MOSHI CO-OPERATIVE UNIVERSITY

HOUSEHOLD SOLID WASTE MANAGEMENT AND THE SUSTAINABLE ENVIRONMENTAL PROTECTION IN NJORO WARD MOSHI MUNICIPALITY, TANZANIA

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BY

LEOCARDIA J.P MOSWERY

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF BUSINESS MANAGEMENT OF MOSHI CO-OPERATIVE UNIVERSITY

NOVEMBER, 2022

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I, **Leocardia J.P Moswery**, declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other learning institution for a similar or any other academic award.

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CERTIFICATION

The undersigned certifies that they have read and hereby, recommends for acceptance by the Moshi Co-operative University dissertation titled **"*Household Solid Waste Management and the Sustainable Environmental Protection in Njoro Ward Moshi Municipality, Tanzania***" in partial fulfilment of the requirements for the award of Master of Business Management of Moshi Co-operative University.

DR. FAUSTINE PANGA

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(Supervisor's Signature)

Date: _____

DR. PROSPER KIMARO

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(Supervisor's Signature)

Date: _____

DEDICATION

This Dissertation is dedicated to my lovely children Mr. Fernando Pio, Fidenice Teddy and Filomena Luminus; my Mom Theresia P. Ndama for their love, moral support, encouragements and guidance that they have provided to me during the whole period of carrying out this study. May the Almighty God reward you with a long-lasting happy life, and full of blessings. My late Mother Theresia P. Ndama for her encouragement and care from my childhood to adulthood and passed away when I was preparing this dissertation…R.I. P my mother.

ACKNOWLEDGEMENTS

Glory be to God, the Almighty, for the chance of life granted to me. This dissertation would not have been possible without the support of many people. I take this opportunity to express my sincere gratitude to all people who have been instrumental in completing this dissertation. First and foremost, I wish to thank Njoro Ward Executive Officer, her office and the surveyed households in Njoro for their timely support during data collection to accomplish my study. Also, my thanks go to my supervisors Dr. Faustine Panga and Dr. Prosper Kimaro who were abundantly helpful and offered valuable assistance, support and guidance in developing this dissertation. They inspired me greatly to work on this project. Their willingness to motivate me contributed tremendously to the successful completion of this dissertation. I would also like to thank all the people not mentioned here, but in one way or the other have contributed to the accomplishment of this dissertation “God bless you all”.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADB	-	African Development Bank
CPCB	-	Central Pollution Control Board
EFDs	-	Electrical Fiscal Devices
MSWM	-	Municipal Solid Waste Management
OECD	-	Organisation for Economic Co-operation and Development
SDGs	-	Sustainable Development Goals
SPSS	-	Statistical Package for Social Sciences
SW	-	Solid Waste
SWM	-	Solid Waste Management
UNEP	-	United Nation Environmental Program
WCA	-	Waste Collection Authority
WDC	-	Ward Development Council
WEO	-	Ward Executive Officer

ABSTRACT

The objective of the study was to examine solid waste management (SWM) at household level and its impact on sustainable environmental protection. Specifically, it determined household SWM methods for sustainable environmental protection, determined household roles on SWM, and examined household SWM limitations. The study adopted a cross-sectional research design by including 102 respondents. Documentary review, Questionnaires and key informant interviews were employed to collect data. Data were analysed using thematic analysis, descriptive and binary regression methods. Findings revealed plastic, food and paper wastes as the common wastes generated in the study area. The SWM practices differ from one household to another based on income, marital status, awareness, household concern and neighbourhood relationships. The SWM system was found to be a factor with a strong influence on sustainable environment protection. The results were statistically significant at p= 0.001. Applied SWM strategies in the study area were found to be significant at p= 0.001, Wald = 2.532 and Exp (β) = 1.876. The findings also revealed that fines, fees and penalties on improper SWm had significant influence on sustainable environment protection at p= 0.000. The findings revealed that in the study area: sorting, burning, burying, dumping and resale of the generated solid waste were the common applied approaches. Heads of the households play the following roles: ensuring availability of waste containers, tightening the waste containers well and reminding the household members on proper disposals of the wastes. The study concluded that the majority of households in Njoro Ward were unaware of the benefits of SWM for sustainable environmental protection. SWM practices in the study were negatively impacted by a number of factors. Household heads were more worried about SWM in their own homes than in their areas or neighbours. The factors that have been researched in SWM are directly related to variations in the SWM techniques used in the study area. Additionally, it was noted that in the research area, some of the crucial SWM techniques for long-term environmental conservation were not being used because of a lack of understanding of how to do so. It recommended frequent and periodic awareness-raising mentorship sessions among households on sustainable SWM, emphasising the need for SWM service providers to promptly and consistently provide the services to make the areas clean, appealing, and safe for the wellbeing of residents.

