transition to sanitary landfilling. In addition, the current solid waste management policy requires that 90% of wastes generated in major urban cities is recovered (30% recycling and 60% composting) while half of the remaining wastes is landfilled and the rest incinerated. This policy has highlighted strategies for achieving these targets among them including formalization of informal waste sector (see figure 1).

Informal waste collectors operate in urban areas, often working in informal settlements or marginalized communities or rather the dumpsites. These workers collect recyclables such as plastic, glass, metal, and paper from households, streets, and landfills. While the formal waste management sector in Kenya primarily focuses on the collection and disposal of household waste, informal waste collectors focus on the recovery of reusable materials that can be recycled or sold.

2.3 Waste Management in Mombasa County

With approximately 1.3 million population [52], the management of municipal solid waste has remained a big challenge in Mombasa County for decades (Mombasa, 2019). Slightly more than 700 tonnes of municipal solid wastes are generated daily in Mombasa (0.59/cap/day), with a collection rate of less than 60%, which is lower compared to the developed countries that average more than 80% waste collection rates; and a recycling rate of less than 10% [4, 38]. The inevitability of future increased waste generation rates is predictable due to rapid population growth and increased urbanization emanating from tourism and port activities in the county (Mombasa County SWM, 2019). Figure 2 below is an illustration of waste flow in Mombasa County, Kenya.

Figure 2: Waste Flow in Mombasa County (4)



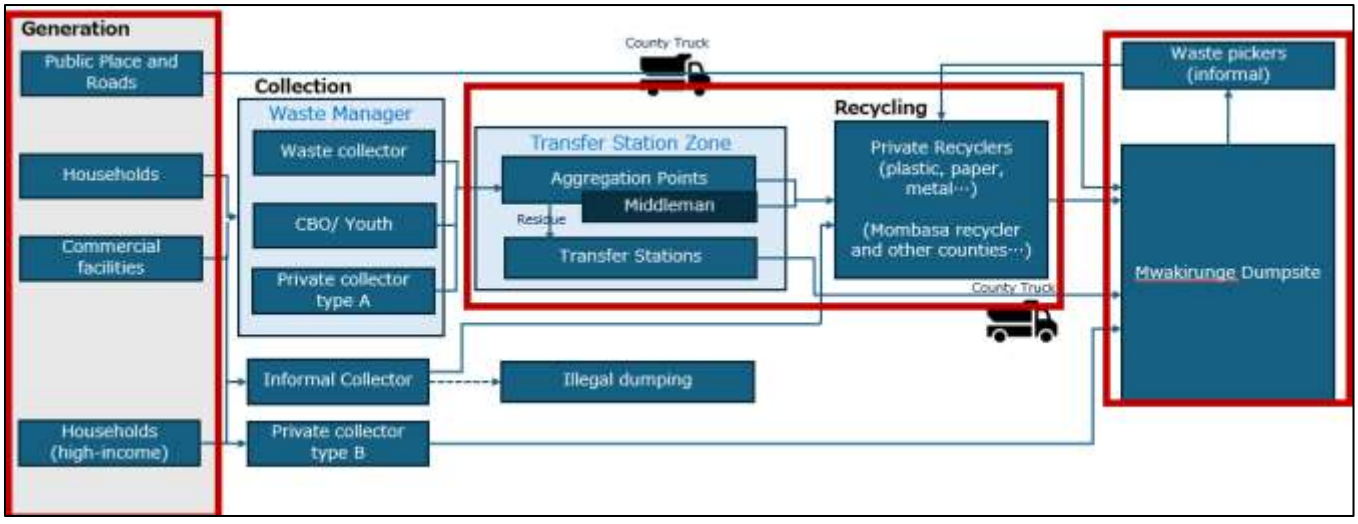
Currently, Japan International Cooperation Agency (JICA) is undertaking a five-year project for promoting circular model of environmentally sound solid waste management in urban areas of Kenya, and Mombasa is one the three pilot counties alongside Nairobi and Kiambu counties. According to their recent baseline survey February 2025 Mombasa County, on average, Mombasa County generates approximately 734.5

tons of wastes per day. High income areas generate relatively higher compared to medium and low-income areas, with food wastes being the highest in proportion.

Their survey report explains that wastes from households, streets, commercial areas, and industries is collected as mixed waste under the coordination of a municipal waste manager. The waste collectors include the municipality staffs/crews, community-based organizations (CBOs) and /or youth groups, private collectors, and informal collectors. All wastes generated and dumped at the public roads and spaces are collected and transported directly to the final dumpsite by the municipality trucks while wastes from household and commercial facilities are collected by private companies (high income settlements), informal waste collectors (low income and high-income settlements), municipality crews and then transported to transfer stations, approximately 20 designated stations.

For the informal waste collectors, their focus is on the recyclable materials so they either collect the wastes from points of generation after being paid then select the recyclable materials for selling or illegally dump the wastes in undesignated dumping sites or at times in the designated sites. Within the transfer stations, there are more than seventy (70) aggregators who buy and sell recyclable materials to manufacturing/recycling companies within or outside the county while the waste residues are transported direct to Mwakirunge dumpsite. At the dumpsite, there are informal waste pickers who select recyclable materials and sell to itinerant waste buyers, who work closely with them at the dumpsite. This is shown in the flow diagram (figure 3) below.

Figure 3: Waste Flow in Mombasa County (JICA, 2024)



2.4 Waste Management at Mwakirunge Dumpsite

Mwakirunge dumpsite is the main garbage dumpsite for Mombasa County after the closure of Kibarani dumpsite, located along the geographical coordinates of 3° 57' 0" South, 39° 40' 0" East in Kisauni Sub County. It measures approximately 52 hectares in size, and the distance from the city (CBD) and Mombasa International Airport (MIA) is approximately 20 km and 13 km respectively [54, 55].

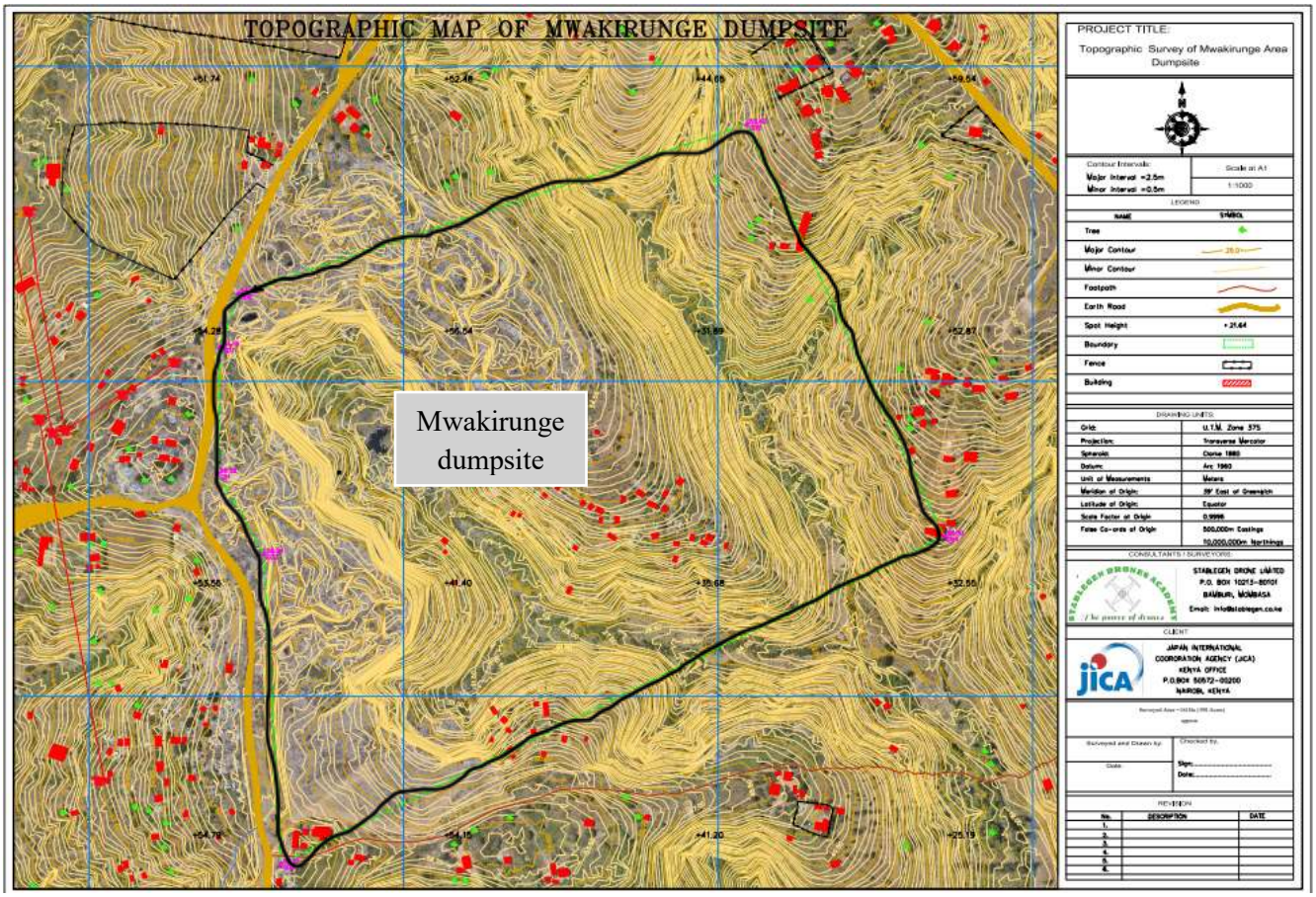
The area features an uneven terrain with valleys, hills, and densely packed settlements in and around the dumpsite (see figure 9). Mixed waste is brought in by municipal and private trucks from different waste accumulation points including designated (primary collection points) and undesignated dumping sites, material recovery facilities, households, streets, and other business enterprises. An officer is assigned close to the pathway to the dumpsite who record vehicle trips, after which the truck heads into the dumpsite.

Prior to offloading, the site supervisor or any assigned municipality staff directs trucks on the location they should offload their wastes within the dumpsite. After offloading, waste pickers then retrieve and sort out recyclable materials to sell to itinerant waste buyers (aggregators) who then sell to manufacturing companies in bulk.

Over 500 individuals, mostly women and children, reside within the dumpsite. According to Benard et al. (2024), those born at the site slightly outnumber those who relocated there. Their main source of livelihood involves scavenging items like plastics, metals, clothes, and furniture for resale, as well as collecting partially spoiled food from markets or hotels for personal use or to feed animals such as pigs [50].

The housing at the dumpsite is temporary and not conducive especially during extreme weather conditions. That is, access roads become muddy and slippery when it rains, and during dry seasons, the area is filled with dust and smoke from burning waste. Drug use is common, particularly marijuana and local liquor. The site is scattered with broken glass, chemicals, and hazardous industrial waste. According to Muindi et al. (2022), insecurity is a major issue at the dumpsite due to the lack of a perimeter wall, allowing criminals to use it as a hideout and threaten waste pickers [56]. Mwakirunge dumpsite also fails to meet the basic standards of a proper dumpsite. It lacks essential facilities like a weighing bridge, truck wheel cleaning unit, container area for holding of recycling or contraband goods, a septic tank, and a laboratory [50].

Figure 4: Topography of Mwakirunge Dumpsite. Source (57)



In terms of waste management at Mwakirunge dumpsite, there is uncontrolled dumping of wastes as trucks bring in wastes from various sources and dump them in the dumpsite with some instructions from the

dumpsite manager. Once the wastes have been dumped, informal waste pickers scramble for recyclable materials such as foods, plastics, metals, bottles, glasses, and clothing among others, after which the remaining wastes are piled and compacted compactors.

In many cases, each truck ferrying wastes into the dumpsite are already booked by a group of individuals and that they are the only ones who can access the recyclable materials immediately offloading has been done by the truck. This has disadvantaged women and the elderly as they are normally subjected to wait for the truck 'owners' to finish picking the items after which they can also pick items left. Normally, informal waste pickers mix all the recyclable materials in a sack that vary in sizes, weighing between 30kg to 60kg per sack, which they then manually transport and sell to the itinerant waste buyers who also have their temporary establishments within the dumpsite. The itinerant waste buyers weigh the full sac, and pay waste pickers as per agreed prices, after which the buyer again employs other individuals (also waste pickers) to separate recyclable materials in terms of the needs of the recycling companies, to whom they sell the consignment.

