



NEAR EAST UNIVERSITY
INSTITUTE OF GRADUATE STUDIES
DEPARTMENT OF ENVIRONMENTAL EDUCATION AND
MANAGEMENT

CHALLENGES AND IDENTIFICATION OF SOLID WASTE
MANAGEMENT IN MONROVIA CITY, LIBERIA

MASTER THESIS

N. ROBERT KERKULAH GENINYAN

Nicosia

December, 2022

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December, 2022

Approval

We attest to having read the thesis submitted by N. Robert Kerkulah Geninyan titled "Challenges and Identification of Solid Waste Management in Monrovia City, Liberia". In addition, we are of the view that it fulfills all of the requirements, both in terms of its breadth and its level of quality, to be a thesis for the Master of Science degree.

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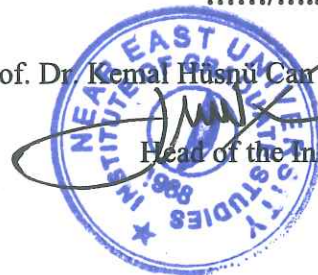
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Declaration

I hereby declare that all information, documents, analysis, and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of the Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

N. Robert Kerkulah Geninyan

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Dedication

This research honors my beloved family for their unwavering support of me. You all remained by my side as my rock when the sky was cloudy, but I was unable to see due to the tears in my eyes. Even though studying abroad has been difficult, you have motivated me.

I also dedicate this work to my loving wife, Mrs. Nowah Flomo Geninyan, my late parents Mr. & Mrs. Geninyan, Honorable Moses Y. Kollie and Mr. Victor M. Collins whose prayers and encouragement have been instrumental in my success. I appreciate every little sacrifice you have made, and I am aware of them.

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I am grateful for the prayers and support of my family and friends while I was away. To overlook my coworkers the ministry of Agriculture staff in Bong County and the Liberian Student Union in Northern Cyprus would be regrettable. I value the reviewers' anonymous comments on my thesis. Thank you to those whose names I may not have stated or recalled.

N. Robert Kerkulah Geninyan

Abstract

Challenges and Identification of Solid Waste Management in Monrovia City, Liberia

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Poor solid waste management procedures can have a variety of harmful effects on the environment and people's health. Therefore, having efficient solid waste management systems can aid in minimizing these adverse effects. Finding the processes behind solid waste management methods in Monrovia, Liberia, was the study's main goal. Using a standardized questionnaire, information was gathered from 400 (female: 294; male: 106) volunteers from four key areas in the city. During the field data collection, a straightforward random sample strategy was employed. According to the findings, the majority of the solid trash they produced 47.79% came from leftover food, followed by plastic (28.25%), paper (18.2%), metal (1.51%), and others (4.16%). An individual produced 0.3 kilograms of solid garbage on average each day. The majority of interviewees (384, or 96%) admit that they have never sorted recyclables from trash. 384, or 89 percent, of the collecting, is done by kids. The majority of respondents (almost all) admitted to engaging in illegal solid waste management methods, including burning in the complex (394, or 98.5%); dumping in their yard (294, or 73.5%); disposing in the ditch (275, or 68.8%); and disposing on the road (312, or 78%). This was validated throughout the gathering of field data, and it represents one of the main dangers to human health. This study also demonstrated that the studied region lacked an effective solid waste management system. The respondents confirmed the absence of any government engagement, community interaction, door-to-door solid trash collection service, and clear environmental policies and laws. They said that the government only attempted to raise awareness during certain epidemics, such as Ebola and COVID-19. Therefore, it is advised that the government focus more on introducing and raising awareness of the nation's policies and strategies. There should also be good lessons (techniques) for managing solid waste brought to the country from other parts of the world.

Keywords: Identification and Challenges, Identification, Solid Waste Management, Monrovia City, Liberia

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CHAPTER I

Introduction

Background

Solid waste refers to the unwelcome and pointless results of human and animal activities that are mostly made of solid materials. Industrial, social, and agricultural activities can all contribute to them. Solid waste is an inevitable part of life, and it looks different in each culture. Solid waste management is the umbrella term for all activities related to solid waste (Maria et al., 2020). These duties comprise all aspects of storage, collection, transport, handling, processing, and disposal. Social, economic, public health, and technological considerations are the main themes that should be kept in mind while handling solid waste. This endeavor can benefit from a variety of aspects, including financial, legal, planning, engineering, sociology, public health, and communication. These make managing solid waste more difficult (Sharma et al., 2020).

Choosing the most efficient waste treatment technology, limiting environmental impact, and educating the public about garbage separation are just a few of the many issues that might arise with waste management (Fernando, 2019). The solid waste management system is a complex one due to multiple waste treatment methods as well as several other economic and technological concerns. In contrast to industrialized countries, many less developed countries, like Liberia, have just one choice for disposing of waste: landfills. But landfills have detrimental consequences for both people and the environment as a whole (Marshall and Farahbakhsh, 2013).

Uncollected solid waste poses a major threat to public health because it regularly transmits contagious illnesses like cholera and dysentery, which are watery diseases (Kwun et al., 2021). Such sickness prevalence increases the burden on the limited health care provided in developing countries with limited resources. The rubbish attracts rats and bug vectors. (Nicholas, 2018) Unchecked waste fermentation contributed to the epidemic by making it easier for rodents and insects that spread disease to grow and have babies.

According to a study by the WHO, in 1994, Angola, Malawi, Mozambique, and Tanzania recorded 616,960 cases of cholera, resulting in 4,389 fatalities (1995).

Water that seeps through waste is likely to spread viruses like hepatitis, poliomyelitis, and gastroenteritis into the groundwater. These viruses can cause dysentery, cholera, and even long-term health problems (Sarder, 2017).

The most immediate health danger associated with solid waste is faced by trash workers, rag pickers, and scavengers in impoverished countries. There are few protections in place in underdeveloped countries to protect garbage workers and rag pickers from direct contact and injury. Combining hazardous and medical wastes with municipal rubbish poses a serious health concern. (Majumder and Karim, 2012; Alam and Ahmade, 2013). Other factors that affect health are burning trash in the open, making dust when getting rid of trash, and the exhaust emissions from garbage trucks.

Garbage is generally burned indiscriminately at disposal facilities in less developed countries. Burning causes heavy metals like lead, toxic gases, and smoke to be spread throughout residential areas. In addition, the wind carries trash, dust, and decomposition smells (Ayilara et al., 2020). Air pollution brought on by the burning of garbage and the release of toxic gases has many detrimental consequences for the environment and human health (Medina 2002). Manisalidis et al. (2020) say that when waste rots in the open, it causes bad smells, blurred vision, and a general lack of atmosphere.

The main barrier to a sustainable solid waste management system is the fact that several persons, groups, and organizations are involved with rubbish as service customers, service providers, intermediaries, and/or regulators. The goals, functions, and conflicts of these participants weave an intricate web that establishes and characterizes the typical waste management system in each developing nation (Goggins, 2018). In urban regions, it has long been believed that the local municipal government is in charge of trash collection and disposal (the formal public sector). The local government's supply of a waste management system, however, is often inadequate, centralized, top-down, and, in most instances, inefficient in a scenario involving a poor country. Then, in many developing countries, garbage has turned into a thriving informal sector that feeds a big part of the urban poor (Kohler, 2019).

Statement of the Problem

Poor and lax laws, particularly in sub-Saharan Africa, have had a significant negative impact on these nations and other nations across the world that improperly

dispose of their solid waste. People's health could be hurt by the spread of infectious diseases, an increase in the number of insects, and the breeding of rodents, as has been seen in Tanzania, Mozambique, Angola, Malawi, and of course, Liberia, especially in the city of Monrovia.

Its impact on the environment is undeniable as it is the main source of greenhouse gases (GHGs); surface and ground water contamination is of course the main concern in the city; stunted economic growth due to a lack of basic finance and infrastructure; and uncontrolled population growth are some of the major concerns. Improper solid waste disposal threatens the realization of human health as it places an additional burden on the meager health services available in the city. Due to this, the majority of homes are at risk for serious health problems and a fragile ecology.

Since unregulated solid waste crosses local, national, and international boundaries, its impact on people and the environment must be reduced (Nanda and Berruti, 2021), primarily through the exchange of cutting-edge technology for recycling and repurposing waste products. Major cities, which continue to be a significant environmental pollutant, haven't received much attention from local governments or the international community, even in non-developed nations like Liberia. Due to the fact that there are virtually no policies or regulations in place to handle solid trash, the people of Monrovia City are particularly seen as dumping waste products everywhere.

In order to understand the reasons for incorrect garbage disposal in the city, which can have both direct and indirect consequences on people and the environment, it is critical to identify the mechanisms of solid waste management practices in the city of Monrovia. For any solid waste management operations, it is essential to comprehend the processes, such as the current partnerships and collaborations, residents' perspectives on solid waste management, and the efficacy of the available policies and plans. Any policy changes must take into account what the local farmers think and care about, since they are so important to the success of the initiative.