CHAPTER ONE
1.0 INTRODUCTION

1.1 Background to the Study

The increase in solid waste generation is now a global issue as it causes environmental pollution which ultimately poses challenges to the survival of mankind and sustainable development (Mbwilo, 2018). It is mainly caused by the increase in population size and urbanisation (Warunasighe and Yapa, 2016). Solid wastes are generally produced from domestic, industrial, commercial and social activities. The increase in the production of solid waste has caused improper and inappropriate disposal which cause severe social, economic and environmental challenges such as loss of habitats, air pollution, reduction of the aesthetic value of the environment and destruction of water bodies (Mandevere, 2015; Guerrero and Hogland, 2013). To address the challenges caused by solid waste, governments and environmental authorities have to introduce effective Solid Waste Management (SWM), especially to the densely populated areas like urban and peri-urban for sustainable environmental protection and economic development of the country (Alaf and Deshazo, 1996). Effective SWM is essential for environmental protection and healthier human settlements (Kumar *et al.*, 2017). The SWM encompasses all activities undertaken from the solid waste generation point up to the final disposal point (McAllister, 2015).

SWM encompasses a wide variety of activities and practices that explain unwanted residuals that damage the environment. Thus, poor management of solid wastes can cause changes in the environment and harm living organisms which finally affects the ecosystems. However, this study assumes that only proper and careful management of the generated solid waste can guarantee sustainable conservation and protection of the environment under the rapidly growing population and urbanisation, especially in the developing countries. This argument is supported by Poswa (2017) who asserted that good SWM limits the damage done to the environment and conserves scarce resources. He also added that SWM is an important side for the sustainable development of any country and global development initiatives. Further it was noted that according to Agenda 21 of the Rio Declaration on Environment and Development affirms that environmental sound management of waste is one of the environmental issues of the major concern in

maintaining the quality of Earth's environment, especially when it comes to sustainable development in all countries. Like in Agenda 21, SDGs indirectly advocate sustainable SWM which addresses environmental sustainability. This aims to foster the integration of the principles of sustainable development into country policies and programs (UNDESA, 2015).

It is globally estimated that the average SW produced per household is 365kg annually (OECD, 2011). In Russia, specifically in the city of Kostomuksha, the solid wastes produced by the households for the past 30 years remained a challenge as there is high production which is estimated to be 840 kg per household annually (Potapova, 2012). The management of the solid waste produced at household levels is a challenge in many Asian countries as most of the households do not play their SWM roles effectively (Chamilos, 2011). The Management and Handling (2010) indicates that in India, the average Indian only generates around half a kilo of solid waste per day, the volume is huge. Given the current developments, the generation of SW in India in the year 2047 is projected to exceed 260 million tons as many households do not recycle their waste, but instead, tend to dispose it outside their homes or on the streets, Central Pollution Control Board (CPCB, 2018). It is, however, only in the last few years that the SW issues have moved up on the country's development agenda and received substantial interest in India whereby, Kumar *et al.* (2017) advocate the need for environmental stakeholders' (government and community) interventions and urgent systems, which will facilitate effective SWM for sustainable environmental protection in rapidly growing cities.

Solid waste is a major challenge particularly in households in many sub-Saharan countries, though the majority are not aware of the factors that cause poor SWM (Frank, 2016). Alamgir *et al*. (2015) assert that household awareness on factors limiting SWM can help the urban households to engage themselves on SWM as the key stakeholder in SWM. It is noted that if the households do not play their roles there will be improper SWM that will intensify environmental pollution and health risks among the household members and the general public (MININFRA, 2013; ADB, 2012). For example, Mbwilo (2018) indicates that in Tanzania like other developing countries, SWM at household levels in several cities have reached critical points and if no effective intervention is undertaken it will become worse not only for the household members but also for the whole community.

The Moshi municipality in Tanzania is among the fast-growing municipalities which needs more efforts towards managing the generated solid waste for sustainable environmental protection (Mbwilo, 2018). If not properly done it may affect human health such as infection transmission, physical injury, non-communicable diseases, emotional and psychological effects and an increase in management and disposal costs. Together with the socio-economic and environmental impacts caused by SW, this problem might also hinder the success and achievements of Sustainable Development Goals (SDGs) number three (3) on good health and wellbeing; number six (6) about access to clean water and sanitation and number eleven (11) which is about sustainable cities and communities. It was noted that there were sparse empirical studies on the status of SWM at household level in Moshi municipality, particularly on the household knowledge on SWM, roles played by households in SWM and hindering the factors limiting effectiveness of household solid waste management.

Due to inadequate source sorting, inappropriate storage, collection, transportation, treatment, and final disposal, waste management in Tanzania is rapidly growing to be a significant problem (Nyampundu, *et al.,* 2020). This suggests that a sizable amount of the trash produced is disposed of in an improper manner that increases the hazards to the environment and the general public's health. Squatter communities, where 70–80% of the urban population lives without the essential infrastructure and social services, are where the waste disposal issue is most severe. As a result, water and sanitation are factors in more than 70% of illnesses treated in medical facilities nationwide. Municipal wastewater, industrial effluent, leachate from landfills, agricultural operations, gaseous emissions from industrial establishments, traffic-related activities, and noise are the main causes of pollution. The trend appears to be becoming worse, especially in metropolitan regions where socio-economic activity is concentrated and population growth is accelerating (Kassim,2021). The majority of the population uses pit latrines and septic tanks for sanitation, which have walls that are not watertight and allow groundwater to readily flow into and out of the pit. As a result, domestic wastewater is the most important source of water contamination. Only 10 to 15 percent of metropolitan residents have access to the sewer system, which increases the risk of water-borne illnesses. Additionally, it is projected that more than 10,000 tons of municipal solid trash are produced every day nationwide. The range of the indicative generation rate is 0.1 to 1.0 kg/cap/day. Up

to 80–90% of the solid garbage produced in metropolitan areas is not collected, and the majority of domestic waste—which makes up about 60% of the total solid waste produced daily—is burned or buried for disposal.