2.5 Informal Waste Picking; opportunities and the associated challenges

The recent surge in waste picker research has been driven by growing recycling needs from rising waste volumes, reducing landfill spaces, advancements in recycling technology, and environmentalists' advocacy [13, 17]. According to, Morais et al., (2022), poverty, social inequity, being youth, economic constraints and limited job opportunities in the formal sector, unfavourable government policies especially to the youth, lack of parental care, climate change and urbanization have been the key reasons individuals have found themselves depending on waste picking as their livelihood means [17].

For instance, in Nigeria, parental neglect and poor policies on protecting the youths forced young children and youths to sort to recovery of materials as their livelihood means [58]. The involvement of individuals with limited skills in informal waste management sector was also reported in Indonesia [59]. Similarly, increased urbanization in Zambia created unemployment especially for individuals without education and high levels of poverty led individuals become waste pickers [60]. Finally in India, climate change, rural poverty, crop failure and starvation led to population displacement, which contributed to the growing number of waste pickers in urban areas [61].

According to previous studies, waste pickers possess diverse sociodemographic and economic characteristics in terms of gender, age, education level, marital status, and years of experience in waste picking. For instance, male waste pickers dominate in Nakuru, Kenya [14], Accra, Ghana [28], Kinshasa, Congo [26] and Enugu, Nigeria [23]. On the other hand, female waste pickers are more compared to their male counterparts in Thika, Kenya [14], Uganda [23], Pakistan [22] and Brazil [62].

Extreme poverty conditions often deny waste pickers access to education, healthcare, basic utilities and livelihood opportunities [63]. For example, in Ghana, low education levels and lack of employment skills excluded waste pickers from obtaining formal employment which is associated with higher income [28]. Similarly, in South Africa, very low levels of education left waste pickers with just few marketable skills and ability to compete for formal employment [64]. In Nakuru (Kenya), waste pickers are the poorest and most vulnerable residents earning less than US$ 2 per day [19]. The same situation was reported in Democratic Republic of Congo (DRC) where waste pickers are generally poor [26].

The situation of low levels of income of waste pickers is further exacerbated by the exploitation from itinerant waste buyers or middlemen who often underpay them [17]. Importantly, gender has been reported to have an impact on income levels of waste pickers. In particular, female waste pickers generally earn less compared to their male counterparts [65]. In many situations, female waste pickers have limited access

to more valuable recyclable items like metals and plastics, while also facing harassments from their male counterparts [66]. While several studies have associated waste picking with low income, in Dar es Salaam (Tanzania) a research by Palferan (2015) reported that waste pickers earned more than the national minimum wages of those in the formal employment by more than 38% [67]. Also in Jakarta (Indonesia), the average monthly income for waste pickers was similar to the national minimum wage [59]. These two scenarios showcase how important waste picking should be given recognition and support as an alternative means of livelihood.

Despite their varied sociodemographic backgrounds, waste pickers are commonly linked to poverty, harsh living and working conditions, and persistent social stigma [17]. In South Africa, they are often viewed by the public as poor, jobless, and homeless individuals, frequently isolated due to their unclean appearance [68, 69]. Stigmatization not only leads to their exclusion from accessing waste bins disrupting their livelihood but also results in their contributions to recycling being overlooked and undervalued [68]. These scenarios indicate that waste pickers are stigmatized and that their knowledge, expertise and pivotal roles in the recycling economy go unnoticed and unappreciated [70]. Stigma further prevents waste pickers from accessing socioeconomic capital like income, education, wellbeing, housing and health [71].

They are also faced with intimidation and exploitation by middlemen and have the lowest pay in the recycling chain [18]. In addition, the reasons for their disregard is due to the perception that engaging the informal waste sector sabotages implementation of modern solid waste management systems that's normally characterized with mechanization and the use of modern capital intensive technologies, such as incineration [18]. The consequences of this stigmatization include issues such as social disorder like increase in criminal activities, drug abuse and alcoholism, poor health and overdependence on social welfare which is unsustainable and unreliable. For example, in Turkey, waste pickers are labelled criminals [72]. In India, waste pickers face public rejection because of their uncleanliness and unhygienic conditions [73]. Similarly, in Lahore (Pakistan), waste pickers are abused, insulted and harassed by both the police and the municipal officials who often extort bribes from them [74]. The issue of waste pickers being stigmatized is also prevalent in Kisumu (Kenya), despite some residents recognizing the significant roles they play in the collection of wastes in the city [75].

With limited practices of waste segregation at source in developing countries, different types of wastes are mixed together including infectious and hazardous wastes from hospitals and chemical industries [76]. This exposes waste pickers to health risks as they collect recyclable materials, making them susceptible to infectious diseases together with their families [77, 78]. For example, in Nigeria, waste pickers are exposed to toxic materials, chemical wastes, hospital wastes like contaminated needles, heavy metals like mercury and other sharp objects like broken bottles [79]. In Guinea Bissau, exposure to the open burning of hazardous and biomedical wastes is prevalent [80]. In Ethiopia, waste pickers face potential health risks due to accumulation of polluted water that provides a breeding ground for disease vectors such mosquitoes and flies [81]. Similar situations have been reported in Kampala where bacterial infections like typhoid, cholera and dysentery among waste pickers are common due high prevalence of flies in the dumpsite [23]. In Palestine, waste pickers complained of intestinal diseases like diarrhoea, constipation and blood with stool, back pains, breathing issues, skin diseases, sore throat and coughing with high temperatures [82]. Despite the challenges associated with informal waste picking, several studies have revealed their positive impacts in municipal solid waste management benefiting public health, municipal budgets and the environment [18].

Economically, they help in the reduction of costs incurred by the formal waste management sectors by reducing volumes of waste that the formal sector has to collect hence lowering labour, transport and infrastructure costs, as well as optimizing landfills [15]. Informal waste pickers' involvement in solid waste management through collection and recycling in various cities have led to reduction of costs related to solid waste collection services to more than 10 million EUR/year in Peru and Egypt, and approximately more than 3 million EUR/year in Philippines while in Lusaka, Zambia, the net cost of informal waste collection is approximately more than 10 USD/ton less than in the formal sector [15]. According to UNEP's report (2010), informal recycling prevents more than 25% in Jakarta (Vietnam) and more than 15% of waste going to landfill in Delhi and Bengaluru (Bangalore). As a result of this, they have helped in the savings on the costs of waste collection and disposal of almost 14,000 US$ per day for the Delhi and Bangalore municipalities (UNEP, 2010). In addition, the informal waste management systems generate approximately more than twenty-five times more jobs than systems in a high- income countries [84].

Environmentally, they protect the environment through resource conservation, improved resource recovery and closing the resources loop in the circular economy [63]. They are also described as service providers in an environmental system as they help to reduce air pollution through greenhouse gas emissions, water contamination and reduce the need to build more landfills which take up valuable spaces [63, 66, 85–87]. This helps in the achievement of SDGs 13 (climate action) and 14 (life below water) as highlighted in [35]. In Abidjan, waste pickers enabled reduction in the number of illegal transfer stations and open dumpsites through recovering and reducing the environmental risks associated with the accumulation of MSW in the streets [74].

According to Paul et al., 2012), informal waste picking reduces environmental contamination caused by uncollected MSW and propagation of disease carriers like rats and flies. This reduces water related infections like malaria and dengue which are mostly common to children [12].

Waste pickers play a vital role in advancing the circular economy by recovering valuable materials that would otherwise be lost. As Gall (2020) notes, their efforts help extend the lifecycle of materials, thereby supporting the core principles of a circular economy that focuses on minimizing waste and maximizing resource use [44]. Waste pickers also help transform waste into valuable resources, thereby improving resource efficiency and supporting the closing of material loops in a circular economy through reuse, recovery, and recycling [88].

On the other hand, due to their lack of education and limited resources, informal waste sectors' poor technologies and improper management of secondary pollutants increases environmental pollution of air, soil, and water [12]. The use of poor technologies burning of rubber insulators to extract e-waste components like power supplies, compressors and capacitors pollute the environment [89]. In Brazil, it was reported that there is a large area of environmental degradation, exacerbated by social conflict from the construction of shanty houses occupied by waste pickers [90]. As reported by Yang et al., 2018, these situations increase the exposure of not only the waste pickers themselves, but also the public to pollutants, injuries, respiratory and dermatological problems, infections, and other serious health issues that contribute to low life expectancy due to insufficient occupational health measures [91].

Existing literature consistently shows that waste pickers are supportive of formalization, primarily because it addresses key concerns such as low income, lack of recognition, and poor working conditions. Medina (2007) observed that waste pickers seek integration into formal systems to gain social protection and acknowledgment of their role [20]. Similarly, Samson (2009) reported that waste pickers value formal

recognition, improved earnings, and access to basic infrastructure [92]. Dias et al., (2016) further argued that formalization should ensure social equity by providing waste pickers with service contracts, fair pricing, and inclusion in policymaking [18]. Gutberlet and Uddin (2017) also highlighted strong support for integration by waste pickers when it guarantees improved workplace safety and access to social and legal benefits [63].

Figure 5: Summary of the benefits of formalizing informal waste pickers. Source [17]

Legal recognition	Improve salary conditions and benefits	Improve representation	Access to training and personal protective equipment
Legal recognition and positive public image and or public acceptance by waste pickers who contribute to the upkeep and cleanliness of the cities they work in.	Increased earnings of workers via stable monthly income.	Increase their voice and representation.	Improve their skills through training.
Identification cards to protect them, so that they can be identified as workers in order to benefit from the payment scheme.	Improve work conditions e.g. uniforms, specially designed carts and buckets for collection of MSW and sorting spaces, etc.	Bargaining mechanisms to negotiate with buyers of the material they collect and with municipal officials	Access to appropriate equipment and protective gear such as carts and gloves.
	Access to welfare e.g. day-care for children, education scholarships, pension schemes	Organizational and bargaining power will help self and social recognition of their workers as a prerequisite toward building a collective voice and self-representation in order to engage in negotiations with employers, suppliers, buyers and or middlemen.	

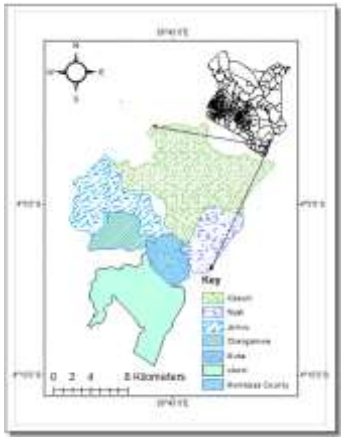
CHAPTER 3: METHODOLOGY

3.1 Study site

For the purposes of obtaining representative results, our survey was conducted at Mwakirunge dumpsite, which is the main solid waste holding and handling facility in Mombasa County, Kenya. It was established in 2008, after relocation of the main dumpsite in Kibarani. With limited practice of source separation and sorting of wastes in the county, all types of wastes are dumped in this site in their mixed form, which attracts individuals working as waste pickers.

While more than 500 inhabit the dumpsite and its surroundings, approximately 200 are actively engaging in scavenging of items such as plastics, bottles, pieces of metal, clothes, utensils, furniture/wood, which they sell to earn income.

Figure 6: Study area

	
Map of Mombasa County, Kenya. Source (93)	**Mwakirunge dumpsite. Source; https://mapcarta.com/**

3.2 Study design

A descriptive cross-sectional study design utilizing an explanatory mixed-methods approach was used to collect both quantitative and qualitative data. This approach, as supported by Creswell (2018), enhances understanding of the research findings by combining numerical trends with in-depth insights [94].

3.3 Study population

This study targeted informal waste pickers and intermediate/itinerant waste buyers operating at Mwakirunge dumpsite using both open ended and close ended questionnaires, as well as municipal authorities from the department of environment, environment agencies (NEMA), Japan International Cooperation Agency (JICA) project manager and the private waste sector.