To lessen the detrimental effects of solid waste on people and water resources, the Liberian government has devised policies and plans to manage the solid waste for the city of Monrovia in accordance with the national environmental and trash disposal strategy. Despite the numerous policies, the citizens of Monrovia City's failure to comprehend how improper garbage disposal might harm their health

and the environment in general hinders the efficacy of the policies and plans. Similar to this, poor decision-making with regard to policy implementation has resulted from low perception among policy decision-makers and other stakeholders. Since they are crucial participants in the process, it is necessary to evaluate the procedures put in place for appropriate solid waste management as well as the extent of the coordination and collaboration among the many stakeholders in the city of Monrovia, Liberia. As accurate and timely data from the field is collected, this study fills in the gaps in research by looking at the mechanisms or factors that affect the right way to handle solid waste.

Objective of the Study

General Objective

The overall objective of the study was to assess the mechanics of effective solid waste management in Monrovia city, Liberia.

Specific Objectives

More specifically, the research was intended to:

- Examine the effectiveness of the solid waste management practices in Monrovia city, Liberia.
- Evaluate the coordination and collaboration efforts by different stakeholders in the study area.

Research Questions

- What are the major solid waste management mechanisms in the study area?
- What is the contribution of the local community and other stakeholders and their level of cooperation and coordination in the solid waste management activities?
- What is the extent of waste separation in the study area?
- What is the level of the communities' awareness on the importance of solid waste management and its associated impact to the environment and the human health?

- How adequate are the policies and legal frameworks, and the environmental legislations in managing the solid waste in the study area?

Significance of the Study

This research assessed the methods used to manage solid trash in the Liberian metropolis of Monrovia. As for the advantages of this research, it will advance science by gathering real-world data that can be used to compare it to current solid waste management procedures and related problems. These details have aided in alerting people to the environmental pollution problems that are currently causing cyclones, typhoons, storms, and other hazardous weather in various regions of the world. So, the results of this study will help both the people who live in the area and other people and groups.

It is critical to assess the city of Monrovia's current solid waste management procedures if you want to be aware of what is really going on both at the local level and throughout the city. Every human being depends on sustainable and ecologically responsible solid waste management practices; thus, city residents must be aware of these practices' effects in order to make the necessary preparations and to be knowledgeable about the state of the environment in the future. Other decision-makers, such as those in government and non-government organizations and policymakers, could use the information to ensure adequate solid waste supplies and landfills; issue alerts in the event that people in any part of the city improperly dispose of solid waste, assess risks, and take preventative action, among other things. Students and academics could also use the results as a source of information for more research on how to deal with solid waste and environmental issues.

Limitation

Despite its significance, this study's scope was constrained by time and financial constraints to the Liberian capital city of Monrovia. However, inappropriate solid waste management is a significant concern in every other city in Liberia. Additionally, despite time constraints, the participants' varied attitudes and ages, high costs, different standards of living, and the lack of detailed information on the research questions from the participants, which prevented every chosen participant from being interviewed, this study directly or indirectly involved numerous people and communities. Many of the respondents declined to take part in the survey

because they felt that it would interfere with their personal lives. As a result, since the results were entirely dependent on the replies of the respondents, they might differ from the real facts on the ground. If the study was bigger and had more time and money, its reliability and validity might be better.

CHAPTER II

Literature Review

Solid Waste

Over 2 billion tons (BT) of solid waste are produced annually in large cities around the world, with estimates showing that number would rise to 3.4 BT by 2050, particularly in developing nations where the pace of garbage output is anticipated to triple by that time (Kaza et al., 2018). Most of this is because of fast population growth, more people moving to cities, and social and economic progress.

Solid waste refers to the largely solid byproducts of human and animal activity that are unwelcome and worthless. Industrial, social, and agricultural activity can all contribute to them. Solid waste is an unavoidable byproduct of life, and it varies from society to society. Early humans lived off the planet's resources and had no trouble getting rid of its waste. When traditional composting and fertilizer production were widely used as solutions for the vast majority of organic wastes, the disposal of solid waste may be traced back to the beginning of human development of community, society, and urban life. Solid waste generation has increased as a result of changing consumption patterns, and worries about its toxicity and quantity have risen. There are eight major groups of solid waste generators, according to Festus and Omoboye's (2015) analysis.

1. Agricultural: Food wastes that have gone bad, waste from agriculture, garbage, and hazardous wastes.
2. Industrial: Consists of two hazardous components that, if poorly handled and managed and could constitute a serious threat to human health or the environment. They are poisonous, corrosive, combustible, strong sensitizers, or irritants. Nonhazardous waste is industrial solid waste that is inert and generally insoluble, typically made up of materials like rock, brick, glass, dirt, some plastics, rubber, etc. that are not easily decomposable.

3. Construction and demolition: Debris left over after constructing, renovating, repairing, and demolishing homes, businesses, roads, and other constructions.
4. Institutional waste is waste that comes from public buildings including schools, hospitals, and research facilities.
5. Commercial: Waste generated by businesses engaged in wholesale, retail, or service activities, including restaurants, shops, markets, theaters, hotels, and distribution centers.
6. Municipal services, such as digested and dewatered sewage treatment plant sludge that doesn't need special equipment for handling liquids.
7. Process: Wastes from treatment plants are primarily made up of residual sludge and
8. Residential: This category includes waste produced in residential structures, such as garbage, ashes, and food and fruit peels.

Collection and Solid Waste Hierarchy Management

One of the most intricate and challenging duties in solid waste management (SWM) is the collecting function. It involves both collecting the solid waste from the appropriate sources and moving it to the location where the containers are to be discharged. Waste collection is more difficult when there is no source-level sorting mechanism. Each residential, commercial, industrial, and other source produces solid waste, which must then be collected from those locations and transported to the waste refinery facilities. Because of this, the waste management system's cost for this function is the greatest. The management of the garbage at the source has a significant impact on the collection process. The key considerations for designing a collecting system are the amount of separated and un-separated trash, the distance between the collection area and the disposal facilities, and the routes (Vidanaarachchi et al., 2006).

The composition of the garbage produced in industrialized and developing countries differs significantly in many ways. The majority of the garbage produced in industrialized nations is of an inorganic character, whereas the majority of the waste produced in underdeveloped nations contains organic materials. The proportion of organic materials in garbage is nearly three times higher in developing countries than it is in developed ones.

Even while the amount of waste produced in underdeveloped nations is far less than that in wealthy nations, the nature of the waste is denser and has very high humidity content (Marshall and Farahbakhsh, 2013).

Reduction in Solid Waste Generation

According to an old proverb, "prevention is better than cure," and it is one of the greatest ways to address the problem of solid waste. We may greatly reduce other trash-related issues (like disposal) by preventing or minimizing waste generation itself. Several techniques or tools can be used to reduce trash generation, some of which include:

1. By raising public knowledge of waste and related issues, education can play a significant role.
2. Promoting locally grown goods and minimizing reliance on packaged foods will significantly cut waste.
3. Implementing laws and regulations that forbid the manufacture, marketing, and consumption of goods with excessive packaging. Places where product flow cannot be controlled should implement the proper policy measures (expanded producer responsibility, taxes, economic incentives, etc.) to reduce the production of unneeded waste. Policies should also include the issue of promoting recyclable and reusable goods rather than single-use goods (Abdel-Shafy and Mansour, 2018).

Composting

Composting would be the optimum method of waste reduction for a developing nation, taking into account the waste composition and other socioeconomic aspects. It is a straightforward, low-tech strategy. The trash of many underdeveloped countries should theoretically be perfect for composting because it has a higher proportion of organic material than waste from wealthy nations. According to a study by Dery (2014), urban areas in developing nations have a waste stream that is 50% organic on average. Early research by Nanda and Berruti (2021) revealed that 78–81% of the household garbage produced in large Indonesian and Sri Lankan cities could be composted. The irony is that composting is not extensively used in poor nations, despite the fact that large Asian cities like Hanoi, Karachi,

Katmandu, and many Indian towns have 68–82% of their garbage that can be composted (Ashburner, 2016).

Composting has a number of benefits, not the least of which is a large reduction in waste. It can be utilized as natural manure and fertilizer for agricultural purposes. It also significantly reduces landfill gas emissions, and because it is a natural process, it causes less environmental harm. Additionally, the stink emanating from any trash disposal site is primarily caused by organic material that is decomposing; however, if we compost the garbage rather than leaving it to rot, this stench will be greatly reduced (Ingels and Graves, 2015). Identifies three levels at which composting can be done: household, communal, and large-scale centralized level (throughout the municipality). Unfortunately, large-scale operations have been a miserable failure because so much money had to be invested, the equipment had to be kept in good working order, etc. 9 large-scale composting facilities built in India between 1975 and 1985 had been shut down, while just 18 of the original 54 facilities were still operational in Brazil (Sharma, 2019).

Incineration

Incineration is the process of burning garbage under controlled circumstances, typically done inside a building. Although burning reduces garbage at a high rate (80–95%), there are a number of problems that make incineration an unattractive alternative in developing nations (Kanhar et al., 2020). Due to their high capital requirements and high maintenance costs, solid waste incineration plants are frequently among the most expensive solutions for managing solid waste. Incineration requires more technically skilled operators and meticulous maintenance than other solid waste disposal methods, which may not be practical or practicable for developing nations. In addition to this, incineration poses a significant environmental risk. Since most developing nations are densely populated, any burning operation close to a human habitat could endanger both human life and the environment (Kazemi and Ghorbanpour, 2017).