1.2 Statement of the Problem

The rapid increase in the amount and forms of solid wastes has been the outcome of the constant growth, urbanisation and industrialization which have become the main challenges in national and local governments to ensure effective management of solid wastes. This is evidenced by Mbwilo (2018) who indicates that in the year 2006, the total amount of household solid waste generated globally reached 2.02 billion tones, representing a seven percent annual increase since 2003. It further projects that in 2007 and 2011 global generation of household solid waste increased by 37.3%, equivalent to a roughly eight percent increase per year. This is evidence that generation of solid waste at household level is the issue of concern that needs a more understanding of the knowledge in managing the generated solid wastes, examining the roles played by stakeholders in managing the generated solid wastes as well as determining factors limiting solid waste management. Such understanding contributes to the efforts of ensuring sustainable environmental protection particularly in rapid growing urban cities.

Studies by Mandevere (2015); Guerrero and Hogland, (2013) indicate that there is growing improper SWM at the household level in developing countries. Abdul *et al.*, (2017) assert that poor waste management practices hamper the progress towards an integrated solid waste management in households. Warunasighe and Yapa, (2016) asserts that inappropriate SWM practices at household levels are of a great threat to the households and the general public health as it leads to a decline in the quality of living standards. Mbwilo (2018); Kazuva and Zhang, (2019) also indicate that poor SWM at household level need more interventions such as financial support, technical support and more research for sustainable environmental protection.

Tanzania’s municipalities including Moshi have undertaken several initiatives to ensure there is proper SWM. Such initiatives are placement of waste containers (dustbins) around the town and communities, implementation of policies and regulations, imposition of penalties for non-compliance and hiring of collection

agencies as pointed out by Kazuva and Zhang (2019); Hussein and Mansour, (2018). Despite the municipal interventions on SWM currently there are improper solid waste disposal in public dwellings and prohibited areas that negatively affect the hygiene and beauty of the areas and increased health risks (Hussein and Mansour, 2018). The environmental report by Moshi Municipal Council (MMC, 2019) also indicates that there is improper solid waste management, especially at household levels. In line with increased improper waste disposal at households while there are municipal interventions, there was a need of this study to add knowledge on current solid waste management status at household levels which is necessary for accurate decision making in the move towards a more sustainable environmental protection in Tanzania.

Despite numerous municipal measures, one of the biggest issues facing Moshi Municipality is solid waste management (MMC,2019). According to the MMC report, more than 50% of the waste produced by households is either not collected or is disposed of improperly. The report also shows that the population is growing at alarming rates, making it impossible for the current systems or processes to collect and properly dispose of all the garbage produced in a timely manner. Due to this circumstance, garbage gathers everywhere near households and residences. The report also identifies Njoro ward as one of the worst wards for solid waste management and disposal. In order to adequately manage the garbage produced, this research sought to identify the main sources of solid waste and examine the impact of solid waste management on the sustainable environmental protection in Njoro Ward, Moshi Municipality, Tanzania.

1.3 Research Objectives

1.3.1 Main objective

The main objective of this study was to examine the impact of solid waste management on the sustainable environmental protection in Njoro Ward, Moshi Municipality, Tanzania.

1.3.2 Specific objectives

To achieve the main objective, the study was guided by three specific objectives aimed to:

i. Determine household solid waste management methods for sustainable environmental protection,
ii. Determine household roles on Solid Waste Management for sustainable environmental protection, and
iii. Examine household solid waste management limitations for sustainable environmental protection.

1.4 Research Hypothesis

The following three research hypotheses guided the study in achieving the specific objectives:

i. H01- There is no relationship between methods used on solid waste management and sustainable environmental protection in Njoro Ward
ii. H02 – There are no positive roles played by households in solid waste management and sustainable environmental protection in Njoro ward
iii. H03- There is no household solid waste management limitations and sustainable environmental protection in Njoro Ward

1.5 Significance of the Study

Urbanisation, industrialisation and economic growth in developing countries and transition in several other social and political issues due to globalisation call for a sustainable environmental management and protection system in which SWM strategies tally with the situation at hand for the benefit of the present and future generations. Poor SWM has impacts on the environment, human health and sustainability of other living organisms. At the local and international level, there have been several efforts towards sustainable SWM, although there is a marked increase of this problem in rapidly growing cities and towns such as in Tanzania. For this reason, there is a need for researching the SWM practice for sustainable environmental protection in urban areas of Tanzania mainland by taking Njoro ward in Moshi municipality as a case study.

In addition, the study findings are of significant importance to policy makers as they will enable the formulation and amendment of SWM policy, strategies, by-laws, regulations that will be used to ensure cleanliness and beauty of the growing urban cities in Tanzania.