3.4 Sample size determination and selection

Sample size was determined using Yamane's formula ($n=N/1+N(e)^2$), targeting 148 waste pickers which considered potential non-response. This is shown below.

$$\mathbf{n = \frac{N}{1 + N(e)^2}}$$

Where:

n is the sample size (number of waste pickers).

N= the finite population (N=200).

e level of significance (limit of tolerable error) where, e=0.05

1= a constant value.

From this formula, $n=200/1+200(0.05)^2$. This gives 134. To cater for the non-response rate, 10% of the calculated sample size (n=134) was added. We then targeted at least 149 respondents (informal waste pickers) for quantitative survey.

3.5 Selection of study participants (sampling process)

Simple random sampling was used to select informal waste pickers for the quantitative survey. simple random sampling technique of participants in a study reduces selection bias while ensuring that everyone in the study area/site has an equal chance of participating in the study [94]. Focus group discussion participants were selected using convenience sampling, based on attributes like age, sex, residence, years of experience as a waste picker welfare membership. An itinerant waste buyer was also selected using

convenient sampling technique. Finally, key informants were purposively selected from the Department of Environment, JICA, itinerant waste buyers, and private waste companies due to their technical expertise and involvement in waste management planning and policy in the county.

3.6 Data collection Procedures

Data collection employed a structured, close-ended questionnaire using a 5-point Likert scale to assess and measure opinions and perceptions on work-related experiences, health risks, and attitudes toward formalization. Insights from the quantitative analysis informed the development of guiding questions for Focus Group Discussions (FGDs) with waste pickers. Additionally, in-depth interviews were conducted with itinerant waste buyers and municipal authority official to gather broader contextual and policy-level perspectives.

Figure 7: Data collection (Author)

3.7 Data analysis, presentation, and interpretation

Quantitative data were analysed using Microsoft Excel and SPSS version 24. Descriptive statistics included frequencies, proportions, means, and standard deviations. Specifically for Likert scale data, responses were analysed by computing means, standard deviations, and frequency distributions to determine the overall trends and central tendencies. The scale was directional, with lower values (1-2) indicating negative or undesirable conditions and higher values (4-5) indicating positive or desirable outcomes. Interpretations were done using weighted average ranges as shown in table 1 below. This interpretation allows the study to objectively assess the extent of agreement, satisfaction, or performance in relation to the variables of interest, and to draw meaningful comparisons across different groups [95].

Table 1: Likert scale interpretation [95]

Likert scales	Intervals/weighted average ranges	Interpretation		
		Extent of agreement	Frequency of exposure/occurrence	Satisfaction levels
1	1.0-1.8	Strongly disagree (SD)	Never (N)	Very unsatisfied (VU)
2	1.9-2.6	Disagree (D)	Rarely (R)	Unsatisfied (U)
3	2.7-3.4	Neutral (N)	Sometimes (S)	Neutral (N)
4	3.5-4.2	Agree (A)	Occasionally (O)	Satisfied (S)
5	4.3-5.0	Strongly Agree (SA)	Always (A)	Very satisfied (VS)

Inferential statistics such as Chi-square tests, t-tests, ANOVA, and Mann-Whitney U tests (for ordinal data) were conducted at a 95% confidence level, with p-values <0.05 considered statistically significant. Summary results were presented using tables, graphs and pie charts. Information obtained through qualitative survey was presented using participants' verbatims and description of the observed activities and phenomena.

Table 2: Study participants/respondents

Sector	Respondents	Frequency	Data collection methods
Formal sector	Department of Environment and Solid Waste Management	1 (Chief Officer)	Key informant interviews (KIIs), In depth interviews (open ended questions)
	JICA project team lead	1	
	Private company/itinerant waste buyer	2	
	Dumpsite supervisor	2	
Informal sector	Informal waste pickers	157 (25 participated in FGD)	Administration of structured questionnaires (close ended questions) FGD (open ended questions)
	Scrap dealers/itinerant buyer	1	Key informant interviews (KIIs) Observations

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Sociodemographic characteristics of informal waste pickers at Mwakirunge Dumpsite, Mombasa County, Kenya (2024)

A total of 157 waste pickers were interviewed with questionnaires. The majority were male (59%, n=92), and the mean age was 36 (±13.5) years. Most respondents (60.61%, n=80) belonged in the 18–37 age group. In terms of education, a sizeable portion neither had formal education (38.2%, n=60) nor completed

primary school education (32.5%, n=51) indicating low educational attainment overall. Household sizes varied, with a median of 3 people [interquartile range (IQR): 1-6], whereby half of the respondents (50.6%, n=79) lived in households of 1–3 members. Most respondents were married (42.04%, n=66). Only 12.1% belonged to a group, suggesting limited access to support systems.

Income levels were low: 38.22% (n=60) earned less than KSH 250 per day, and majority at 41.40% (n=65) earned between KSH 251–500. More than three quarters (80.3%, n=126) lived within the dumpsite, and most had 1–10 years of experience (59.2%, 93), with a median of 10 years. Regarding employment, 71.97% relied solely on waste picking, while a smaller number engaged in casual nonskilled work (26.1%) or other minor occupations. See table 3 below.

Table 3: Characteristics of waste pickers at Mwakirunge dumpsite

Sn	Variable	Frequency (n=157)	Proportion (%)
1	**Gender**		
	Male	92	59
	Female	65	41
2	**Age (n=132)**		
	Mean (Standard deviation)	36	13.50
	18-37	80	60.61
	38-57	[43]	32.58
	58-77	9	6.82
3	**Education level**		
	No formal education	60	38.22
	Primary School completed	29	18.47
	Primary School not completed	51	32.48
	Secondary school completed	9	5.73
	Secondary school not completed	8	5.10
5	**Household Size**		
	Median (Interquartile range)	3	1-6
	1-3	79	50.64
	4-6	45	28.85
	7-10	29	18.59
	>10	3	1.92
6	**Marital status**		
	Divorced/separated	33	21.02
	Married	66	42.04
	Single	[[44]]	28.03
	Widowed	14	8.92
7	**Welfare membership**		
	No	138	87.90
	Yes	19	12.10
8	**Income Level (KSH.)**		
	< 250	60	38.22
	251-500	65	41.40

Sn	Variable	Frequency (n=157)	Proportion (%)
	501-750	12	7.64
	>750	20	12.74
9	**Residence**		
	Within Dumpsite	126	80.25
	Outside Dumpsite	31	19.75
10	**Years of experience**		
	Median (Interquartile range)	10	7-14.5
	< 1	1	0.64
	1-10	93	59.24
	11-20	59	37.58
	>20	4	2.55
11	**Other occupations**		
	Waste picking only	113	71.97
	Casual nonskilled	41	26.11
	Casual skilled	1	0.64

The demographic profile of waste pickers at Mwakirunge dumpsite reported in this survey highlights both opportunities and challenges for formalization. The predominance of young adults (mean age 36, with 60.6% aged 18–37) suggests a workforce with long-term potential and adaptability for structured integration. However, the low levels of formal education over 70% either without any schooling or not having completed primary school indicate that formalization programs must be designed with simple, accessible language and strong capacity-building components to ensure inclusivity and effectiveness. Income data further underscores the economic precarity of the waste pickers, with 80% earning less than KSH 500 per day. This economic vulnerability makes the promise of better and more stable income a strong motivator for formalization. Like highlights by Kasinja et al., (2018), waste pickers at Mwakirunge dumpsite in Mombasa County are likely to support formalization efforts if they address core needs such as improved income, legal recognition, and better working conditions [16, 20, 92].

The fact that over 80% of participants live within the dumpsite itself, and nearly three-quarters rely solely on waste picking for their livelihood, points to deep socio-economic entrenchment in the sector. This indicates that any disruptions to waste picking, if not managed inclusively, could worsen livelihoods. Therefore, as emphasized by Morais *et al*., 2020, formalization must be participatory and account for their lived realities [17]. Additionally, the low rate of group membership (only 12.1%) reflects limited organization among the waste pickers. This suggests a need to first build social capital and cooperative structures that can facilitate engagement, collective bargaining, and smoother transitions into formalized arrangements. This is in accordance with Dias et al., 2016 who emphasized on collective organizing as a foundation for successful and sustainable formalization [18].

1.1.1 Distribution of participants' income

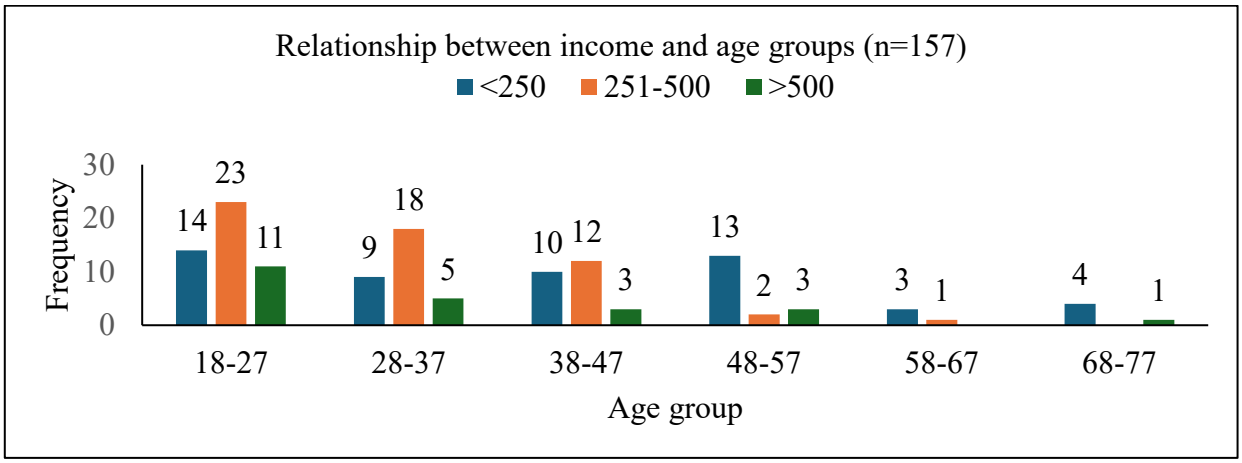
Distribution of participants' income by age groups

Figure11 below suggests that income levels are highest among younger age groups and tend to decline as age increases. An analysis of variance (ANOVA) at a confidence level of 95% showed a statistically significant association between age (n=132) and income levels of participants (F=1.557, p=0.042). At Mwakirunge dumpsite, young and energetic male waste pickers help in manually offloading the waste

trucks, thereby having added advantage in accessing highly valuable recycling materials for sale, leaving behind less valuable recyclable materials to the elderly waste pickers. One respondent said, 'young men have advantage because they are called upon to help in offloading waste trucks during which they rush to pick more valuable recyclable materials before we join.' The difference in income was also associated with the exploitation by the itinerant waste buyer which was more common on older and female waste pickers. A female waste picker said, 'you agree with them about the price, but after they weigh, they pay you less than the actual agreed price…this is so common among us women and the older people.' According to Morais et al., (2022), exploitation of waste pickers by waste buyers is prevalent even in other regions [17].

This inequality in accessing more valuable recyclable materials calls for the site supervisors to ensure control of offloading activities in the dumpsite to ensure everyone has an equal chance in accessing recyclable materials of any kind, regardless of their gender, age or any other factors. Additionally, the situation calls for promotion of financial literacy and planning among young waste pickers to save for the future as well as support to the elderly and weak waste pickers from exploitation by waste buyers.