Reuse and Repair

Reusing is the process of recovering items for future use. Reusing ensures a decrease in the need for raw materials, which saves money on energy and water, lessens pollution, and stops the production of waste. Reusing goods and materials is

more socially desirable than recycling the same ones (Shankar, 2017). For instance, India uses a deposit- refund system and sells soft drinks (Coke, Pepsi, etc.) in glass bottles. When buying a soft drink, a customer deposits money, which is refunded when the bottle is returned. This allows the manufacturer to control his supply of containers without having to create new ones. Appliances and furniture for offices can also be recycled. A reuse program can generate income for the businesses or people that use it in addition to saving money. Public policies that encourage reuse can have a major and beneficial economic and environmental impact on businesses and individuals (Juan et al., 2010).

Recycle

Recycling may not be a viable choice in poor countries even if it is one of the most crucial parts of waste management in developed countries due to the makeup of trash and other reasons. Perhaps worldwide phenomena, household waste separation keeps jewels and recyclable items from being thrown away. This is especially true in developing nations where valuables are carefully separated. Other valuable resources are prevented from entering the garbage stream by the presence of waste pickers, scavengers, etc. Itinerant buyers are essential in recovering materials for recycling, especially in underdeveloped nations. They purchase any item with a monetary value, such as newspapers, plastic bottles, used shoes, etc (Narayana, 2009).

However, it is obvious that there are a number of ways in which these traditional procedures might be enhanced. An organized waste recycling or recovery system supported by the local government can go a long way toward ensuring worker health and safety as well as providing opportunities for increased income for rag pickers, scavengers, and other minor garbage merchants (Aparcana, 2017). Recycling waste can be a wise financial decision, even in certain urban areas with waste that is roughly comparable in nature to that produced in industrialized nations. If the waste's makeup precludes recycling, recovery, diversion, and other approaches, they should be carefully considered. If local municipal governments are unable to provide recycling facilities owing to a lack of financing, private partnerships should be encouraged and researched as a potential option (Xiao et al., 2017).

Community and Stakeholder Participation on Solid Waste Management

When systems fail and problems grow worse, people frequently turn to societal components. This has frequently been the case while dealing with the incorrect treatment of solid waste in developing nations. Many academics have argued that since human behavior is at the root of the waste problem, changing that behavior is the only way to solve the issue. Public attitudes and waste perceptions can have an effect on the SWM as a whole (Olukanni et al., 2020). In the poor world, what exactly is waste? Why have garbage disposal practices become so widespread in some areas? What effect do cultural beliefs and expectations have on these actions? What actions are necessary to bring about a change in these behaviors? Babaei et al. (2015) say that the answers to these questions are needed to find ways to handle solid waste in developing countries.

Peoples' Perception on Solid Waste

Waste can mean many different things to different people. Some people see "trash" as a resource or a way to make money in a market when job possibilities are few, like rubbish collectors in Ghana. On the other hand, the majority of people in the developing world see solid waste as a burden and a problem that needs to be fixed. It is untrue to assume that people in underdeveloped countries do not see waste as a problem. The contrary is frequently true. Recognizing the problem with garbage, however, does not make reckless waste management practices such as littering go away (Marshall and Farahbakhsh, 2013).

This attitude-behavior gap commonly manifests and may be made worse by a variety of factors, including practicalities, social mores, a dearth of public participation, and a lack of education and comprehension of effective waste management techniques. Within this attitude-behavior gap, there is a disparity between one's values and behaviors. This statement highlights the discrepancy between people's environmental concerns and their inadequate attempts to reduce their waste or embrace other ecologically friendly behaviors (Barloa et al., 2016). Another critical social intervention for more effective SWM is raising community involvement in waste management activities like recycling and in decision-making about waste management programs. The issues of public acceptance, shifting value systems, public participation in the planning and implementation phases, and changes in waste behavior are just as important as the technical and financial aspects

of waste management. For trash management to be successful, the local government and the general public must both fully support it. Additionally, all stakeholders must be included in the decision-making process for waste management. Hamad et al. (2017) say that the success of these integrated projects depends on the public's participation and ability to make decisions, on the openness of decisions, on networking, on cooperation and collective action, on communication, and on how easy it is to get information.

Researchers in India found that while most respondents thought that garbage was a big problem in Delhi, they knew very little about how one might contribute to solving it. However, waste reduction was shown to be mostly driven by one's money and was not perceived as a part of the waste problem. Littering and garbage separation were found to be mostly influenced by one's sense of responsibility for one's waste (Almasi et al., 2019). Researchers suggested that public advertisements should emphasize residents' accountability for their trash and the necessity for every citizen's involvement in order to establish a sense of a shared community goal around solving the trash problem (Oduro- Appiah et al., 2022). The information and motivation campaign should include ways to get more people involved.

Another study recommended that towns be required to manage their own waste collection and disposal. Through community self-help, waste management costs are reduced and community self-interest is increased. The advantage of this approach is that it strongly emphasizes community involvement in garbage recycling (Al-Khatib et al., 2014). Al-Khatib et al. (2014) suggested the following steps to get people involved in their neighborhoods: promoting environmental education, information, and capacity building in communities; supporting community-based initiatives to deal with waste management, sanitation, and access to resources; and setting up community forums whose job it is to come up with integrated environmental, development, and space plans.

Incentives

Researchers have recently focused on incentives as a crucial social intervention to increase the effectiveness of waste management systems. One of the main forces behind behavior modification is the application of incentives. Many researchers think that economic and sociopsychological incentives can be effective social interventions in poor countries and powerful tools for helping with behavior

change. Socio-psychological incentives are rewards that, among other things, convince people to reduce waste by educating them, showing them how reducing waste helps them reach important goals, and putting social pressure on them (Owojori et al., 2022).

The media can be used for a variety of sociopsychological purposes and plays a crucial role in increasing public awareness and participation. According to a study conducted in Cuba, the mass media used commercials and campaigns that promoted recycling and product reuse to urge the general public to take part in waste management education and awareness initiatives. Television ads that show local celebrities or other well-known people doing similar SWM activities could also be helpful in developing countries like Peru, where TV use has become common and widespread (Diéguez-Santana et al., 2021). But information alone is insufficient. People need to feel in control of their participation and that their actions matter. So, when the media is used to make these kinds of awareness campaigns, it should try to create a shared goal of getting rid of waste problems and be very clear about how people can help and why it is important and necessary for them to do so (Farrah & Ng'ang'a, 2022).

Numerous scholars have also acknowledged the importance of economic incentives as a key tactic for behavior modification. However, in some cases, market and financial incentives might be even more effective at modifying the public's behavior and enhancing trash diversion. Economic incentives are those that offer financial compensation for cooperation. In developing countries, picking up trash or scavenging is a common activity. These trash collectors have little formal education and few opportunities for stable employment. Solid waste collection and disposal services are often not as good as they could be because of trash pickers and scavengers (Nanda & Berruti, 2021).

This is due to the fact that these scavengers are removing recyclable materials from waste piles in order to make money, and many local governments rely on this cash to fund SWMS. However, with careful planning, their operations can be successfully incorporated into a waste recycling system. This kind of opportunistic approach is essential for the sustainable growth of SWM programs in impoverished countries. An effective example of an economic incentive program can be seen in Gaborone, Botswana (Abdel-Shafy & Mansour, 2018).

Most shops in the city will accept customers' empty beverage bottles in exchange for a refund of their deposit. The majority of respondents (51%) set aside glass bottles due to the financial incentive for returning the bottles. Similar exchanges occur all throughout the developing world, and this is a great example of how employing financial incentives may result in long-term change (Bolaane, 2006). The two incentive methods' success has had a range of results. An analysis of Mexican programs found that financial incentives had a greater influence on behavioral changes like source separation than environmental education. However, if motivations are extrinsic from the beginning, as many scholars have expected, it is likely that the rise in external incentives will improve effort, according to a review of the literature done by Farrah and Ng'ang'a (2022). Results show that non-financial incentives for recycling garbage have been emphasized in the research, which suggests that social rather than economic incentives are more effective in encouraging recycling, to the extent that some households may even be willing to pay for the opportunity to recycle. Non-monetary incentives must also be considered if minimizing waste is the goal.

Lack of Education and Awareness

Another big barrier that exists throughout the developing world is a lack of awareness of effective waste-management methods. One study found that although the people of Gaborone, Botswana, were aware of recycling and other sustainable waste-management techniques, participation in such programs was not always the case. Despite their lack of comprehension of these programs, they do not seem to have embraced waste management innovations. Communities that do not take part in decision-making tend to have a culture of non-participation. This kind of thinking promotes a lack of responsibility for waste and pollution issues. For solid waste management to be sustainable (Fatuase and Ajibefun, 2014), people need to learn more about it in school.