Further, the findings shall provide a significant knowledge and awareness on SWM practices to the households and other communities living in Njoro and the rest of the wards in Moshi municipality. Gaining such knowledge and awareness will enable them to take more appropriate measures to ensure sustainable protection of their environment. This will also add value in the process of conserving the environment and reducing eruption of diseases caused by improper sanitation or improper waste disposal practices.

The study findings also add value to the body of knowledge on the solid waste management practices. This also adds value to academicians and the researcher who will be dealing with the same or related study. In this case therefore, the findings from this study shall be of use as a source of literature review or knowledge base on solid waste management and sustainable environmental protection in that matter.

CHAPTER TWO
2.0 LITERATURE REVIEW

2.1 Definitions of the Key Terms

2.1.1 Waste

The UNEP (2012) defined wastes as the substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law. This study adopted the Mugambwa and Kizito (2019) and Mukisa (2019) definition of waste which is defined as items, materials or substances that individuals consider useless at a given time and place. Usually, the definition of wastes depends on the types of categories and characteristics of waste under consideration. Some of the dominant types of waste include municipal waste, solid waste, hazardous waste and electronic waste.

2.1.2 Solid waste

This study adopted the Solid waste definition as defined by Schubeler (2016) and Cointreau-Levine and Coad (2014) which is defined as the refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments, market waste, yard waste and street sweepings but excluding excreta, except when mixed with solid waste. It is, however, necessary to note that in developing countries, it becomes difficult or even impractical to separate excreta from solid waste. In many instances, solid waste mixes with excreta to the extent of being potentially hazardous to human health (Schubeler, 2016).

2.1.3 Solid waste management

This study defines solid waste management as practices used for collection, transportation, processing, recycling or disposal of garbage (Mugambwa and Kizito, 2019). It ought to be appreciated that waste management practices differ from developed and developing countries, urban and rural areas and residential and industrial producers. The volumes and types of solid waste in the different sources of waste justify the difference in the waste management practices. Therefore, it implies that the methods appropriate in one setting may be different from another setting. Felix (2010) points out some key elements of SWM as waste generation, waste storage, collection and transportation.

2.1.4 Sustainable environmental protection

Sustainable environmental protection is an integrated approach that involves waste collection and treatment methods that enhance environmental benefits, economic optimisation and societal benefits (Mbwilo, 2018). This study considers sustainable environmental protection as the effective and efficient use of environmental treatment and disposal options that lead to waste reductions such as reuse, recycling, recovery of energy materials and composting. It also considers sustainable environmental management as an integration in terms of management of wastes from different sources such as commercial, household and industries, or else in terms of different materials, such as metal and papers or other forms of wastes generated from various activities.

2.2 Sustainable Waste Management Principles

According to ILO (2007) the management of household solid waste is critical and some principles have been formulated in a bid to ensure proper waste management. These principles, if well implemented, lead to good waste management. The Cradle-to-grave principle is a policy of controlling wastes from its creation (cradle) to its final resting place (grave). The Life cycle principle states that products should be designed, produced and managed so that all environmental concerns are considered, accounted for and minimised during generation, use, recovery and disposal. The duty of care principle extended producer responsibility that individual or organisation that produces waste (the generator) is under all circumstances, responsible for that waste from cradle to grave.

The Integrated waste management principle on the other hand requires that waste generation should be avoided or minimised as much as possible. Any generated waste should be recycled or reused wherever practical. Any waste that cannot be recycled or reused should be treated or compacted to reduce toxicity and volume. Any waste that cannot be subjected to the above should be disposed of in a properly designed and managed landfills. The Polluter pays principle requires a person who causes pollution to pay for its clean up and any damages caused. Furthermore, the precautionary principle states that unknown waste must be treated as extremely hazardous until it is identified and classified. Based on the stated principles, this study hypothesised that if well implemented and followed they would have a positive impact on sustainable environmental protection in the study area.

2.3 Theoretical Literature Review

This study was guided by the theory of human interaction with the environment which describes environmental protection through solid waste practices. Solid waste is defined as household waste and any other waste collected by a WCA or its agents including waste from parks, beaches, commercial establishments, offices, industries and fly-tipping (Read, 2009). The Organisation for Economic Co-operation and Development (OECD) (2011) defined environmental protection as the practice of protecting the natural environment by individuals, organisations and governments. Its objectives are to conserve natural resources and the existing natural environment and, where possible, to repair damage and reverse trends.

2.3.1 Theory of Human Interaction with the Environment

This theory was propounded by Hammond (1995). It expresses how human activities through MSW bear imprints on the environment. Proponents of this theory argued that it concerns the entirety of human activities, knowledge of interacting variables which enhances understanding of possible outcomes for different behaviour within the environment (Mbwilo, 2018). They also support that human interaction is the best component in explaining the causal relationship between SWM and sustainable environment especially, in rapidly growing cities. Proponents added the four interactions between human activities and the environment. These are the source, sink, life support and impact on human welfare as explained hereunder.

Source: From the environment, people derive minerals, energy, food, fibres, and other natural resources to use in economic activities, thus potentially depleting these resources or degrading the biological systems (such as soils) on which their continued production depends.

Sink: Natural resources are transformed by industrial activities into products (such as pesticides) and energy services that are used or disseminated and ultimately discarded or dissipated, thus creating pollution and wastes that (unless recycled) flow back into the environment.