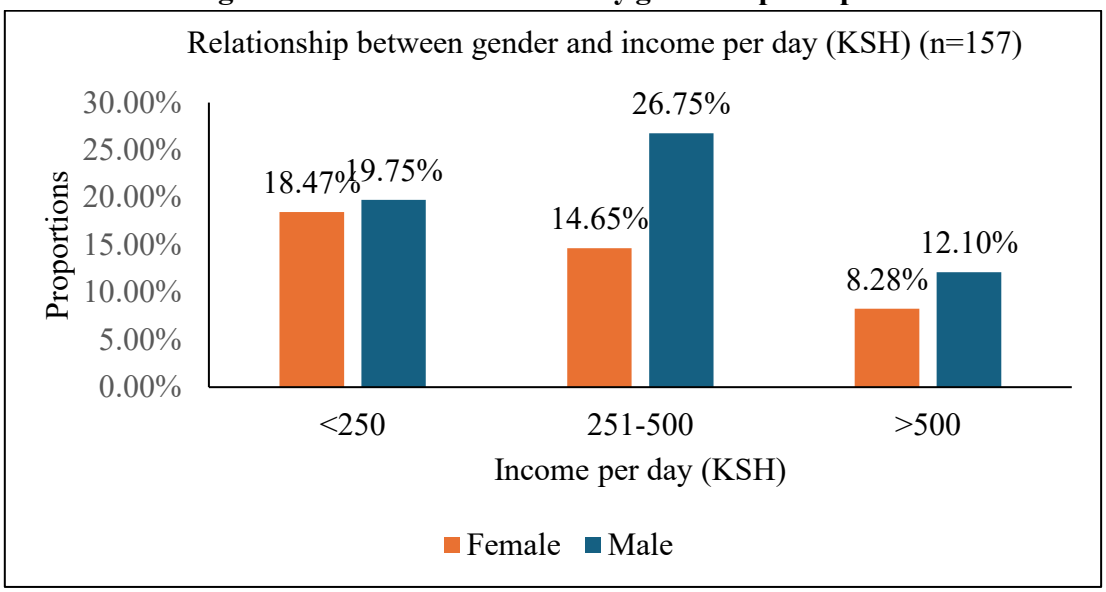
Figure 8: Relationship between income/day (KSH) and age groups of participants.



Income distribution by gender

The data in figure 12 shows that female respondents earned less than male respondents although a Chi-square test at 95% confidence level showed no statistically significant association ($X^2 = 2.166$, d.f = 2, p = 0.339). This observed difference in our survey is similar to a study in Brazil by Marques et al., (2021) where male waste pickers earned at least US$ 50 per month more than their female counterparts [65]. In our study, the observed trends with women earning less still warrants attention, even if it was not statistically conclusive. This is because female waste pickers in our study site continuously face harassments from their male counterparts, often made to fear and wait for men to finish collecting valuable materials after which they can join. These scenarios call for the need to promote controlled dumping of the wastes at the study area and ensure everyone has equal access to any kind of recyclable wastes from any truck, regardless of gender.

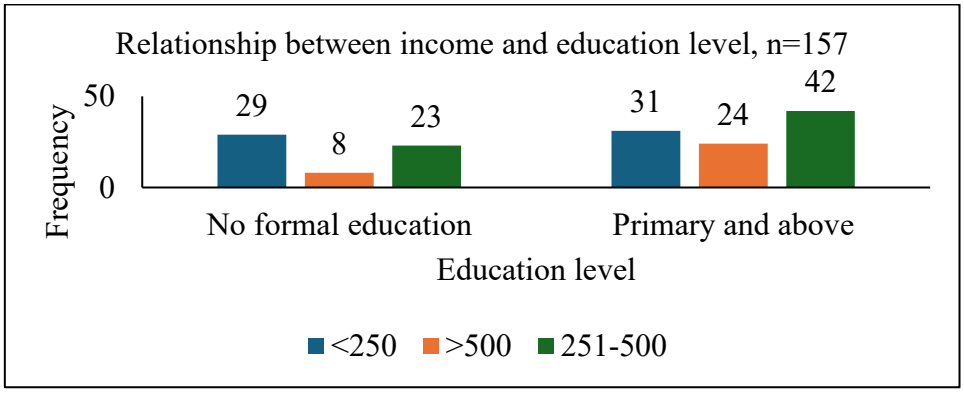
Figure 9: Distribution of income by gender of participants.



Income distribution by education level

The chi-square test result indicates that there is no statistically significant association between participants' daily income and their education levels at the 95% confidence level ($X^2 = 5.189$, d.f = 2, p = 0.075). This means that, based on the current data (see figure 13), education level does not appear to have a clear or direct influence on income among the participants. However, the p-value is close to significance, suggesting that there might be a potential relationship. One participant was a welder himself, so he looked for metals, which are more valuables. In general, because waste picking does not require many conditions like education to become one, it does not really matter unless one diversifies with other activities such as casual labour or small-scale businesses.

Figure 10: Income distribution by levels of education among respondents.

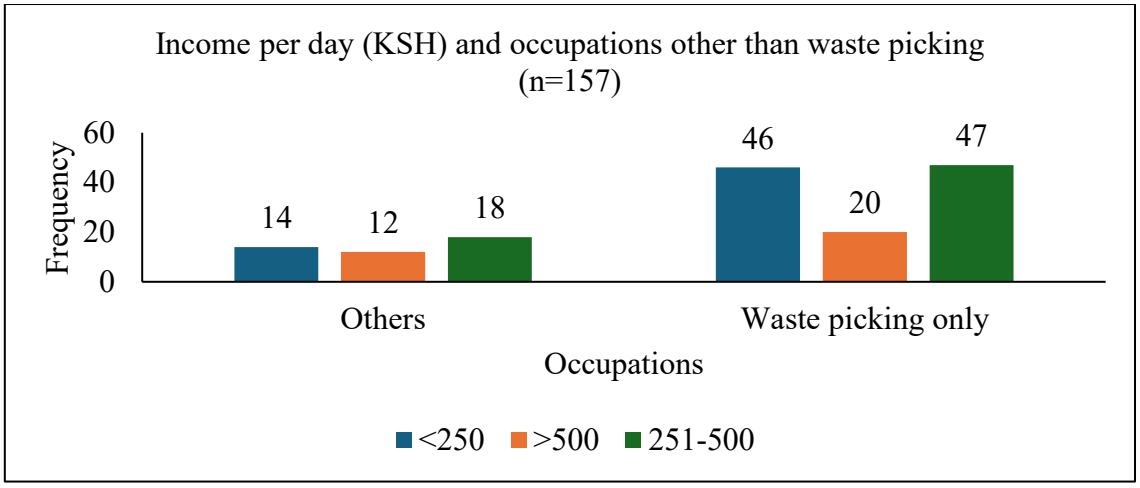


Distribution of income and other occupations other than waste picking

From the figure 14 below, while majority of the participants engage in waste picking as their sole source of income, and it appears to yield a slightly higher number of individuals earning 251–500 KSH daily, this difference is not statistically significant (X^2 =2.314, d. f=1, p=0.128). In other words, while waste picking is a common and seemingly viable income source, the data does not show a strong enough difference to confidently claim it yields better income than other informal jobs. Our study emphasizes that this sector

needs support and formalization into groups such as cooperatives through which they can be trained in diversifying their sources of income, and waste picking only is associated with low incomes. The itinerant buyer pointed out that there are numerous opportunities for the waste pickers to venture into, within the dumpsite. These include pig rearing, poultry farming, bee keeping, farming, among others. This is what he said, "I have come up with an initiative called 'one plus one initiative'… to engage them in income generating activities like poultry, bee keeping, and farming."

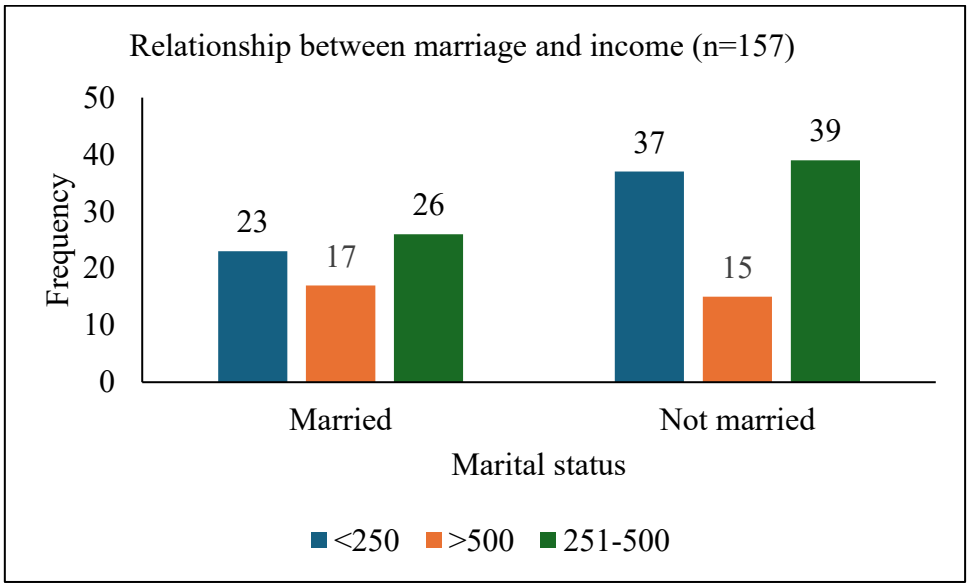
Figure 11: Relationship between income and occupations other than waste picking.



Relationship between marriage and income of participants

According to this survey (see figure 15), it is observed that respondents who said that they are married earned less compared with their counterparts who were not married. However, this difference was not statistically significant (X^2 =2.063, d. f=2, p=0.356) implying that marital status alone does not influence income levels. Despite the lack of statistical significance, targeted interventions like family support programs should be integrated into formalization initiatives.

Figure 12: Distribution of income by marital status.



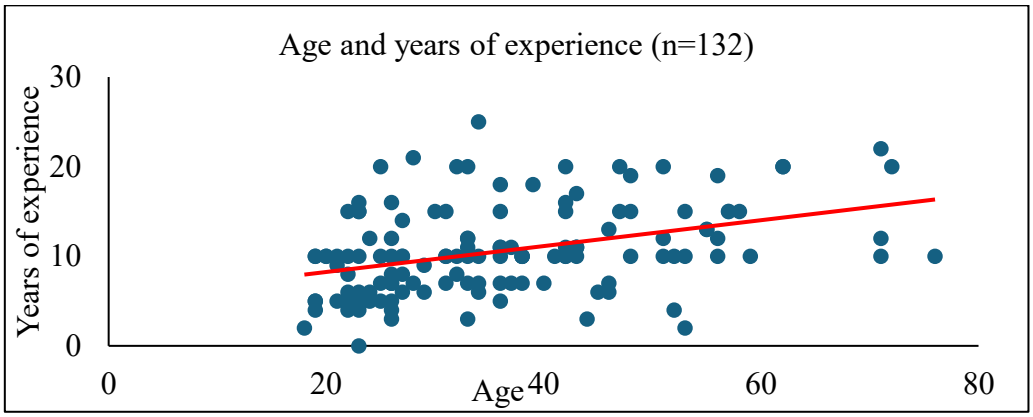
Years of experience and child labour at Mwakirunge dumpsite

There was a significant moderate positive correlation between age and years of experience of participants with older participants having more years of experience compared to their younger counterparts (r =0.34, p=0.000). Additionally, an independent sample t-test analysis at 95% confidence showed that male respondents had a higher mean (11.36) years of experience compared to their female counterparts (9.60), and this was statistically significant (p=0.034). See figure 16

Forty-six participants (29%) reported that they had children under the age of eighteen years working as waste pickers. Approximately 117 of waste pickers at Mwakirunge dumpsite, as reported by their parents or guardians had not attained the age of 18 years or more. The median number of children reported by participants was 2 (IQR: 1-4). This study observed that approximately 35 respondents joined waste picking before they attained the age of eighteen years.

These findings highlight the need for intervention by the local authorities to ensure that no child is found at the dumping site during school days, and that they are supported to attain the basic primary education. Alternatively, learning institutions can be established close to the dumping site where they can attend primary education through the support of the government, the local authorities and collaboration with other relevant stakeholders.

Figure 13: Relationship between age and years of experience.



Distribution of informal waste pickers by counties of origin

Mombasa, being Kenya's second-largest city and a major economic hub, naturally attracts people from across the country seeking employment and livelihood opportunities. With limited employment opportunities within the city, people resort other livelihood means particularly in the informal sector such as waste picking. This migration trend is evident in this study's findings, where respondents represented 17 out of Kenya's 47 counties accounting for over one-third (36.17%) of the counties.