The distinction between knowledge and information may be what it all comes down to. If you get information without any prior knowledge, trying to affect change may be fruitless. If prior knowledge of waste management was paired with new knowledge, these communities might be more receptive to embracing it and implementing these changes. Researchers have long understood the importance of raising public awareness of and community involvement in waste management in

order to create sustainable waste management systems and promote environmental citizenship among community members. People are more likely to engage in waste management practices like recycling themselves when they observe others around them doing so. Since there aren't many formal recycling programs in developing countries, the wealthier people who live there often use their own methods (Goggins, 2018).

Ingels and Graves (2015) found that in order to solve the problem of solid waste, it is essential to increase people's awareness of environmental issues, encourage sustainable consumption patterns, and provide waste management education. Waste managers need to take steps to help match the information given to the public with what people already know about environmental awareness and environmental conservation (Olukanni et al., 2020). This will improve the relationship between the information given to the public and what people already know about environmental awareness and environmental conservation.

Reviews of contemporary research on the topic of social interventions usually cover education and awareness programs as they relate to SWM, with recycling being a common topic of discussion. In many developing countries, it is difficult to implement recycling and waste disposal programs because people are unaware of the harmful impact that improper solid waste management has on the environment and human health. The community must be involved and socially aware for recycling to be successful. Recognizing how important it is for people to get involved in recycling, laws and policies should be based on promoting people-centered recycling methods, with public education as the main way to get more people involved (Ikhlayel, 2018). There is a link between education level and involvement in recycling activities, according to research on this educational gap that was done in Palestine (Sulemana et al., 2018). If the results are unfavorable, local governments will have the difficult task of informing the public and promoting sustainable measures and practices with the objectives of 1) enhancing environmental sustainability, public health, and family and child safety; and 2) putting into practice the waste management principles of reduction and segregation at the source, reuse, and commitment to participate in recycling programs. According to a related study done in Jordan, people will understand the environment better and waste management will work better if proper environmental awareness efforts are made. These are only two examples of the numerous statistics that demonstrate how crucial

it is to educate the public about SWM in order to achieve waste segregation, which would reduce solid waste contamination. Include health messages in education and awareness programs, such as how open-burning trash is bad for air quality and human health (Sharma et al., 2020). This will give people in the community the push they need to change how they handle trash. Starovoytova and Namango (2018) found in another study that educational programs had an effect on people's attitudes toward SWM and the reasons they recycle. As a result, it was found that attitudes toward recycling have a big impact on waste recycling. Both extrinsic incentives (i.e., social reinforcement and financial reward) and inner motivation were found to influence recycling behavior (i.e., personal satisfaction). But even if someone wants to recycle a lot and thinks recycling is a good idea, that doesn't mean they will do it the right way.

Various government and non-governmental groups should educate the public in a systematic and thorough manner, focusing on the fundamental advantages of recycling and the detrimental effects of expanding trash on the ecosystem. In order to promote recycling participation specifically and more environmentally conscious behavior generally, the respondents' intrinsic motives, which were found to be more potent motivators, should be supported and enhanced. When people are aware of the connection between their actions and the environment's influence, they are more likely to adopt pro- environmental behaviors. The ability to recycle properly has a significant influence on how people act (Kumar & Agrawal, 2020).

People are more likely to participate in recycling campaigns when they are informed about the benefits of recycling and garbage sorting and when they are involved in the design of the programs, according to research conducted by Nicholas (2018) in over twenty-two developing nations. Social norms can have a big impact on how people recycle and dispose of their waste. People are more likely to recycle if they see others in their neighborhood doing it, so it would be good to ask influential people in the community to take the lead in changing these bad environmental habits.

Although recycling is an essential component of waste management, authorities in less developed countries usually underestimate the need for waste minimization strategies. As a result, excess garbage is routinely transported to disposal sites or recycling facilities.

Waste reduction, according to the dictionary, is a process of elimination that comprises reducing the quantity of trash produced in society in order to assist

initiatives to foster a more sustainable society. Additionally, it assists in preventing the accumulation of dangerous and chronic wastes (Yuan et al., 2019). Struk (2017) asserts that in order to decrease waste creation, products must either be redesigned or social patterns of consumption and production must be changed. There haven't been many studies on this topic, especially in developing countries, but the ones that have been done have found waste minimization to be an effective and financially viable way to manage solid waste. To minimize waste permanently, the public must be made aware of the benefits of waste minimization. Waste minimization is a relatively new concept in developing countries, where people's consumption is just starting to climb. But tackling this problem head-on might be the most cost-effective way to handle waste management in the developing world. There are many ways to get more people involved in reducing solid waste, such as using social norms, focusing on environmental benefits, making it easy to use facilities and get the right information, appealing to positive feelings about reducing waste, and reducing waste through responsible consumption (Sulemana et al., 2018).

Mugambi (2017) says that the success of recycling and waste-reduction programs, whose main goal is to change people's behavior, depends on taking societal and cultural norms into account, getting households involved, and being aware of people's needs. Each of these might be beneficial in specific situations and countries. Many of these strategies can be combined with one another to produce a more effective waste management program that places a high focus on waste minimization. Many of these strategies are versions of or related to those used to promote recycling.

Choice versus Response

Another problem is that many people do not protest the government because they feel powerless to change how decisions are made. This mindset changes throughout various social tiers. Wealthier socioeconomic groups are more likely to feel that they can make a difference when it comes to these environmental concerns or become involved in doing something about them because they think they can have a greater impact on addressing and solving the issue. According to some experts, people at lower socioeconomic levels tend to show less care for environmental issues because work and housing are their primary priorities (Olukanni et al., 2020). Turning to the more reactive aspect of this problem, there is frequently a lack of

accountability, which is demonstrated by the accumulation of enormous amounts of rubbish in both public and private areas, such as business enterprises and highways, parks, and recreational areas. One can talk about this in terms of how ownership functions (Nanda & Berruti, 2021).

All men care the least about what is shared by numerous people because they value their individual assets more than the things they share with others. Simply expressed, this implies that those who own property have an incentive to take care of it as opposed to people whose ownership is scattered or nonexistent, such as in public places. It appears that this issue is a "tragedy of the commons." According to Kazemi and Ghorbanpour (2017), people act against the interests of the entire group by depleting a resource like a river or, in the case of rubbish management, public areas like parks. People react rationally and autonomously in their own self-interest. According to one study, households' involvement and cooperation in South Africa's waste management have historically been overlooked in favor of a technical fix. The casual and careless disposal of trash in public streets, alongside roads and highways, and adjacent to community trash cans for residential waste were examples of communities' lack of involvement in waste management. According to Kabera et al.'s one study, households' involvement and cooperation in South Africa's waste management have historically been overlooked in favor of a technical fix. The casual and careless disposal of trash in public streets, alongside roads and highways, and adjacent to community trash cans for residential waste were examples of communities' lack of involvement in waste management. Kabera et al. (2019) say that this kind of problem shows how important it is to have strong public education programs and more community involvement.

Importance of Effective Policies and Strategies

Littering is a poor habit that is typically linked to how solid waste is handled in developing countries. There are a number of reasons why it is anticipated that public littering rates may increase, including a lack of societal pressure to do so. Other things to think about are the amount of trash already there, whether or not there are signs telling people not to litter, the number, position, and/or look (if any) of trash cans at the place, and how littering affects the environment.

According to research, solid garbage cans are essential for disposing of trash. When they aren't there or there aren't enough of them, littering is okay (Yuan et al.,

2019). When a community lacks a formal system for waste disposal and sorting, people can develop bad habits, such as throwing their trash in the street or other unsuitable locations. Due to pure habit and tradition, people do not alter their disposal behavior when the conditions of life are performed. Different socioeconomic factors can have an impact on how individuals feel about littering, how often they litter, and how to stop someone from littering in an effective way (Starovoytova and Namango, 2018). If a program to stop littering is to be made, it is important to study these qualities, which vary by region and culture.

For instance, in a study on the connection between social norms and pro-environmental behaviors carried out in Cuba, researchers discovered that the majority of individuals took part in recycling buybacks and anti-littering activities. This was true due to the community's social pressure as well as the government's support for these programs due to economic considerations. People also think that if they do not act in accordance with these norms, it will be seen as bad, since they have taken society's norms to heart (Mouro et al., 2021).

CHAPTER III

Methodology

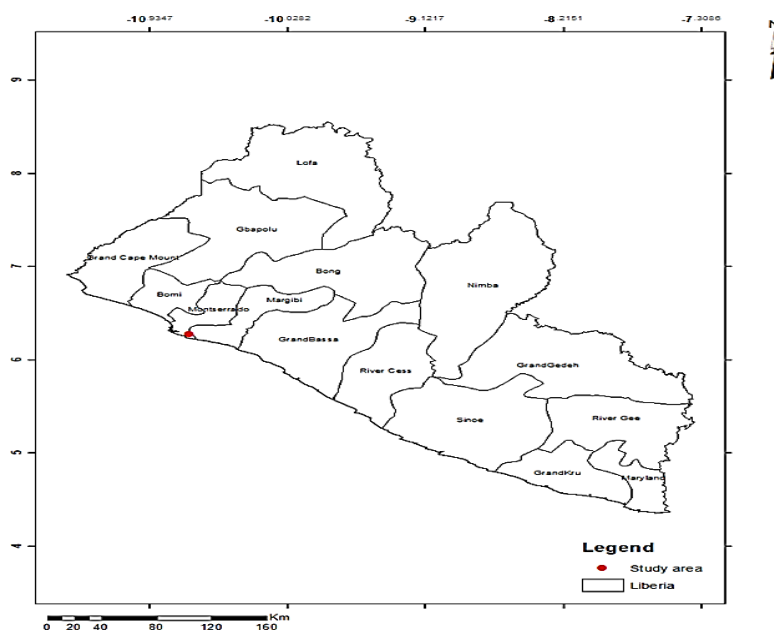
Study Area

The study was carried out in Liberia's capital city, Monrovia, which was established in 1822. It is the most populated city in the nation and is situated on Cape Montserrado on the Atlantic coast. According to the 2022 estimates, it is home to 1.6 million people, or 30% of Liberia's total population. It is 18 meters above sea level and is located at 6.3156° N and 10.8074° W. It was chosen for this study because of how poorly it handles solid waste and how vulnerable and sensitive it is to environmental problems, such as surface and groundwater pollution and health problems.