Life support: The earth's ecosystems especially unmanaged ecosystems provide essential life-support services, ranging from the breakdown of organic wastes to nutrient recycling to oxygen production to the maintenance of biodiversity. As

human activity expands and degrades or encroaches upon ecosystems, it can reduce the environment's ability to provide its usual services.

Impact on human welfare: Polluted air and water, and contaminated food affect human health and welfare directly or indirectly and thus affecting the ecosystem and the environment too. Despite the potentiality of the theory of human interactions' theory, opponents provided critiques that such human interaction can be interfered with by natural occurrences that are beyond human interactions. This study took that assumption by checking the natural occurrence in the study area and how they may affect SWM practices apart from human interactions. But generally, the theory was good in assessing the impact of household solid waste management on the sustainable environmental protection in Njoro ward, Moshi Municipality, Tanzania

2.4 Empirical Literature Review

Gumbi (2015) examined some challenges on patterns, practices as well as trends regarding sustainable municipal SWM and minimization. He revealed that at the household level, there is a certain level of awareness on environmental solid waste management practices provided by the municipality as well as local recycling options. Although, there are numerous challenges to be resolved before these functions can become effective. With informal recycling, several waste materials are being reclaimed at various landfill sites. However, current informal waste picking activities by the so-called scavengers are not sustainable as waste is not separated before disposal at various point sources.

Another constraint hampering the effectiveness of informal waste recovery has to do with their daily exposure to several environmental and health risks. Furthermore, the study has found out that many municipality administrations lack adequate infrastructure to undertake waste minimization effectively. Also, waste minimization and awareness campaigns are found to be inadequate and at an infant stage, unlike those carried out by private companies.

Studies by McAllister (2015).; Adogu *et al*. (2015); Mnyaki (2014) and Kirunda (2009) revealed that effectiveness and success towards management of MSW are influenced by several factors ranging from micro to macro level. The main factors revealed include culture, knowledge, awareness, infrastructure, social provisions, technology, policy and regulation. The study recommended that to make progress in

MSWM communities need to embrace new systems of MSWM that are participatory, contextually integrated, complex and adaptive. Conversely, Adogu *et al.,* (2015) recommended that integrated and sustainable systems should be applied by environment stakeholders to address those multiple constraints while McAllister (2015) argued that SWM is a multidimensional issue that needs to incorporate political, institutional, social, environmental and economic aspects which require efforts to raise public awareness, increase funding, build expertise and invest in infrastructure.

According to Njoroge and Kimani (2014) in many local government administrations, there is little scope for financial planning in connection with solid waste collection systems, because funds are received according to availability and at the decision of the mayor or another senior administrator. The study by Thomas *et al*. (2017) revealed that a lack of proper planning for waste management services eventually leads to the inability of the authorities to predict and forecast the quantity of waste to be generated. These findings are similar to the findings by Bubegwa (2012) who purported that lack of proper planning for waste collection keeps policy priority in waste management relatively low. Shashank (2014) observed that unplanned settlements and cities accelerate the problem in solid waste management. In unplanned areas of the city where wards have not taken the initiative to collect waste or in areas of the city where collection service is poor, individuals commonly dump their waste into drainage ditches, streams and by the roadside.

Ogwueleka (2010) revealed that institutional (agencies and administrations) factors hinder sustainable MSWM. The constraints facing environmental agencies and administrative authorities include the lack of institutional arrangements, insufficient financial sources and urbanisation, absence of by-laws and standards, inflexible work schedules, insufficient information on the quantity and composition of waste and inappropriate technology. In Tanzania, there are several factors such as lack of awareness, technical knowledge, legislation, policies and strategies (Stiftung, 2016).

The study by Mbwilo (2018) on factors affecting the sustainable municipal SWM and collection services in other parts of Tanzania, shows that the SWM is left to individuals or residents and sometimes waste may be left to accumulate in the streets. He argued that this situation experiences several challenges emanating from

factors such as low community environmental education and awareness, shortage of skip buckets and bays, insufficient Electrical Fiscal Devices (EFDs) for refuse collection, inadequate enforcement of laws, increasing population and socio-economic activities, human and financial constraints, shortage of vehicles and increasing waste production against collection capability.

2.5 Household SWM in Developing countries

In studies by Jibril *et al.* (2012) and Ezeah (2010), very few urban areas in the developing world have adequate and sustainable waste disposal systems. Household solid waste is an increasing urban problem that has not received much attention in sub-Saharan Africa (Ezeah, 2010). The complexity of household solid waste management unfolds due to increasing urbanisation, changing waste composition and other issues (Tevera *et al.,* 2003). This makes most developing countries home to waste. In India, for example, 70 – 90% of landfill is open dumping (Kurian, 2002).

The generation of waste, according to Williams (2002), will continue to rise. This is supported by UN HABITAT (2003) which indicated that if present trends continue, two billion people could be living in slums by 2030 which will result in increased waste generation and worsening the already bad household SWM. This is because there is no household solid waste collection in such settlements. They tend to dump their wastes anywhere, illegally, just as they are also regarded as illegal hence complicating the waste management systems in general.