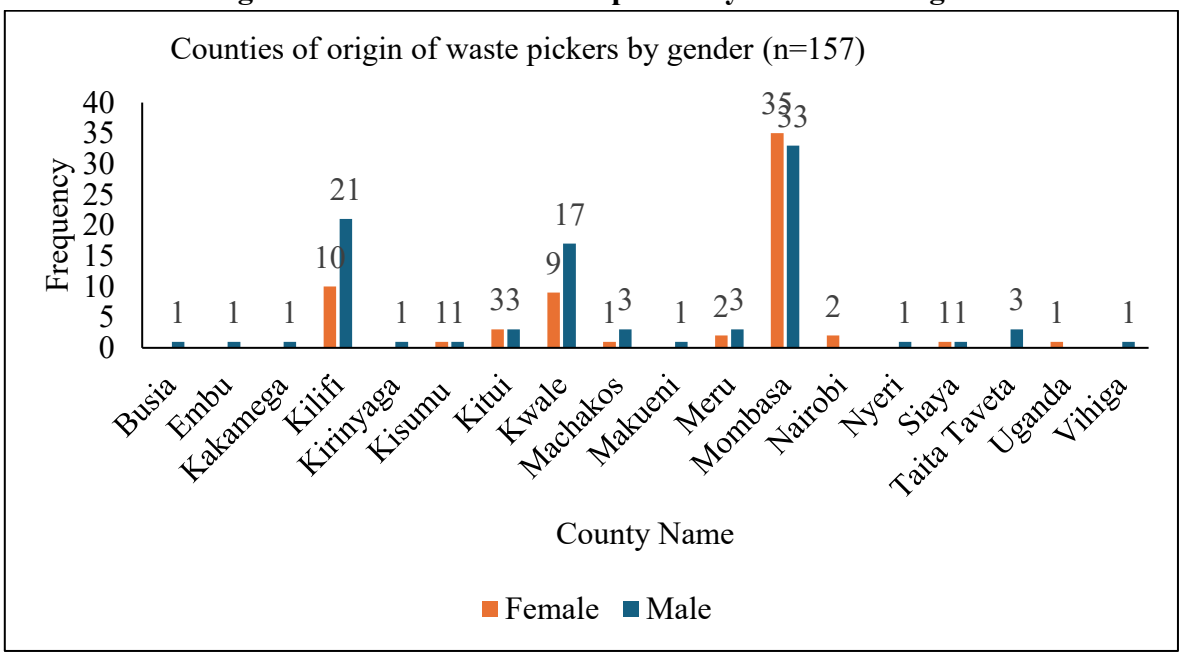
Notably, 56.69% of the respondents (n=89) identified their counties of origin as being outside Mombasa County, highlighting Mombasa's strong pull as a destination for economic migrants. Kilifi County, which borders Mombasa to the northeast, had the highest share of these migrants (34.83%, n=31), likely due to its proximity and similar socio-economic conditions. The diversity of origins also included one respondent from Uganda, emphasizing Mombasa's role as a cross-border employment destination.

A chi-square test conducted at a 95% confidence level revealed a statistically significant relationship between gender and counties of origin ($X^2 = 4.59$, d.f = 1, p = 0.032). This suggests that gender may influence migration patterns or the likelihood of individuals becoming involved in waste picking

depending on their counties of origin mostly due to economic factors influencing their migration and engaging in waste picking as a livelihood means.

These findings imply the interconnected nature of urban migration, gender, and informal employment in rapidly growing cities like Mombasa. They also point to the need for inclusive urban policies that address the needs of a diverse, mobile, and gender-sensitive workforce.

Figure 14: Distribution of waste pickers by Counties of origin.



1.1.2 Reasons for being a waste picker.

According to table 4 below, respondents highly perceived lack of alternative job opportunities as the main reason they became waste pickers. That is, majority at 80.77% (n=126) strongly agreed that they became waste pickers due to lack of other opportunities, with an overall mean of 4.49 (±1.16). According to Mann Whitney U test, the distribution of male and female responses was the same (p=0.320).

Respondents also expressed a high perception that waste picking as a job requires little resources like capital, education, skills among others to start or join. In this case half of the respondents strongly agreed with this statement, and it had a mean score of 3.62 (STD=1.68). A Mann Whitney U test showed that female waste pickers had a lower mean distribution of responses (69.67) compared to their male counterparts and the difference was statistically significant (p=0.026).

On the other hand, respondents expressed low perception on becoming waste pickers because of family involvement (mean=2.14, STD=1.50) as slightly more than half of the respondents (51.92%, n=81) strongly agreed with the statement. The distribution of male and female responses regarding family influence was the same (p=0.877).

Additionally, becoming a waste picker because it is an easy way of making money received mixed responses from respondents. Only 31.41% strongly agreed with this statement, while a significant portion 30.13% strongly disagreed and 28.21% disagreed indicating that many do not perceive waste picking as an easy way to earn money. The mean score of 2.81 (±1.67) suggests a low to moderate agreement, showing that although some may find it accessible, the majority do not view it as an easy livelihood option. The distribution of male and female responses regarding this was the same (p=0.712).

On contributing to waste reduction by waste pickers, only a small fraction agreed (8.33%, n=13 strongly agreed, mean = 2.66), with 41.67% (n=65) strongly disagreeing. This implies that economic survival outweighs environmental motivations in driving participation in waste picking, and that waste pickers at Mwakirunge are unaware of their contribution in waste reduction through separation of recyclable materials before final landfilling of wastes.

Table 4: Reasons for being a waste picker.

		Level of agreement, frequency (%), n=156							
Sn	**Statement**	**SD**	**D**	**N**	**A**	**SA**	**Mean**	**STD**	**Interpretation**
1	I couldn't find any job currently	9(5.77)	9(5.77)	4(2.56)	8(5.13)	126(80.77)	4.49	1.16	Strongly agree
2	It's an easy way to earn money	47(30.13)	[[44]](28.21)	6(3.85)	10(6.41)	49 (31.41)	2.81	1.67	Neutral
3	My family is involved	81(51.92)	31(19.87)	10(6.41)	9 (5.77)	25 (16.03)	2.14	1.50	Disagree
4	Little resources are required	37(23.72)	12(7.69)	3(1.92)	26(16.67)	78 (50)	3.62	1.68	Agree
5	I want to contribute to reducing waste	65(41.67)	12(7.69)	28(17.95)	12 (7.69)	13 (8.33)	2.66	1.64	Neutral
		Weighted average					3.14		

From this survey, it is observed that the primary driver for waste picking at Mwakirunge dumpsite is the lack of alternative employment, with over 80% of respondents citing unemployment as their main motivation. This strongly aligns with broader literature that identifies economic vulnerability as a key factor pushing individuals into the informal waste sector [17, 30]. Additionally, the perception that waste picking requires minimal resources such as capital, education, or formal skills highlights the accessibility of this livelihood option for marginalized individuals particularly those excluded from the formal job market. This situation displays the scarcity of employment opportunities not only in Mombasa County, but Kenya as a whole. It is also important to note that education is one of the requirements for any formal employment in Kenya and many other economies globally, and with low levels of education among the study participants, their chances are limited even if there are any openings.

Despite its ease of accessibility, waste picking is not widely perceived by waste pickers as an easy source of income. The low mean scores for this item, and the mixed responses, reflect the harsh, exploitative, and physically demanding nature of the work. Family influence was not a major factor, suggesting that most individuals join waste picking out of necessity rather than tradition or generational involvement. This contrasts with findings in other countries like Pakistan [96] where children were influenced to become waste pickers by their parents. However, our data supports research from Nigeria indicating that individual hardships and lack of parental support play a greater role [58].

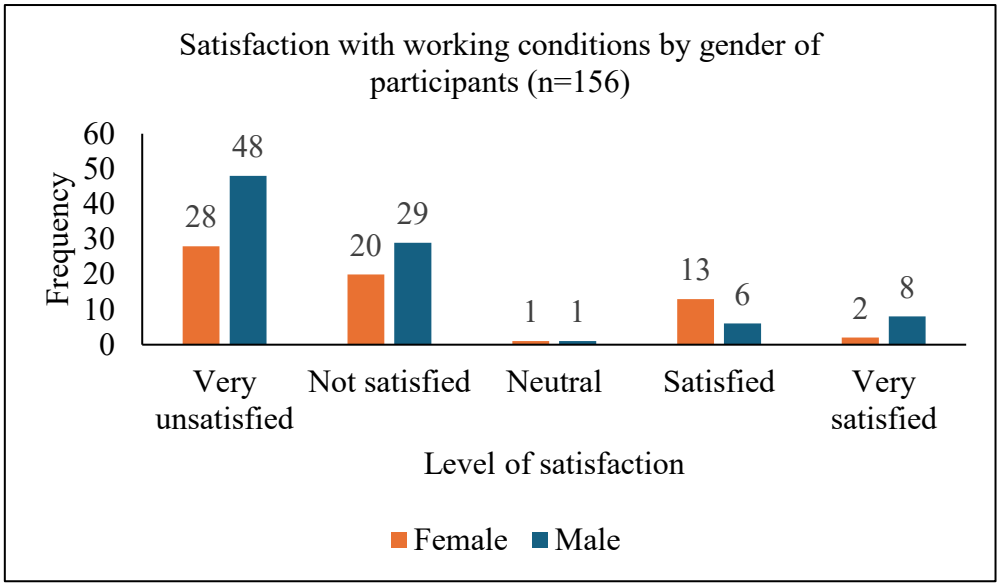
Moreover, the fact that very few respondents viewed their work as contributing to waste reduction suggests a gap in environmental awareness. Their motivations are primarily survival driven rather than ecological. This underscores the need for formalization programs that not only improve working conditions but also incorporate environmental education and empowerment.

4.2 Perspectives and perceptions of informal waste pickers on their challenges.

4.2.1 Satisfaction with working conditions

As shown in the figure 18 below, participants' satisfaction with working conditions at the dumpsite was low; a weighted mean of 1.97 (STD=1.27) signified dissatisfaction. Slightly less than half of the respondents 48.72% (n=76) were very unsatisfied while 31.41% (n=49) said they were unsatisfied. Two participants were undecided while the rest expressed their satisfaction with the dumpsite saying that the site gave them an opportunity to generate income and that was the most important thing. The Mann Whitney U test showed that the distribution of satisfaction with working conditions was the same across categories of participants' gender (p=0.572, 95% confidence level).

Figure 15: Satisfaction with working conditions at Mwakirunge Dumpsite



The findings of this study reveal a stark dissatisfaction among waste pickers at Mwakirunge dumpsite regarding their working and living conditions, with a low weighted mean score of 1.97 indicating widespread discontent. Nearly 80% of the respondents expressed dissatisfaction, citing unsafe and unsanitary environments, poor shelter, inadequate access to water and sanitation, and limited or no access to health care services and insurance. These findings mirror similar conditions observed among waste

pickers in Latin America and South Africa [62, 97], and underscore the marginalization and neglect of this group in urban waste management systems.

With the majority living and working within the dumpsite, waste pickers face systemic barriers that not only endanger their health and dignity but also contravene global commitments such as the Sustainable Development Goals (SDGs), particularly SDG 3 (health), SDG 6 (sanitation), SDG 8 (decent work), and SDG 10 (reduced inequality). The absence of basic services such as functioning toilet facilities, nearby healthcare, and clean water at Mwakirunge dumpsite highlights the lack of municipal recognition and support, further exacerbating their vulnerability.

These findings underscore the urgent need to formalize waste picking as a legitimate form of employment within the broader waste management system. Formalization should not only provide legal and social recognition but also ensure institutional support, including occupational health protections, access to sanitation, clean water, and inclusion in social protection schemes. The participants' suggestion to form groups for collective bargaining further emphasizes the need for organizing and representation in municipal and national decision-making processes.

Therefore, any policy or intervention aimed at improving waste picker conditions must be grounded in a rights-based and participatory approach. This includes upgrading dumpsites to environmentally safe sanitary landfills or, implementing controlled dumping practices, as successfully done in other countries [3]. Addressing these systemic challenges will not only enhance the dignity and welfare of waste pickers but also contribute meaningfully to inclusive and sustainable urban development in terms of efficient and effective waste management.