Examples of endemic problems include overpopulation and ailments like malaria, typhoid, and tuberculosis. Since there is a lack of basic sanitation in the area and inhabitants frequently use the beach as a latrine and dump, drinking the water and eating fish that have been caught in contaminated water present health dangers. With an average annual temperature of 25.7°C and 3583 millimeters of rain spread out from May to October, the climate is mostly tropical in terms of things like temperature and rainfall.

Figure 1.

Map of Liberia and The Study Area (Red)



Overpopulation and diseases like tuberculosis, typhoid, and malaria are examples of endemic issues. The area lacks basic sanitation, and the beach surrounding the city is frequently used as a latrine and dumping site by the residents, posing health risks due to the usage of the water for drinking and consumption of fish caught in the polluted water. Climatic variables such as temperature and rainfall pattern are largely tropical type with an annual average temperature of 25.7 °C and annual average rainfall of 3583 mm distributed from May to October.

Research Design

In this study, survey research was conducted. Quantitative data were collected. More specifically, a descriptive research design which is theory-based design method was performed to collect the field data. This research was conducted in Monrovia city, Liberia and it relies on several data collection methods which include: Field observations and a questionnaire survey were used to gather information on the mechanisms of solid waste management practices in Monrovia city-Liberia.

Sample Size Determination

From an approximate population of 1.6 million which are perceived to be residents of Monrovia city, the required sample size was using the following formula:

$$\text{Sample size} = N / (1 + N(e^2))$$

Where: N is the total number of populations; e is the margin sampling error. Sample size = $1,600,000 / (1 + 1,600,000([0.05]^2))$

Based on the result from the above calculation, 400 individuals were considered for the study.

Sampling Techniques and Data Collection Procedures

Among the four administrative towns, two towns were randomly selected. Then a structured questionnaire survey using KoboCollect App was used for collecting the primary data to assess the mechanisms of solid waste management practices in Monrovia city, Liberia. It included details of primary data on the respondents' socio-economic characteristics, solid waste production scale, income-expenditure scenario, perceptions of residents' on solid waste management and its'

effect, factors determining solid waste management, strategies to minimize improper disposal of solid waste. A purposive sampling technique was used to obtain a survey population in the study area to include residential (household), institutional, construction, health care, agriculture, industry and commercial areas. Then, a random sampling approach was conducted to select representative participants for this particular study. For the accuracy and reliability of the data, participants were asked for their willingness to participate in the survey before administering the questionnaires to them. Upon their agreement, they were given the detailed information on how to respond on each of the provided questions.

Data Analysis Procedures

Data on the mechanics of effective solid waste management in Monrovia city-Liberia were collected, organized, and analyzed. Descriptive data analysis such as frequency and percentage were performed. Spearman correlation matrix was also done to see the relationship between different variables such as income, expenditure, solid waste expenses, solid waste generation, and family size. It was then presented using a pie/bar chart and tables. All data analysis was done using SPSS Version 25 and results were tested at $p < 0.05$ significance level.

CHAPTER IV

Findings and Discussion

Demographic Characteristics of The Respondents

400 respondents were chosen at random from the research region during the field data collection. 73.5% of the respondents were women, which is the majority. Only 24.75 percent of respondents, who made up the majority, were from age categories other than 30 and 35. Secondary school had the largest performance in education (176, 44%), followed by primary education (141, 35.3%), with just a few responders in tertiary education (32, 8%) and informal education (51, 12.8%).

Only a small number of respondents worked in agriculture and other occupations; the majority of respondents (47.5%) were married and worked in business (54.25%), wage labor (21.75%), and services (17%). The majority of respondents to the study, 214 (53.5%), had 1-3 persons living in their home, followed by 4-6 (133, 33.25%), 7-9 (42, 10.5%), and >10 (11, 2.75%). The respondents' average monthly income was between \$100 and \$200, while their average monthly spending was about \$100.

Table 1.

Demographic Characteristics of The Respondents

Characteristic	Category	Frequency	Percent (%)
Gender	Female	294	73.5
	Male	106	26.5
Age	20-25	35	8.75
	25-30	76	19
	30-35	99	24.75
	35-40	92	23
	40-45	60	15
	>45	38	9.5

Table 1. (Continue)

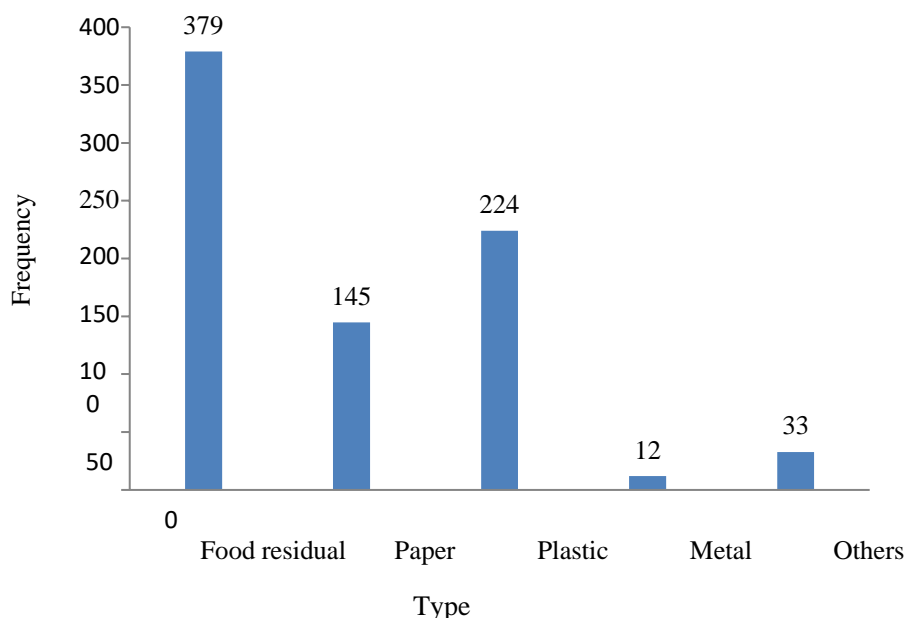
Marital status	Single	94	23.5
	Married	190	47.5
	Divorce	89	22.25
	Widow	27	6.75
Educational Level	No formal education	51	12.8
	Primary	141	35.3
	Secondary	176	44
	Tertiary	32	8
Family size	1-3	214	53.5
	4-6	133	33.25
	7-9	42	10.5
	>10	11	2.75
Occupation	Agriculture	13	3.25
	Service	68	17
	Business	217	54.25
	Wage labor	87	21.75
	Others	15	3.75
Monthly income (\$ USD)	1-100	65	16.25
	101-200	152	38
	201-300	71	17.75
	301-400	42	10.5
	401-500	33	8.25
	>500	37	9.25
Monthly expenditure (\$ USD)	1-100	103	25.75
	101-200	84	21
	201-300	75	18.75
	301-400	39	9.75
	401-500	32	8
	>500	67	16.75

Types of Solid Waste Generated by The Respondents

The majority of respondents admitted that they created solid trash from food remnants (47.79%), plastic (28.25%), paper (18.2%), metal (1.51%), and miscellaneous sources (4.16%) (Figure 1). It is possible that the majority of families produce a large amount of solid trash since it is a big product that takes up more storage space. Additionally, the respondents thought that solid trash would collect until it was disposed of since it would not always be cleaned up when they wanted it to be.

Figure 2.

Multiple Response Analysis Results of The Types of Solid Waste Generated by The Respondents' Households



The amount of solid waste (kg) that each respondent generates on a monthly basis was requested of him or her. The greatest number of kilograms for responders, according to the results, was between 6 and 10 kg (45.25%). A solid waste generation of 1-5 kg, 11-15 kg, 16-20 kg, and >20 kg was followed by 29.5%, 13.5%, 7.5%, and 4.25%, respectively. Similar to this, the majority of respondents (277) stated that they spend \$10–15 per month on solid waste disposal operations. Only 11 respondents admitted they spend between \$26 and \$30 each month. The Table 5 correlation matrix demonstrates a positive link between trash creation and the monthly cost of solid waste handling and management. In other words, when

solid waste creation rises, so do solid waste expenses. This association is also statistically ($p = 0.001$) significant.