Makwara and Magudu (2013) assert that the problem of household solid waste mismanagement in developing countries started way back in the early 1990s when the Economic Structural Adjustment Programme (ESAP) was introduced followed by the infamous land invasion in the early 2000s which triggered the unprecedented economic meltdown. This negatively impacted the revenue base of municipalities that now depend heavily on government and donor funding. This situation saw the standard of waste management continue to fall way below-accepted standards with town councils failing to collect waste around their areas of jurisdiction as regularly as scheduled.

A study by Katyal and Satake (2001) revealed that financial and material resources are scarce in developing countries. Thus, waste collection is less effective resulting

in serious environmental problems. Studies by Masocha and Tevera (2003); Mapira (2001); Mapira and Mugwini (2005); Makwara (2011) show that, because of lack of capacity, household solid waste has become one of the most visible and pressing urban environmental problems. Their findings are supported by Nhete (2006) who assert that in most of the municipalities and big cities in developing countries, waste collection has virtually collapsed and has given birth to chaotic and rampant illegal dumping. A study by Chidavaenzi (2006) also shows that until the mid-1990s very few urban areas in developing countries were regarded as models of cleanliness in Africa and beyond, but the economic meltdown resulted in no fuel and frequent breakdown of waste collection vehicles without repair led to poor waste management in many cities and towns.

In Tanzania, the local government system was also seriously affected by the withdrawal of donor support from 1998 owing to the political difference between donor countries and central government (Machivenyika, 2012). This is supported by Makwara and Magudu (2013) who indicated that before the withdrawal of external aid, local authorities tended to over-rely on external technical, material and financial assistance. Due to the economic meltdown between 2000 and 2010 many challenges militating against sound urban solid waste management (Musademba *et al.*, 2011). Machivenyika (2012) indicates that the country's household solid waste management is poor because of its deteriorating infrastructure which hinders proper movement of trucks that collect waste and this together with poor financial backup makes the whole waste management issue a vicious cycle. Chinobva and Makarati (2011) lament that failure by the local authorities to collect refuse results in urban dwellers dumping it at open sites as well as peri-urban areas which are health hazards and cause pollution. This explains why UNHABITAT (2006) indicated that less than 20% of urban solid waste is collected and disposed of properly.

2.6 Appropriate Household SWM Options

The proper household SWM needs proper establishment and improved facilities for collection, recycling, treatment and disposal of household solid waste. Urban managers are therefore, encouraged to pursue the paths of Integrated Solid Waste Management (ISWM) and the 3Rs of waste management (Reduce, Reuse and Recycle) that place the highest priority on waste prevention, waste reduction and waste recycling instead of just trying to cope with the ever-increasing amounts of

waste through treatment and disposal. Such efforts will help city authorities to reduce the financial burden on cities for waste management, as well as reduce the pressure on landfill requirements. Internationally known principles of waste management are the only noble way to go.

Figure 1 illustrates the best waste management options. It illustrates that if the environment is to be protected there is a need to completely avoid waste generation. This can be done by avoiding the use of non biodegradable products and encouraging the use of biodegradables. In cases where the population cannot avoid the non-biodegradable, it is wise to reduce whatever waste is being generated. This reduced waste should be reused and be recycled to reduce the sprouting of waste dumps. This includes the reusing of waste that can be used again before throwing it away as waste. In cases where recycling and recovering waste fails, it is environmentally proper to treat all waste to avoid releasing poisonous substances into the environment. After treatment, the waste can safely be disposed into a landfill and not a dumpsite where it is not properly managed.

There is, therefore, a need to recover high-value recyclable materials at residential places and small industries (Nhete, 2006) to ensure proper household solid waste management, using colour-coded bin bags to encourage waste separation at the source. These receptacles should be properly labelled plastics, glass, paper, cans and so on (Environment Africa, 2013). This makes it easy to collect the recyclables and items that can be reused; the material will be cleaner to use than ‘mixing then separate at the end of the chain approach. Rajagopalin (2005) however, indicated that recycling is not a solution to managing every kind of waste material. In fact, recycling technologies are unavailable especially in developing countries. It is also important to note that, according to Environment Africa (2013), there are only twenty-eight (28) recycling plants recorded in their database and most of these companies are unknown to many people, especially those from the high and medium density areas. This makes the management of waste a bit difficult as there is a need for separation facilities as well as environmental education.