4.2.2 Health and safety challenges/risks

In this survey (See table 5), there was high overall exposure to health and safety risks (overall weighted average=4.17). The highest consistent exposure was to airborne hazards whereby majority of the respondents reported that they were always exposed to smoke (n=147, 94.23%), harmful gases (n=145, 92.95%) and dusts (84.62%, n=132). These gases arise from constant open burning of wastes at the dumpsite caused by internal pressure from piled wastes or burning by waste pickers, and dusts due to strong winds during dry seasons. These finding reflect a significant occupational hazard profile, consistent with existing literature which identifies air pollution and particulate exposure as major risks in informal waste work environments [20, 38]. Exposure to airborne contaminants at the dumpsite was also reported in Guinea-Bissau due to constant burning of hazardous and biomedical wastes [80].

Exposure to biological risks was moderate and varied (mean=4.00, ±1.15) whereby slightly more than half (53.21%, n=83) of the respondents said that they were always exposed. The biological risks included contact with dead bodies of animals, babies, faecal matter, and other infectious wastes from the hospitals. One respondent said, ‘one doesn’t know what is inside the bag of mixed wastes…you put your hands inside, get in contact with faeces of children from pampers, or sometimes a dead newborn....’ This finding aligns with studies by Makki (2017) and Andrianisa et al, (2016) that highlighted that informal waste workers frequently handle unsorted, decaying waste without protective gear, increasing risks of infectious diseases [71, 74].

The lower but present exposure to chemical risks (mean=3.0) and extreme weather (mean=3.31) echoes the findings of Aparcana (2017) and Hettiarachchi et al. (2018), who noted that chemical exposure is often underreported due to lack of awareness, while weather-related exposure is a growing concern, especially under climate change [11, 15].

Generally, the distribution of exposure to health and safety risks was the same across the participants' gender (p=0.286). These results emphasize the urgent need for occupational health interventions, including access to personal protective equipment (PPE), health training, and climate-resilient infrastructure, recommendations that Dias et al., (2016) highlighted [21]. Formalizing the waste sector, as various authors suggest, would help enforce health and safety standards and improve working conditions for informal waste workers.

Table 5: Frequency of exposure to health and safety risks at Mwakirunge Dumpsite

		Exposure frequency (%); n=156							
	Health risk	**Never**	**Rarely**	**Sometimes**	**Occasionally**	**Always**	**Mean**	**STD**	**Interpretation**
1	Harmful gases	0	0	7 (4.49)	4 (2.56)	145 (92.95)	4.88	0.[[44]]	Always
2	Biological risks	0	19 (12.18)	45 (28.85)	9 (5.77)	83 (53.21)	4.00	1.15	Occasionally
3	Dusts	0	0	3 (1.92)	4 (2.56)	132 (84.62)	4.83	0.[43]	Always
4	Smoke	0	2 (1.3)	3 (1.92)	4 (2.56)	147 (94.2)	4.90	0.46	Always
5	Chemical substances	18 (11.54)	28 (17.95)	53 (33.97)	33 (21.15)	24 (15.38)	3.11	1.21	Neutral
6	Extreme weather conditions	1 (0.64)	25 (16.03)	62 (39.74)	61 (39.10)	7 (4.49)	3.31	0.816	Neutral
		Weighted average					4.17		

Figure 16: Smoke from burning wastes (Photo by Author)

4.2.3 Exposure to causes of injuries

The data (see table 6) reveals that exposure to broken glasses is the most common physical injury risk, with the majority at 93.59% (n=146) of respondents reporting they are always exposed, resulting in a very high mean score of 4.89 (STD=0.43). Exposure to used needles was also found to be significant, with majority at 37.18% (n=58) experiencing frequent contact (mean = 4.05, STD=0.848). This is similar to a study done in Nigeria where exposure by waste pickers to contaminated needles from hospitals and broken bottles and other sharp objects was very common [79]. Despite these increased exposures, the use of personal protective equipment is limited among waste pickers at Mwakirunge, based on the observations during the survey.

Accidents like falls or motor vehicle incidents were infrequently experienced, with over half (54.49%) stating they had never been exposed, with a low mean score of 1.57 (STD=0.692). Long working hours are another key risk, with 57.69% of respondents always exposed and a mean score of 4.13 (STD=1.117). Overall, the weighted average score of 3.66 suggested that exposure to physical injury risks ranged between moderate to high levels of exposure. The distribution of exposure to physical injury risks was the same across categories of participants' gender (p=0.559).

The exposure to several types of physical injuries found in this survey is because of limited practice of source separation of wastes whereby all wastes are picked and transported to the transfer stations or final dumping sites in their mixed forms. This practice is very common in developing countries where MSW is not well managed and all wastes are mixed together including hazardous and infectious wastes from the hospitals [76].

Table 6: Frequency of exposure to physical injury risks at Mwakirunge Dumpsite

Sn		Exposure frequency (%); n=156					Mean	STD	Interpretation
		Never	Rarely	Sometimes	Occasionally	Always			
1	Broken/ sharp objects	0 (0)	0 (0)	7 (4.49)	3 (1.92)	146(93.59)	4.89	0.[43]	Always

Sn		Exposure frequency (%); n=156					Mean	STD	Interpretation
		Never	Rarely	Sometimes	Occasionally	Always			
	and glasses								
2	Used needles	0 (0)	2 (1.28)	46 (29.49)	50 (32.05)	58(37.18)	4.05	0.85	Occasionally
3	Accidents (falls, motor vehicles)	85(54.49)	53(33.97)	18 (11.54)	0 (0)	0 (0)	1.57	0.69	Never
4	Long working hours	4(2.56)	6(3.85)	46 (29.49)	10 (6.41)	90(57.69)	4.13	1.12	Occasionally
		Weighted average					3.66		

Figure 17: Exposure to truck accidents by young men during offloading.

4.2.4 Business challenges

As summarized in table 7 below, with the weighted average of 2.98, the distribution of business challenges was the same across the categories of participants' gender (p=0.647). Satisfaction among participants with income was moderate (mean=3.08, STD=1.79), and that while 38.46% (n=60) of participants strongly agreed they get enough money through waste picking, 35.26% (n=55) strongly disagreed. In terms of pricing of the recyclable materials collected, waste pickers have limited autonomy on deciding the prices. It is observed that most of the respondents (n=88, 56.41%) strongly agreed they allow buyers to determine the prices, with the mean of 3.94 (STD=1.50). additionally, female had more limited bargaining power (mean=84.35) than their male counterparts (m=74.32) though not statistically significant (p=0.129).

Limited price determination by waste pickers implies exploitation by the middlemen who take advantage of their situations. A respondent said that most of the times they weigh the bags together with the buyer then agree on the payment amount, but often, when it comes to the times of payment, the buyer changes tune and pay them less. The participant said, 'we agree on the price, then they will give you less money in the end, and you cannot question because they use their weighing scales which have lower values compared to ours.' This confirms a previous report by Morais et al., (2022) which stated that waste buyers buy recyclable materials from waste pickers at low prices but make huge profits after selling at higher prices to the manufacturing or recycling companies [17].

The study also found out that there is a high competition amongst waste pickers and intruders (mean=4.44, STD=1.22), as slightly more than three quarters of the respondents (78.21%, n=122) strongly agreed that competition for recyclable materials exists. The aspect of competition in Mwakirunge has favoured the strong male and youthful waste pickers over their elderly and women counterparts as they are often called upon by truck owners to help in offloading trucks. Moreover, there are groups of young men who have assigned themselves particular trucks, and no other persons can access the trucks before them. This gives them added advantages in getting more valuable recyclable materials which also have high competitions, often resulting in violence amongst themselves and other intruders who are only interested in the specific valuable recyclable materials. The violence reported in this survey confirms the findings of a survey done by Muindi et al., (2022) who recommended formalization of waste picking at Mwakirunge dumpsite to establish controls in the collection of recyclable materials by waste pickers in the dumpsite [56].

In this survey, transportation costs are not universally seen as high as most of the respondents 46.15% (n=72) strongly disagreed that the transportation costs were burdening them (mean=2.35, STD=1.57) while only 18.59% (n=29) strongly agreed. To understand this scenario, our interview with one of the itinerant waste buyers highlighted that waste buyers come close to the waste picking points with their trucks due to competition with other buyers and to relieve the waste pickers the burn of having to transport mixed recyclable wastes for long distances.

Another major challenge was lack of cleaning facilities at the dumpsite as more than three quarters of respondents (87.18%, n=136) strongly disagreed that they have cleaning facilities with a mean of 1.32 (STD=0.96) indicating very high perception. Lack of cleaning facilities in Mwakirunge dumpsite is justified by the inadequate water supply. This in return reduces the prices of the recyclable materials as waste buyers often argue that they must buy water on their own and hire other waste pickers to help in the cleaning prior to shipping to the manufacturing industries. An itinerant waste buyer said, 'recycling/manufacturing companies expect that the recyclable materials are slightly cleaned before they are shipped, forcing us to buy water and pay a few individuals here to clean for us before we can pack them for sale.'

Table 7: Waste Pickers' perceptions on business challenges at Mwakirunge Dumpsite

Sn	Extent of agreement, frequency (%), n=156						Mean	STD	Interpretation
	Statement	SD	D	N	A	SA			
1	I get enough money from this work	55(35.26)	17(10.90)	5(3.21)	19(12.18)	60(38.46)	3.08	1.79	Neutral

Sn	Statement	Extent of agreement, frequency (%), n=156 SD	D	N	A	SA	Mean	STD	Interpretation
2	I allow buyers to negotiate prices	23(14.74)	13(8.33)	3(1.92)	29(18.59)	88 (56.41)	3.94	1.50	Agree
3	There is competition with other waste pickers/intruders	11 (7.05)	9(5.77)	3(1.92)	11(7.05)	122(78.21)	4.[[44]]	1.22	Strongly Agree
4	Transportation cost is high	72(46.15)	28(17.95)	14(8.97)	13(8.33)	29 (18.59)	2.35	1.57	Disagree
5	I have cleaning facilities	136(87.18)	8(5.13)	1(0.64)	4(2.56)	7(4.49)	1.32	0.96	Strongly disagree
		Weighted average					2.98		

Figure 18: Preparation and transportation of recyclable materials (Author).

Female waste pickers transporting recyclable materials to itinerant waste buyers. Source (Author)

Mixed recyclable waste materials ready for sale. Source (Author).

4.2.5 Social challenges

According to this survey in table 8, there was a high perception on the fact that families of the respondents were aware of their work as waste pickers (mean=3.83, STD=1.86) as majority (66.67%, n=104) strongly agreed with this statement. While we observed mixed responses regarding participants' relationship with the landfill management, slightly more than half of the respondents at 51.92% (n=81) strongly agreed that their relationship with the landfill management was good. This had a mean score of 3.29 (STD=1.86). However, there exists lack of municipal support to the waste pickers (mean=1.79, STD=1.41) as majority of the respondents at 69.23% (n=108) indeed strongly disagreed that they get support from the municipality. Regarding this, participants noted that they faced harassment and lack of support in public

utilities like dispensaries and are often neglected during public health campaigns and outreaches for vaccination, family planning, screening for cancers and other chronic conditions among others.

Other social challenges reported were community stigma and violence among waste pickers and intruders. That is, more than half of the respondents at 58.97% (n=92) strongly agreed that they are called bad names by community members who are not waste pickers (mean=3.65, STD=1.77). During our discussions, waste pickers highlighted how the society looks down upon them generally but are very happy whenever they buy items from them especially food items. In public places, they are seen as dirty, called bad names, and during distribution of food aids and other items in the nearby communities, they are chased away. One respondent said, 'they call us dirty people, '*chokoraa*', criminals…but whenever we buy items from them, we are good people…'. Another respondent added, 'whenever we are fortunate to receive items like food aid distributed outside the dumpsite, the community will grab them from us by force and chase us away, saying that we are not part of them,'. These situations echo observations in Pakistan, Turkey and India where waste pickers are perceived as criminals, not part of the society, and dirty [72, 73, 74].