Table 2.

Respondent Monthly Income and Expenditure and How Much Generate and Spend in Waste Solid Disposal Service

Option	Category	Frequency	Percentage
How much solid waste do you generate monthly (Kg)	1-5	118	29.5
	6-10	181	45.25
	11-15	54	13.5
	16-20	30	7.5
	>20	17	4.25
How much do you spend in a month for the service? (\$ USD)	10-15	277	69.25
	16-20	93	23.25
	21-25	19	4.75
	26-30	11	2.75

Solid Waste Separation

As previously mentioned, the majority of respondents created the following primary solid waste types: food residue, plastic, paper, metal, and others. However, the respondents' reported separation level was relatively low. 96% of respondents said they had never separated solid trash previously, whereas just 4% of respondents said they did

(Figure 2). They suggested that segregating solid waste was not necessary. But the large number of people who didn't separate their solid waste showed that the solid waste management methods in the research area weren't working.

Figure 3.

The Level of Solid Waste Separation by The Respondents

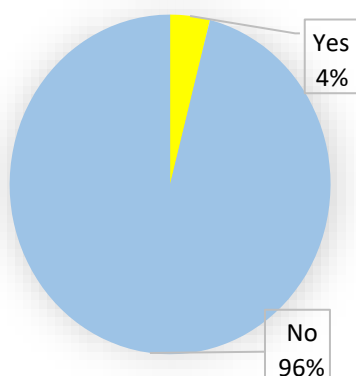


Table 3.

Percentage of Solid Waste Separation, Collection Methods, and Type of Vehicle Used by The Respondents

Variables	Frequency	Percent (%)
Waste separation		
Yes	16	4
No	384	96
Collection of waste is done by		
Children	357	89
Waste pickers	15	4
Children and waste pickers	28	7
Type of vehicle(s) used to collect the waste		
Wheelbarrow	356	89
Rickshaw	9	2.25
Wheelbarrow Tricycle	10	2.5
Rickshaw Tricycle	6	1.5
Wheelbarrow Tricycle Rickshaw	19	4.75

Solid Waste Collection Interval

Figure 3 displays the outcomes for the solid waste collection period. It was found that 63.5% of respondents collected their solid garbage once a week, compared to 34.3% who did so once every two weeks or more.

Figure 4.

Solid Waste Collection Interval by The Respondents in Monrovia City

Solid Waste Handling by The Respondents

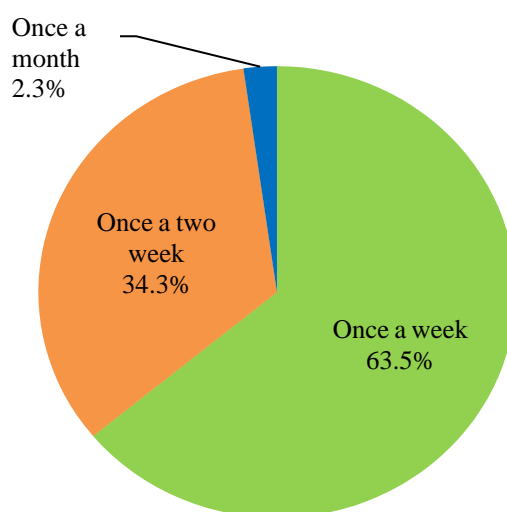


Table 4.

Solid Waste Handling by The Respondents

Variables	Frequency	Percent (%)
Burn SW in the compound		
No	6	1.5
Yes	394	98.5
Dump in the yard		
No	106	26.5
Yes	294	73.5
Dispose in the ditch		
No	125	31.3
Yes	275	68.8
Dispose on the road		
No	88	22
Yes	312	78

Figures 4 and, 5a and 5b show that Monrovia City is now dealing with a trash issue because of an inadequate solid waste management system, particularly pollution from plastic bags. Every part of the city is experiencing severe drainage

issues because of these bags. As a result, the adjacent towns are experiencing major health issues as the area turns into a favorable environment for mosquito breeding. To stop this terrible issue at its root, the nation urgently needs to restrict the use of plastic bags. Other east African nations, including Kenya, Uganda, Tanzania, Ethiopia, and Botswana, have some positive examples to share.

Figure 5a and Figure 5b.

Dumping of Waste in Un-Finished Buildings in The City



Figure 6.

Dumping of Solid Waste Materials Under the Bridge, River in The Center of Monrovia City



Variables were correlated with one another, as seen in Table 5's correlation matrix. It has been demonstrated that the variables have a significant positive correlation. This association is also statistically ($p = 0.001$) significant. For instance, solid waste expenditures rise along with rising solid waste creation. All other factors showed comparable patterns as well.

Table 5.

Correlation Between Variables

Item	Income	Expenditure	SW expense	SW generation	Family size
Income					
Expenditure	.826**				
SW expense	.788**	.803**			
Family size	.802**	.867**	.847**	.876**	

Citizens Participating in The Decision-Making Processes for SWM?

This research's main goal was to explore the accessibility of low-cost SWM technology, public involvement in SWM decision-making, the existence of local health initiatives, and the presence of environmental awareness campaigns in the city. However, all participants said that their community lacked any low-cost technology that supports SWM. In addition, they all agree that no one has ever made an official decision about how SWM operates. Majority of the respondents (79.5%) indicated that there was no collaboration among stakeholders; the level of coordination and cooperation between service users and service providers is also very bad as indicated by 223 (55.75%) of the respondents. They also stated that Adequacy of policy and legal frameworks to manage SW was very bad. Practice of law enforcement and implementation of the country's law by the municipality is also bad according to many of the respondents (Table 6).

Table 6.

Respondents' Collaboration and Their Perceptions on The Available Policies

Item	Very bad	bad	good	very good	excellent
Collaboration among stakeholders	318 (79.5%)	82 (20.5%)	0	0	0
Level of coordination and cooperation between service users and service providers	223 (55.75%)	177 (44.25%)	0	0	0
Adequacy of policy and legal frameworks to manage SW	280 (70%)	120 (30%)	0	0	0
Environmental legislation in place	249 (62.25%)	151 (37.75%)	0	0	0
Practice of law enforcement	179 (44.75%)	221 (55.25%)	0	0	0
Clear implementation of the country's law by the municipality	171 (42.75%)	229 (57.25%)	0	0	0

CHAPTER V

Discussion

Solid Waste Generation and Separation

A person's degree of affluence is mostly associated with how much solid trash they create. Colorado and Echeverri-Lopera (2020) assert that countries with smaller GDPs produce less solid waste overall. The average amount of solid garbage produced daily by an individual was 0.3 kilograms. This outcome matched the findings in Elmnifi et al.'s publications (2020). They said that a person typically produces between 0.16 and 5.7 kilograms of solid waste every day.

The study looked into how frequently families collected their solid garbage. As shown by the data in Figure 3, 34.3% of respondents stated they collected their solid garbage once a week, while 63.5% claimed they did it once every two weeks or more. But the fact that trash isn't picked up on time shows that solid waste isn't being handled properly, which could lead to more environmental and health problems. 96% of respondents, according to the findings, never split their solid trash into several categories. The lack of efficient solid waste management procedures in the research region indicates a lack of adequate solid waste separation. The results of this study were in line with those of studies from Ghana (Kanhai et al., 2021) and Nigeria (Ike et al., 2018), which found that both nations had major waste management issues. Kabera et al. (2019) say that the way solid waste is managed now is very different from how it is done in Kampala.

Although the economies of Kampala and Monrovia are comparable, Kampala has considerably superior solid waste management techniques and produces manure from its solid waste. In contrast, people in Monrovia dump it in their yards, dump it in ditches and rivers, and burn it carelessly in their complexes. In the city of Monrovia, using solid waste is not practicable.

In Tanzania, 62% of households inappropriately disposed of their solid waste, according to Banaga (2020). This high percentage of improper solid waste disposal was linked to the difficulty in accessing some locations because of squalid housing and narrow roads, which is a similar issue in Monrovia city. Genati et al. found that 75% of the people who lived in Debre-Birhan, an important city in Ethiopia, threw away their solid trash in the wrong way in 2021.

These findings show that a lack of knowledge about waste management technology and best practices, a lack of equipment for gathering sorted materials, and a lack of decision-makers engaged in environmental concerns prevent municipalities from implementing trash separation programs (David et al., 2020). Waste separation awareness campaigns have an impact on people's behavior because they care about the environment and want to participate in finding answers. To support their daily existence, many underprivileged people go from door to door, on the streets, or to the disposal site to collect recyclables (Uddin et al., 2020).

Due to the numerous fees that these garbage pickers must pay, households separate their trash in order to sell it for money (Adeyemi, 2020). Recycling companies have sprung up in the cities as a result of the rising expense of these secondary materials. Together, these two facts seem to have supported a rise in household separation. Lastly, separation is improved when people and the city government work together to make decisions about the waste system (Wang et al., 2021).