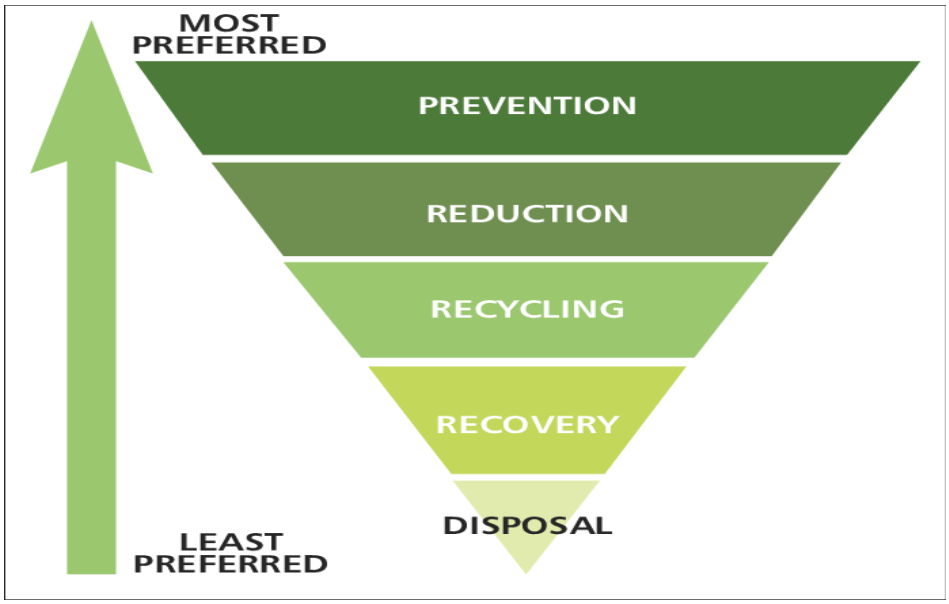

Figure 1 : Proper Household Solid Waste Management

Source: Edith Cowan (2008 as cited from Mbwilo (2018)

2.7 The National Solid Waste Management Strategy and initiatives in Tanzania

The national plan for solid waste management (SWM) aims to achieve sustainable management of solid waste that contributes to obtaining economic and social advantages for Tanzanian citizens during the next few years, according to the study by Nyampundu *et al.*, (2020). The Vice President's Office, the Ministry of Health, Community Development, Gender, Elderly, and Children, the Ministry of Industry, Trade, and Investment, the Ministry of Regional Administration and Local Government, the Municipal Councils of Dar es Salaam, and environmental NGOs have all contributed to the presentation, discussion, comments, and modification of this strategy. This strategy will need to be modified periodically to reflect changes in Tanzania's situation and global advancements in waste management technologies. The following initiatives, according to Yhdego, 1999/2019, have been put into practice: a) To provide solid waste management (SWM) services, the government has enlisted the help of the commercial sector, non-governmental organisations, and community-based organisations. Although more efforts are still needed, this has made an effort to limit the amount of solid trash in metropolitan areas.

b) To reduce the amount of non-biodegradable waste materials, the private sector and investors are urged to build solid waste recycling systems. This could be a

source of money, employment, and jobs. There are now only a few communities with rudimentary recycling programs for some sorts of waste. Paper scraps, metal, glass, plastic bottles, and old tires are some of these resources. c) In recent years, the government issued a Public Notice outlawing the production, importation, sale, purchase, and use of plastic bags with a thickness of less than 30 microns (or 0.03 mm) and those with a thickness of less than 65 microns (or 0.065 mm), which are used for packaging water and juice. Additionally, it surtaxes other plastic bag types (often referred to as Rambo) with a thickness of 30 micrometres (or 0.03 mm) and higher by more than 100%. The bags and packages degraded the environment, raised the risk of diseases like malaria and cholera spreading, clogged sewage systems and drainage ditches, decreased the productivity of the land, and put cattle in danger. d) Business owners and investors in the industry are urged to support the manufacturing of paper-made bags as an alternative to plastic bags.

e) Through biogas flaring and energy production, the government is pushing diverse stakeholders to take advantage of the potential of decomposing solid waste for climate change mitigation. As the first CDM project of its sort in East Africa, a CDM project on Landfill Gas Methane Recovery and Electricity Generation is being undertaken at the Mtoni Dumpsite in Dar Es Salaam. f) Some sectors, such as biogas facilities for energy demands, have begun to employ the waste produced for economic objectives. In one of the sisal processing plants in the Tanga region, the world's first facility to generate electricity from sisal trash was just opened. It's intended to be another CDM project dealing with waste management. Similarly, some sugar refineries use bagasse as fuel to create steam and power. g) A National Waste Management Strategy and Action Plan.

2.8 Conceptual Framework

Figure 2 presents a conceptual framework of the study which shows both the independent and dependent variables. The independent variables in this study include Household Solid Waste Management methods, Household Solid Waste Management Roles and limiting factors for Household in Solid Waste Management. On the other hand, the dependent variable is sustainable environmental protection. It was assumed that effectiveness of the independent variable eventually leads to sustainable environmental protection. The conceptual framework also shows that there are intervening variables that might influence the relationship between

independent variables and dependent variables directly or indirectly like environmental policy, although it will not be used as a major variable in this study.