In Kisumu (Kenya), the society have bad perception on waste pickers despite some residents recognizing the importance of waste pickers in solid waste collection services [99]. In South Africa, waste pickers were being denied access to waste bins which severely disrupted their livelihood [68]. The results of stigmatization to waste pickers often prevent them from accessing socioeconomic capital like income, education, wellbeing, housing and health as reported leading to cases of social disorder like increased crime rates, drug abuse and overdependence on social welfare [71].

In terms of facing violence, slightly more than half of the respondents (52.26%, n=81) strongly agreed with this statement (mean=3.62, STD=1.71). Participants also expressed very low perception regarding security of the dumpsite as majority (n=109, 69.87%) strongly disagreed they are secured at the dumpsite (mean=1.75, STD=1.35). This scenario confirms the earlier research by Muindi et al., (2022) who highlighted the insecurity situation at Mwakirunge dumpsite, and later suggested formalization of waste picking to promote and curb intruders [56]. With reference to a weighted average of 3.00, an independent samples t-test showed that the difference in the distribution of social challenges across the participants' gender was statistically significant (p=0.045).

Table 8: Waste pickers' perceptions on social challenges

		Level of agreement Frequency (%) n=156							
Sn	**Statement**	**SD**	**D**	**N**	**A**	**SA**	**Mean**	**STD**	**Interpretation**
1	I have a good relationship with the landfill management	52(33.33)	16(10.26)	4(2.56)	3(1.92)	81 (51.92)	3.29	1.86	Neutral
2	My family members are aware of my work	39 (25)	6(3.85)	1(0.64)	6(3.85)	104(66.67)	3.83	1.75	Agree

Level of agreement Frequency (%) n=156									
Sn	**Statement**	**SD**	**D**	**N**	**A**	**SA**	**Mean**	**STD**	**Interpretation**
3	I am called bad names by the community	40(25.64)	13(8.33)	0	11(7.05)	92(58.97)	3.65	1.77	Agree
4	I face violence from other waste pickers	38 (24.52)	12(7.74)	2(1.29)	22(14.19)	81(52.26)	3.62	1.71	Agree
5	I receive support from the municipality	108(69.23)	17(10.90)	6(3.85)	5(3.20)	20(12.82)	1.79	1.41	Strongly disagree
6	I am secured	109(69.87)	19(12.18)	1(0.64)	12 (7.69)	15 (9.62)	1.75	1.35	Strongly disagree
		Weighted average					3.00		

4.2.6 Prevalence of diseases/events of public health importance

From this survey, all respondents experienced tiredness with majority of the respondents at 75% (n=117) reporting that they always felt tired (mean=4.62, STD=0.71). Other conditions with higher frequency of occurrence reported were headache (mean=3.61, STD=0.84), musculoskeletal diseases like backpains (mean=3.49, STD=0.94) and respiratory illnesses (mean=3.44, n=1.26). With these conditions, majority of the respondents reported that they sometimes experienced at 50.64% (n=79), 53.21% (n=83) and 41.02% (n=64) respectively.

Diarrhoea was moderately experienced with a mean of 3.16 (STD=0.77), whereby most of the respondents at 73.72% (n=115) said that they sometimes experienced diarrhoea. Eye problems and skin infections were less frequent among the respondents (mean=2.21; STD=1.18 and mean =1.88, STD=1.05) respectively. Majority of the respondents reported that they had never experienced eye problems and skin infections at 35.26% (n=55) and 50% (n=78) respectively.

The weighted average frequency of disease occurrence is 3.20, indicating that on average, respondents sometimes experience the above health issues, with some conditions occurring more frequently than others. The Mann Whitney U (independent sample) tests showed that the distribution of frequency of occurrence of the diseases or event of public health importance was the same across categories of participants' gender (p=0.308)

Tiredness, headaches, musculoskeletal disorders, and respiratory illnesses are the most common health complaints, linked to frequent exposure to health and safety risks (e.g., smoke, harmful gases). Meanwhile, eye problems and skin infections occur infrequently.

Table 9: Frequency of occurrence of diseases/events of public health importance at Mwakirunge Dumpsite

	Disease	Frequency of occurrence (%); n=156					Mean	STD	Interpretation
		Never	Rarely	Sometimes	Occasionally	Always			
1	Respiratory illnesses	14(8.97)	14(8.97)	64(41.02)	17(10.90)	47(30.13)	3.[[44]]	1.26	Neutral
2	Tiredness	0(0)	0(0)	21(13.46)	18(11.54)	117(75)	4.62	0.71	Always
3	Musculoskeletal diseases	3(1.92)	9(5.77)	83(53.21)	30(19.23)	31(19.87)	3.49	0.94	Occasionally
4	Headache	1(0.64)	4(2.56)	79(50.64)	[43](27.56)	29(18.59)	3.61	0.84	Occasionally
5	Eye problems	55(35.26)	39(25)	38(24.36)	16(10.26)	8(5.13)	2.21	1.18	Rarely
6	Skin infections	78(50)	31(19.87)	38(24.36)	5(3.21)	4(2.56)	1.88	1.05	Never
7	Diarrhoea	6(3.85)	5(3.21)	115(73.72)	18(11.54)	12(7.69)	3.16	0.77	Neutral
		Weighted average					3.20		

This study has revealed the precarious working conditions faced by informal waste pickers at the Mwakirunge dumpsite in Mombasa County, Kenya. The findings highlight a troubling reality whereby despite waste pickers playing a critical role in waste recovery and environmental protection, they continue to operate under unsafe, unhealthy, and unregulated conditions. Any formalization approach must be designed to meet the health and safety needs of this group. Without these actions, waste pickers will remain vulnerable. With proper support, they can contribute safely to sustainable waste management.

4.2.7 Training programs and prevention practices among informal waste pickers at Mwakirunge Dumpsite, Mombasa County (Kenya)

The survey findings (see table 10) reveal significant gaps in training, vaccination, and consistent use of personal protective equipment (PPE) among waste pickers at Mwakirunge. Only 23.1% of respondents reported ever participating in any form of training, with most of these trainings focusing on health and safety (48.6%) and waste management (45.7%). Critical areas such as disease prevention (25.7%) and substance abuse awareness (8.6%) received minimal attention, indicating insufficient coverage of relevant occupational health topics.

Preventive health practices were also found to be inadequate. Only 19.9% (n=31) of respondents had received hepatitis vaccinations, while 53.9% reported being vaccinated against tetanus. This low immunization coverage exposes the workers to preventable infectious diseases, especially given the hazardous nature of their work and living environments.

Although 91.7% of respondents demonstrated awareness of PPE benefits, only 30.8% reported always using them. A significant 26.3% never used PPEs at all. The main barriers to consistent PPE use included lack of affordability (72.6%), absence of mandatory enforcement (35.8%), and the perception that PPEs are only necessary when handling dangerous materials (29.2%).

Table 10: Training and preventive practices at Mwakirunge Dumpsite

	Variable	Frequency	Proportion (%)
1	**Participated in a training**	n=156	
	Yes	36	23.1
	No	120	76.9
	Training topics (MCQs)	n=36	Percent of cases
	Health and safety	17	48.6
	Waste management/recycling	16	45.7
	Disease prevention	9	25.7
	Finance	4	11.4
	Alcohol and drug abuse	3	8.6
2	**Hepatitis vaccination**	n=156	Proportion (%)
	Yes	31	19.9
	No	125	80.1
3	**Tetanus vaccination**	n=156	Proportion (%)
	Yes	84	53.9
	No	72	46.1
4	**Frequency of PPEs use**	n=156	Proportion (%)
	Always	48	30.8
	Occasionally	14	9.0
	Sometimes	37	23.7
	Rarely	16	10.2
	Never	41	26.3
	Reasons for NOT ALWAYS using PPEs (MCQs)	n=108	Percent (%) of cases
	I cannot afford	77	72.6
	It is not mandatory	38	35.8
	I only use when handling dangerous materials	31	29.2
	Make me feel uncomfortable	10	9.4
	My colleagues do not use them	2	1.9
5	**Knowledge on PPEs use benefits**	n=156	Proportion (%)
	Yes	1[43]	91.7
	No	13	8.3

The limited scope and reach of training in our study reflect broader trends observed in other developing countries as reported by Aparcana et al,. 2017, where training programs for informal waste workers are often limited and fail to address the comprehensive needs of waste pickers [15, 92]. In contrast, evidence from countries like Brazil and India suggests that continuous training and cooperative organization significantly improve working conditions, health outcomes, and waste recovery efficiency [99]. These examples highlight the potential benefits of structured and inclusive training programs tailored to the needs of waste pickers. By investing in such programs, Mombasa County can empower waste pickers with practical knowledge and skills, contributing to safer working conditions, improved livelihoods, and the gradual formalization of the informal waste sector in general.

The low vaccination coverage among waste pickers in Mombasa County highlights a major public health concern, especially given their high exposure to sharp objects and biomedical waste. This eventually increases their risks to preventable and communicable infections, which they can spread to the entire population. This finding aligns with previous literature, which emphasizes the vulnerability of informal waste workers to occupational health risks due to limited access to health services and preventive care. For example, Samson (2009) noted that waste pickers often operate outside formal health systems, making it difficult for them to access vaccinations and safety equipment [92](92). Similarly, Aparcana (2017) highlighted that informal waste workers are commonly excluded from public health programs like vaccination campaigns, thereby increasing their risk of disease infections [15].

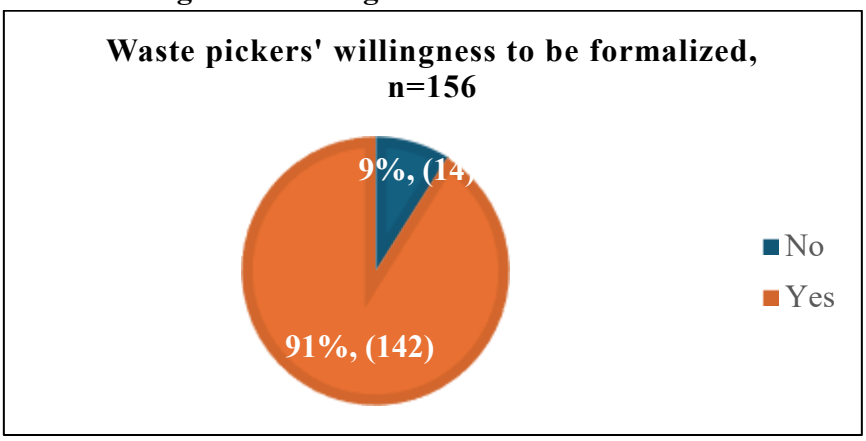
Regarding the use of personal protective equipment (PPE), the findings of this study are in consistent with the previous studies. For example, in Indonesia less than a quarter of the waste pickers used PPEs regularly despite majority of them (more than 65%) noting constant respiratory and injury risk exposures [100]. Notably, despite high proportions of study participants being aware of the benefits of safety practices especially on PPE use (91.7%), the actual implementation of preventive measures remains limited due to systemic barriers such as poverty, lack of regulation, and inadequate training programs. These findings highlight that economic constraints and a lack of enforcement are the most significant obstacles to regular PPE use among waste pickers at Mwakirunge dumpsite.

Figure 19: Waste pickers sorting recyclable waste materials without PPEs (Author)

4.3 Willingness to be formalized

The study found a strong overall willingness among waste pickers at Mwakirunge dumpsite to be formalized, with majority at 91% (n=142) of respondents expressing readiness to be registered and be formalized into groups. On the other hand, 9% (n=14) of respondents were hesitant to be formalized (See figure 19). A chi-square test revealed no statistically significant association between gender and willingness to be formalized (p=0.884).

Figure 20: Willingness towards formalization.