Solid Waste Collection Services

Poor solid waste management methods in Monrovia City have been linked to a lack of door-to-door solid garbage collection services by the town administration. Lema et al. (2019) found that 76.6% of respondents burned waste in their complex, 7.2% dumped it in their yard, 8.5% dumped it in a ditch, and 24.2% dumped it on the road. They concluded that homes that received door-to-door solid trash collection had a roughly threefold higher likelihood of using good solid waste management techniques. But in Monrovia City, the percentage was enormous: dumping in their yard (293, 73.25%); discarding in the ditch (269, 67.25%); disposing on the road (312, 78%); and burning in their compound (394, 98.5%).

Many respondents claimed that burning their garbage was their only alternative, mostly as a result of not having access to door-to-door solid waste collection services and the lengthy wait times or delays experienced while using the infrequently accessible informal solid waste collectors. This was in stark contrast to other African cities like Mombasa, Kenya, where better door-to-door solid waste collection services are available (Farrah & Ng'ang'a, 2022), and Addis Abeba, Ethiopia, where 84% of households had access to door-to-door solid waste collection services (Tassie et al., 2019).

In addition to the subpar door-to-door solid trash collection service, homeowners also have little knowledge of the rules and regulations governing the management of solid waste, or the 3Rs (reduce, reuse, and recycle). As a result, as compared to citizens of other African nations like Addis Ababa, Ethiopia, and Mombasa, Kenya, people in Monrovia city lag far behind in terms of knowing the 3R solid waste management concepts. This difference in knowledge may be due to the work of government and non-government groups, whose main goal is to raise awareness about how to manage solid waste well in these cities.

Although door-to-door solid trash collection is almost impossible in the study region, the payment rate is still a significant element in determining how effectively a community manages its garbage collection. The majority of the solid trash collectors in Monrovia City are kids whose survival depends on their work. People make individual arrangements to pay for these services. The results of this survey revealed that consumers spend, on average, \$10 to \$30 each month. Among the 400 people surveyed, 69.25% claimed to spend \$10–15 per month, whereas 23.25% claimed to spend \$16–20 per month. Thus, the majority of people (92.5% of them) only spend \$20 or less every month.

According to Table 5, there was a strong relationship between solid waste output and income ($r = 0.81$, $p 0.001$), spending ($r = 0.84$, $p 0.001$), and family size ($r = 0.88$, $p 0.001$). Other elements that may affect the collection, separation, and transport methods in a specific community include the availability of roads and the quantity of vehicles, information and the organization of neighborhood businesses, and bin collecting systems. Other researchers, Sujauddin et al. (2008), who discovered that a variety of variables, including family size, educational attainment, and monthly income, can impact the output of garbage, also came to similar conclusions. Their expenditures have an impact on how they feel about waste separation. Residents in the community have a significant impact on this area.

Communities' Awareness on The Importance of Solid Waste Management

A shortage of awareness of waste treatment facilities, a lack of garbage containers and a greater distance to the collection locations, a lack of money, and the absence of appropriate laws and legislation are all factors that increase the possibility that waste will be deposited in public areas and on the roadside. One of the problems restricting the safe disposal of garbage in well-equipped and constructed landfills is

reportedly high disposal costs. Even though it is thought that some populations have a natural tendency to recycle trash, there are no signs of recycling in the research region. This is because recycling is heavily influenced by social, altruistic, and regulatory factors that do not exist there.

Other studies have shown that people who often use trashcans to dispose of their ordinary rubbish also recycle certain waste products at home and that, in most cases, people separate and gather more fractions as they get closer to the trashcans (Struk, 2018). To increase recycling rates, the government should support markets for recycled products and improve the professionalism of recycling companies. The funding of recycling infrastructure projects, recycling enterprises, buy-back and drop-off sites, and informal sector groups are other factors that other researchers have brought up.

Effect of Policies and Legal Frameworks on Solid Waste Management

The system's supporting elements, or enabling factors, have an effect on waste management as well. Some of these are technical, environmental, financial, socio-cultural, institutional, and legal. Nawaz et al. (2020) list a number of technical system issues, such as inadequate infrastructure, dangerous roads and automobiles, outdated equipment, and inaccurate data, as well as a lack of technical experience among municipal and governmental workers. Iklhayel (2018) stated that the challenges influencing the environmental side of solid waste management in developing nations are the absence of environmental control systems and the evaluation of the genuine consequences. Aparcana (2017) proposed that a nation should have effective policies that incorporated active environmental-related concerns in order to have improved solid waste management systems.

Municipalities have struggled financially to manage solid waste, claim Kumar and Agrawal (2020). The high cost of providing the service, the lack of financial support, the lack of resources, the users' reluctance to pay for the service, and the wrong use of economic instruments have all made it difficult to provide adequate waste management services. The involvement of the business sector, according to Sharma et al. (2020), is one factor that can boost the system's efficacy. Garbage management is often considered the major responsibility and duty of local authorities and is not anticipated to include the general public.

As a result, decision-makers, community knowledge, and society's indifference toward problem solving are some socio-cultural variables mentioned by certain academics. The active participation of the public and the municipal agency is essential for the operational efficacy of solid waste management. Municipalities regularly display management flaws, such as a municipal waste management authority's lack of professionalism and organizational abilities, which affect the system and produce institutional variances. Additionally, Guerrero et al. (2013) draw the conclusion that there is not a lot of information available to the general audience. Since there is so little information available and it is spread out across so many different entities, it is very difficult to gain an understanding of the complex topic of municipal solid waste management.

Because they frequently work in low-status settings, solid waste personnel lack motivation (Aparcana, 2017; Furedy, 1992). Politicians give other municipal duties precedence over managing solid trash, which leaves the local government short on trained and skilled staff. Support from the government and strategic waste management plans that allow for annual review and system monitoring are cited as good aspects that improve the system (Sulemana et al., 2018). Researchers have demonstrated that having a strong legal framework is beneficial for building an integrated approach to solid waste management systems, but it is detrimental to have insufficient regulations and weak laws.

CHAPTER VI

Conclusion and Recommendations

Conclusion

The main goals of this study were to identify the main solid waste management mechanisms, investigate local community involvement in solid waste management practices, and determine whether policies and legal frameworks are in effect in the studied region. In Monrovia City, Liberia, 400 participants were chosen at random from four communities. The respondents' socioeconomic characteristics, the amount of solid waste produced, the income-expenditure scenario, the residents' perceptions of solid waste management and its effects, the factors influencing solid waste management, and the strategies to reduce improper disposal of solid waste were all the subject of primary data collection. Due to their direct involvement in home solid waste management operations, women made up the majority of respondents (73.5%). The survey made an effort to include people from a range of age groups, marital situations, educational levels, family sizes, occupations, income and spending levels, religious backgrounds, and communities. Plastic (28.25%) and food residue (47.79%) were found to be the two most common wastes produced by the respondents. An individual produced 0.3 kilograms of solid garbage on average each day. In terms of garbage separation, just 4% of respondents claimed to separate solid waste, while 96% of respondents said they had never done so.

Participants stated that kids pushing wheelbarrows collect their trash once a week. Although it is nearly impossible to collect solid trash door to door in the study region, the payment rate is nevertheless a key factor in assessing how well a community organizes garbage collection. The bulk of the youngsters who gather solid garbage in Monrovia City depend on their labor to survive. Individual agreements are made by each person to pay for these services. Participants also admitted to throwing trash in their yards, burning it, and disposing of it by the side of the road and in drainage ditches. However, there were differences in the severity of inappropriate waste management between families and towns. The SWM position of Monrovia City was compared favorably to other African cities with comparable economic standing, such as Addis Abeba, Ethiopia, and Kampala, Uganda. The two

cities displayed significantly more effective methods for managing solid waste. In Monrovia, though, people just burn it in their apartments, throw it in ditches and rivers, and put it in their yards. It is hard to imagine a good way to get rid of solid waste there.

The correlation matrix revealed a significant association between the quantity of solid waste produced and family size, income, and spending. The major objectives of this study were to investigate if low-cost SWM technology was available, whether the public participated in SWM decision-making, whether there were any neighborhood health programs, and whether there were any environmental awareness campaigns in the area. All panelists acknowledged the unavailability of low-cost SWM-supporting technology in their area nonetheless. They also concurred that nobody has ever participated in official decisions involving SWM operations.

Recommendations

After carefully reviewing and analyzing the results, the following recommendations are forwarded:

- The government needs to focus more on introducing and raising awareness of the nation's policies and strategies on solid waste management related issues.
- There should be an introduction of good solid waste management techniques (lessons) to the nation from other regions of the world.
- Residents should avoid burning and dumping in their yards.
- There should be a mechanism in place to stop people from illegally disposing of waste along roadsides and ditches and bridges. Both the individuals and the communities should take their own initiation to stop such acts, which has serious health consequences.

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Appendices
Appendix A
Letter of Confirmation from The Autors of The Article to Use The
Questionnaire

Lilliana Abaíca <abaícalilli@gmail.com>

May 25, 2022,
9:17 PM

to me, William

Dear friend

Please feel free to use information you need from the article related to wastemanagement in the world cities. Give the credits to the authors.

Best regards

On behalf of all authors

Lilliana Abarca Guerrero

Appendix B

Questionnaire

My name is N. ROBERT KERKULAH GENINYAN, a student at the NEAR EAST UNIVERSITY, INSTITUTE OF GRADUATE STUDIES, and DEPARTMENT OF ENVIRONMENTAL EDUCATION AND MANAGEMENT. I am conducting research titled “**Challenges and Identification of Solid Waste Management in Monrovia City, Liberia**”.