The high level of willingness among waste pickers at Mwakirunge dumpsite to be formalized highlights the strong potential for successful and sustainable formalization initiatives. Community acceptance is widely regarded as a key driver of long-term program success, and in this context, the positive response suggests a readiness for transition, particularly when linked to improved income, safer working conditions, and access to social protection. This finding is consistent with the reports of earlier research that waste pickers welcome formalization with the desire of gaining not only economic and health-related benefits but also legal recognition, labour rights, and representation [16, 20, 21, 29, 63, 92, 101]. The convergence of these motivations across different geographic contexts highlights that with proper design, stakeholder engagement, and support mechanisms, formalization efforts are likely to gain traction and deliver long-term social and economic benefits both to the waste pickers and the municipal solid waste management systems in Mombasa County.

While this study showed a high proportion of participants' willingness to be formalized (91%), a similar study by Kasinja et al., (2018) in Malawi showed that only less than half of surveyed waste pickers expressed their willingness to be formalized [16]. This disparity may be attributed to contextual and methodological differences. While the Mwakirunge study focused on randomly selected dumpsite-based pickers, the Malawi study used snowball sampling to reach waste pickers operating in city streets settings. This disparity highlights how waste pickers' working environments and lived experiences such as operating in dumpsites versus urban streets can significantly influence their perceptions of formal organization. According to Aparcana et al., (2017), successful formalization strategies must be context-specific, responsive to local conditions, and informed by the unique needs and dynamics of target groups [15, 20]. This implies that any policies and approaches to formalize and integrate waste pickers into formal systems in Mombasa County should avoid one-size-fits-all approaches and instead be tailored to the sociocultural and occupational realities of each setting.

4.3.1 Waste pickers' aspirations if formalized

Based on our data (see table 11), most of the participants expressed a strong willingness to be formalized, primarily with the expectation of increased income (90.1%) from their daily activities of collecting and selling recyclable wastes, as well as gaining access to better working conditions (73.2%). Other notable motivations included receiving social benefits like health insurance and loans (39.4%), obtaining legal recognition including enhanced support from the municipality (31.0%), and gaining access to training and other resources (28.9%). The most cited reason for willingness in study (increased income) align with the

previous studies which emphasized that stable and enhanced earnings are among the most tangible benefits expected from transitioning into formal systems [15, 29].

Another major motivator in this study is access to better working conditions. Informal waste pickers are often exposed to hazardous materials, poor sanitation, and unregulated labour environments. The desire for occupational safety in this study echoes findings by Antonia et al., 2019 [63, 101], who documented waste pickers' concerns about health risks and their hope for safer, better-structured work environments under formal schemes.

Social benefits such as access to health insurance and loans, were also key motivators. This is supported by Medina (2007), who highlighted the exclusion of informal workers from social protection mechanisms and the transformative impact that formalization can have on their social security and dignity [20]. Also, legal recognition and access to training and resources point to a broader aspiration for institutional support, legitimacy, and capacity building. These findings are consistent with Aparcana (2017), who argued that recognition by local authorities and training programs enhance waste pickers' productivity, bargaining power, and sense of identity [15].

The strong interest among waste pickers in income stability, safer working conditions, and social benefits highlights a clear opportunity for inclusive policy development. Formalization programs should therefore focus on economic empowerment, health and safety, and social protection to enhance acceptance and sustainability. Active involvement of local authorities is key to providing legal and technical support for integration. Ultimately, formalizing informal work supports broader SDG goals, including decent work, reduced inequalities, and sustainable urban development.

Table 11: Aspirations for willingness towards formalization

	For willingness	n=142	Percent (%) of cases
1	Increased income	128	90.1
2	Access to better working conditions	104	73.2
3	Access to social benefits	56	39.4
4	Legal recognition	44	31.0
5	Access to training and resources	41	28.9

Among the 9% (n=14) of waste pickers unwilling to be formalized, the primary reason cited was a preference for working alone (42.86%). Other reasons included the desire for flexibility (14.29%), fear of conflict (14.29%), spousal disapproval (7.14%), and the belief that formalization is better suited for the younger generation (7.14%). The rest (14.29%) provided no specific reason (see table 12). The desire to work independently and maintain flexibility suggests a value placed on autonomy, which formal systems may threaten. Other barriers like fear of conflict, spousal disapproval, and age-related perceptions highlight the influence of household dynamics and generational attitudes which must be given the necessary attention.

Table 12: Reasons for unwillingness to be formalized.

	Reasons	n=14	Proportion (%)
1	I prefer to work alone	6	42.86
2	I want freedom/flexibility	2	14.29
3	I am afraid of conflicts	2	14.29

	Reasons	n=14	Proportion (%)
4	My husband will not allow that	1	7.14
5	It is suitable for young generation	1	7.14
6	No reason	2	14.29

4.3.2 Municipal views on formalizing informal waste pickers in Mombasa County

Key informant interviews with Mombasa County's formal waste management actors, including the County Executive Committee Member (CECM) for Environment and Japan International Cooperation Agency (JICA) staff, highlighted the important role played by informal waste pickers in the city's waste management chain. They emphasized the need to formally recognize and integrate waste pickers into future strategies, particularly in recycling which is emphasized in the National Sustainable Waste Management Policy.

However, there was strong consensus that waste picking at the Mwakirunge dumpsite should be phased out. A JICA staff member stated, "Valuable materials should not reach the dumpsite... we must reduce the waste taken to the dumpsite at the generation points." Concerns were raised about the high health and safety risks at the site, including open leachate, risk of fire, and structural hazards that have caused fatalities in countries like Mozambique and Uganda. The municipality staff added, "living within Mwakirunge dumpsite is dangerous... we want them to work and collect recyclable materials near households and waste collection points, far away from the dumpsite." These insights support formalization efforts not only to improve efficiency in waste recovery but also to uphold the safety, health, and dignity of waste pickers in line with sustainable urban development goals.

The observations during the survey support the above sentiments. Some of the temporary dwellings of the waste pickers are located along the pathways of trucks bringing wastes to the dumpsite. This endangers their lives as they are exposed to accidents, smoke, fires, and noise pollution, as well as the leachate that stagnate near the dwellings. The municipality staff acknowledged that the plan is to recognize the waste pickers, register them and license them to work at the waste collection points and households as alternatives to dumpsite surroundings. This is because they have enhanced ease of access to recyclable materials both from the points of generation and the waste aggregation/collection points.

To encourage waste pickers' relocation from the dumpsite to the waste collection points or points of generation, it necessary to consider that waste should be sorted and separated at generation points, such that all wastes taken to the dumpsite contain fewer recyclable materials. By doing this, waste pickers at the dumpsite will have limited access to recyclable materials and will be forced to move closer to waste generation points, or primary collection points.

4.4 In depth interview with the itinerant waste buyer

The itinerant waste buyer provided critical insight into the operations, challenges, and dynamics of the informal recycling economy: This is summarized in table 13 below.

Table 13: In-depth interview with itinerant waste buyer

Sn	Theme	Key points
1	**Daily operations and waste volumes**	• On a normal day, the buyer collects 1 tonne of recyclable materials, increasing to up to 3 tonnes on peak days. • Collectively, all itinerant buyers at the dumpsite buy up to 10 tonnes of recyclables daily. • Common materials include PET bottles, metals, plastics, tins, boxes, sacks, and nylon. • Prices vary significantly: "One kilogram of copper can cost up to Ksh.600."
2	**Material handling and pricing**	• Waste pickers deliver mixed recyclables in sacks (30–60 kg each). After inspection and further sorting (removing ~5 kg), payment is made based on weight. • The buyer emphasized: "I must consider buying all the wastes in a sack. This is done by all other waste buyers… otherwise they gang against you."
3	**Buyer-waste picker relationship**	• Building rapport is essential: "I work with 5 waste pickers specifically whom I pay Ksh.300 per day. I give them meals, or we prepare food together on site." • Overall, he works with up to 40 waste pickers daily. • Support goes beyond payment includes food and occasional employment.
4	**Critique of NGO involvement**	• The buyer was critical of some NGOs: "They train and equip the waste pickers… but do not provide start-up programs." • He advocated for sustainable livelihood support: "They need to be enlightened… and provided with capital to start poultry, pig rearing, and farming."
5	**Relationship with the Municipality**	• Positive relations exist for licensed buyers, though he urged more inclusive support: "Some of the revenues government collects… should also be used to support waste pickers… through provision of PPEs, health facilities, insurances." • He cited tragic consequences of neglect: "A boy was recently involved in an accident with a waste truck… due to lack of health facilities, he died."
6	**Community initiatives**	• Some buyers, including the respondent, are initiating grassroots programs: "I have come up with an initiative called 'one plus one initiative'… to engage them in income generating activities like poultry, bee keeping, and farming."

Sn	Theme	Key points
7	**Child involvement in waste picking**	• The buyer highlighted poverty as a driver for children working at the dumpsite: "Children here do not find any importance of going to school because they stay there hungry." • He recommended school feeding programs as a solution: "In Kiambu County, there is a system called 'tap tap system'… each child pays Ksh.25 daily for breakfast and lunch."

CHAPTER 5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study underscores the importance of addressing informality within Mombasa County's waste management sector as part of broader efforts to realize sustainable waste management systems. The findings support the feasibility of formalization as a viable strategy, provided it is approached comprehensively and inclusively. However, sustainable waste management cannot be achieved through a single intervention. It requires a multi-faceted approach that includes education and public awareness, policy reform, stakeholder engagement, use of appropriate technology and a strong collaboration among all the stakeholders involved in the waste management sector. These elements are essential to building a resilient, socially inclusive, and environmentally sound waste management system in Mombasa County and other cities of developing countries.

This research offers a critical foundation for developing policies and programs that support the integration of informal waste actors, contributing to Kenya's ongoing transition toward a circular economy and sustainable urban development.

5.2 Limitation

The study was limited in its ability to quantify the contributions of informal waste pickers in terms of amounts of specific recyclable materials collected. This was due to the practice of sorting mixed recyclables into bags, which were then sold to itinerant waste buyers who conducted further sorting based on market demand. Additionally, the Mwakirunge dumpsite lacks a weighbridge, making it impossible to estimate the total volume of waste dumped by trucks. This makes it difficult to estimate the approximate amounts of wastes reduced from being landfilled by the informal waste pickers. Nonetheless, valuable insights into the flow of recyclable materials were obtained through interviews with itinerant buyers, shedding light on the journey of recyclables from waste pickers to final manufacturing markets. This calls for further research to understand and quantify the approximate quantities of recyclable materials by waste pickers, of course in consideration with the infrastructural improvements.

5.3 Recommendations

In line with the results of this research, formalization should not only focus on registration and recognition of waste pickers but also to ensure that the challenges and issues reported are minimized. We therefore recommend the following.

1. The local authority in collaboration with the municipality of Mombasa County to facilitate registration of all waste pickers by issuing them with national identification (ID) cards which are necessary for formalization processes.

2. Promote health and safety practices through provision of WASH facilities, regular training, provision of important of vaccinations.
3. Develop engineered sanitary landfills with proper zoning and access control (fencing and a gate).
4. Itinerant waste buyers must be engaged throughout the formalization process. This is because they work very closely with the waste pickers and therefor have the potential of sabotaging the entire process if left out.
5. We recommend establishment of material recovery facilities within the dumpsite which can be monitored by the municipal staffs at the dumpsite to ensure waste pickers are not exploited in terms of pricing of the recyclable materials.
6. Controlled dumping should be promoted to limit accidents from trucks as well as ensuring equality of opportunities regarding access to recyclable materials. This will ensure that women and the elderly also have equal opportunities to collect recyclable materials without being harassed by the young energetic male waste pickers.

Ethical considerations and approval

The study observed all the ethical concerns and codes of ethics in research that involves human population. Prior to conducting the research, ethical clearance and approval was obtained from the Institutional Review Board (IRB) of Toyo University (Approval number; GRS Y2024-0008). Permission to access and conduct survey in the study site was sought from the department of Solid Waste Management in Mombasa County, Kenya. Data collection from respondents was preceded with obtaining informed verbal consent from each participant by asking them for their willingness to participate in the study and their responses of either yes or no were recorded at the beginning of the questionnaires. Participants under the age of eighteen (18) years were excluded from the study. All the other procedures were carried out in compliance with the applicable rules and regulations including storing data in password secured laptop and maintaining anonymity of respondents.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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