This questionnaire is prepared to collect primary data from selected respondents. You have been identified as a potential candidate for this particular research, I firstly wish to know your willingness to participate in this survey. I promise that every respond from you will be confidential and will be used for my academic purpose only.

Thank you for your cooperation!!

Section A. Background Information

1. Interviewer’s name:
2. Date of the interview:
3. Community:
4. Coordinate of the household:
5. Starting time:

Section B. Respondents’ demographic information

1. Name:
2. Gender: Female () Male ()
3. Age: _____
4. Marital status:
Single () Married () Divorced () Widow () Other ()
5. How many people are in this household? _____
6. Religion: _____
7. Level of education:
No formal education () primary () secondary () Tertiary (College

and University)

8. Occupation status:

Agriculture () Service () Business () Wage labor () Other ()

9. Average monthly income: _____

10. Average monthly expenditure: _____

Section C. Solid Waste Management

Type of sector	1 = Household; 2 = institutional; 3 = construction, 4 = health care; 5 = agriculture; 6 = industry; 7 = commercial
How much solid waste do you generate monthly? In kg	
Extend of waste separation at the house level	1 = None; 2 = some; 3 = half; 4 = most; 5 = all
Extend of waste separation at the business level	1 = None; 2 = some; 3 = half; 4 = most; 5 = all
Extend of medical waste separation at the healthcare centers	1 = None; 2 = some; 3 = half; 4 = most; 5 = all
Extend of waste dispersed in the city	1 = None; 2 = some; 3 = half; 4 = most; 5 = all
The collection of waste is done by: (you can write more than one)	1 = Municipality; 2 = private sector; 3 = waste pickers; 4 = children; 5 = public private partnership; 6 = transfer point (station); 7 = other
Frequency of waste collection at commercial sites (times/ week) Frequency of waste collection at inner city (times/week) Frequency of waste collection at rural areas (times/week) Type of vehicle(s) used to collect the waste (you can write more than one)	1 = Rickshaw; 2 = wheelbarrow; 3 = truck; 4 = tractor; 5 = compactor; 6 = animal; 7 = tricycle; 8 = motorcycle;
Citizens participating in the decision making processes for swm	1 = None; 2 = some; 3 = half; 4 = most; 5 = all

Local available low cost technologies for swm	1 = None; 2 = very few; 3 = few; 4 = sufficient; 5 = Extensive
Presence of health campaigns in the community	1 = Never; 2 = sometimes; 3 = often; 4 = very often; 5 = Always
Presence of environmental awareness campaigns in the city	1 = Never; 2 = sometimes; 3 = often; 4 = very often; 5 = Always
Solid waste service provided for free	1 = Yes; 2 = no
Community willing to pay for waste collection	1 = None; 2 = some; 3 = half; 4 = most; 5 = all
Options for implementation of fees according to income of waste generators	1 = Yes; 2 = no
Private sector providing waste collection	1 = Yes; 2 = no
Private sector participating in swm services different than collection	1 = Yes; 2 = no
Public awareness campaigns available for wm in the community	1 = Never; 2 = sometimes; 3 = often; 4 = very often; 5 = Always
Stakeholders willing to participate in the wm Solutions	1 = none; 2 = some; 3 = half; 4 = most; 5 = all
Collaboration among stakeholders	1 = Very bad; 2 = bad; 3 = good; 4 = very good; 5 = Excellent

Presence in the community of active public platforms	1 = None; 2 = few; 3 = some; 4 = many; 5 = very many
Level of coordination and cooperation between service users and service providers	1 = Very bad; 2 = bad; 3 = good; 4 = very good; 5 = Excellent
Extent to which goals and objectives of service users and service providers are shared	1 = None; 2 = some; 3 = half; 4 = most; 5 = all
Adequacy of policy and legal frameworks to manage sw	1 = Very bad; 2 = bad; 3 = good; 4 = very good; 5 = Excellent
Environmental legislation in place	1 = Yes; 2 = no
Practice of law enforcement	1 = Very bad; 2 = bad; 3 = good; 4 = very good; 5 = Excellent
Clear implementation of the country's law by the municipality	1 = Very bad; 2 = bad; 3 = good; 4 = very good; 5 = Excellent

Ending time: _____

Appendix C
Ethics Approval



NAER EAST UNIVERSITY
SCIENTIFIC RESEARCH ETHICS COMMITTEE

04.11.2022

Dear N.Robert Kerkulah Geninyan

Your application titled “**Challenges and Identification of Solid Waste Management in Monrovia City, Liberia**” with the application number NEU/ES/2022/891 has been evaluated by the Scientific Research Ethics Committee and granted approval. You can start your research on the condition that you will abide by the information provided in your application form.

Prof. Dr. Aşkın KIRAZ

The Coordinator of the Scientific Research Ethics Committee

Appendix D

Turnitin Similarity Report

Challenges and Identification of Solid Waste Management in Monrovia City, Liberia

ORJINALLIK RAPORU

% 15

BENZERLİK ENDEKSİ

% 13

İNTERNET KAYNAKLARI

% 10

YAYINLAR

% 5

ÖĞRENCİ ÖDEVLERİ

BİRİNCİL KAYNAKLAR

1	pure.tue.nl internet Kaynağı	% 3
2	Lilliana Abarca Guerrero, Ger Maas, William Hogland. "Solid waste management challenges for cities in developing countries", Waste Management, 2013 Yayın	% 2
3	docs.neu.edu.tr internet Kaynağı	% 1
4	erepository.uonbi.ac.ke internet Kaynağı	% 1
5	dspace.kuet.ac.bd internet Kaynağı	% 1
6	docplayer.net internet Kaynağı	% 1
7	pdfs.semanticscholar.org internet Kaynağı	<% 1
8	www.walshmedicalmedia.com internet Kaynağı	

Appendix E

Selected Article for the Questionnaire

Waste Management 33 (2013) 220–232



Contents lists available at [SciVerse ScienceDirect](http://www.sciencedirect.com)

Waste Management

journal homepage: www.elsevier.com/locate/wasman



Review

Solid waste management challenges for cities in developing countries

Lilliana Abarca Guerrero ^{a,†}, Ger Maas ^a, William Hogland ^b

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Developing countries

abstract

Solid waste management is a challenge for the cities' authorities in developing countries mainly due to the increasing generation of waste, the burden posed on the municipal budget as a result of the high costs associated to its management, the lack of understanding over a diversity of factors that affect the different stages of waste management and linkages necessary to enable the entire handling system functioning. An analysis of literature on the work done and reported mainly in publications from 2005 to 2011, related to waste management in developing countries, showed that few articles give quantitative information. The analysis was conducted in two of the major scientific journals, Waste Management Journal and Waste Management and Research. The objective of this research was to determine the stakeholders' action/behavior that have a role in the waste management process and to analyze influential factors on the system, in more than thirty urban areas in 22 developing countries in 4 continents. A combination of methods was used in this study in order to assess the stakeholders and the factors influencing the performance of waste management in the cities. Data was collected from scientific literature, existing databases, observations made during visits to urban areas, structured interviews with relevant professionals, exercises provided to participants in workshops and a questionnaire applied to stakeholders. Descriptive and inferential statistical methods were used to draw conclusions. The outcomes of the research are a comprehensive list of stakeholders that are relevant in the waste management systems and a set of factors that reveal the most important causes for the systems' failure. The information provided is very useful when planning, changing or implementing waste management systems in cities.

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1. Introduction

Increasing population levels, booming economy, rapid urbanization and the rise in community living standards have greatly accelerated the municipal solid waste generation rate in developing countries (Minghua et al., 2009). Municipalities, usually responsible for waste management in the cities, have the challenge to provide an effective and efficient system to the inhabitants. However, they often face problems beyond the ability of the municipal authority to tackle (Sujaudun et al., 2008) mainly due to lack of organization, financial resources, complexity and system multi dimensionality (Burntley, 2007).

In the last years, a large number of research studies have been undertaken to determine influential factors affecting waste management systems in cities in developing countries. An examination of the publications from 2005 to 2011, from two of the major scientific journals, related to waste management, Waste Management Journal and Waste Management and Research, 37 showed informa-

tion related to factors affecting the system. Surprisingly, few gave quantitative information.

This research has the aim to determine the stakeholders that have an interest in the waste management system of cities under study and the factors that influence the performance of the system in three continents, from more than thirty urban areas in twenty two developing countries.

2. Theoretical framework

Integrated Sustainable Waste Management (ISWM) Model is a model that allows studies of the complex and multi dimensional systems in an integral way. The model was developed by WASTE advisers on urban environment and development (WASTE, 2004) and partners or organizations working in developing countries in the mid-1980s and further developed by the Collaborative Working Group (CWG) on solid waste management in the mid-1990's (Anschütz et al., 2004).

The model acknowledges the importance of three dimensions when analyzing, developing or changing a waste management system. The dimensions are: the stakeholders that have an interest in solid waste management the elements or stages of the movement

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