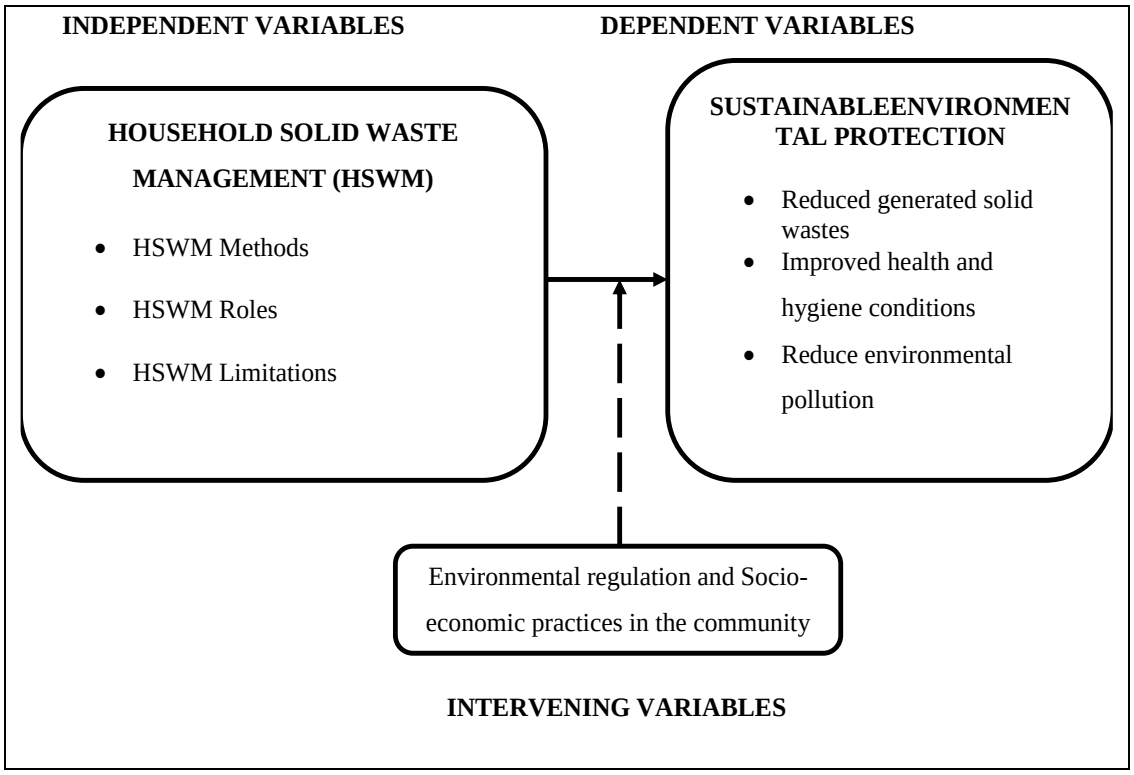

Figure 2 : Conceptual Framework on the impact of household solid waste management on the sustainable environmental protection

Source: Researcher's own construct (2021)

CHAPTER THREE
3.0 RESEARCH METHODOLOGY

3.1 Research Design

This study applied a cross-sectional research design. This design allowed the data to be collected by using mixed method approaches of data collection at a single point in time and it was useful for description purposes as well as for determination of the relationship between variables (Bailey, 2008). This design was favourable to this study as it allowed the collection of both qualitative and quantitative data with consideration of limited resources like funds and time (Kitala, 2014). The adoption of the combined approach also provided a more complete understanding of the research problem than using a single approach as advocated by Mayala (2018).

3.2 Study Area

Moshi municipality is situated in North-eastern Tanzania close to the Kenya border on the slopes of Mount Kilimanjaro, which is also the highest mountain in Africa. Moshi municipality is one of seven districts of the Kilimanjaro Region. The municipality covers 59 km^2 with a population of 202 379 residents in 14 692 households. The annual population growth rate is 2.9 percent which is attributed mainly to rural-urban migration and migrant labourers. According to the 2012 population and housing census, 52.6 percent of people in Moshi municipality are unemployed. Moshi was selected as a case study due to the fact that it has been a leading urban with hygiene environment though the MMC (2019) reported improper solid waste management in the study area. Like any other places in Tanzania, Njoro ward in Moshi Municipality generates a lot of wastes on a daily basis. Njiro ward is one among the squatter settlements with high population and poor infrastructure between one household and another.

In addition, the ward has many people participating in petty business which in turn generates a lot of waste. Sensitization has been done by Moshi Municipality but people’s culture and attitudes of ensuring a safe and clean environment has not changed significantly. Most of the places at Njoro wards are stinking with scattered and leaking wastes. The situation is more harmful particularly during the rainy season which may lead to outbreak of diseases such as cholera. According to the Environmental Report from Moshi Municipality (2019), Njoro ward is considered to

be among the leading wards with a dirty environment in the Municipal. This therefore, called for this study to be conducted at Njiro Ward Moshi Municipality, Tanzania.

3.3 Population, Sample and Sampling Procedures

3.3.1 Population

All households in Njoro ward who gave their consent to participate in the study and who were present during the survey were included in this study. During the survey period, 1 492 heads were expected to be present in Njoro ward (MMC, 2019). Additionally, it was stated that several family heads weren't always available because of their hectic work schedules. As a result, the sampled population was roughly 753 households with heads who were reported to be present on the study's date.

3.3.2 Sample size

The sample size for this study was 102 households residing in Njoro ward. This sample size was determined by the Sample size table ((Appendix 4).) as recommendation by Israel (2008) who suggest that a sample size for population below 100 000 is recommended to be between 51 and 100 respondents.

3.3.3 Sampling procedures

The study adopted a convenient sampling technique to select members of the households (for the interview) with the help from the local executive officers. The households found closed or with persons who could not provide information as far as the research ethics are concerned were excluded. Key informants; Ward health officer and Ward Executive Officer (WEO) were selected purposely to provide official information and clarifications on the issues raised by the households' members.

3.4 Data and Data Collection Methods

3.4.1 Types and source of data

Both primary and secondary data were collected. Primary data was collected using a questionnaire and key informant interview which included socio-demographic characteristics of the respondents, HSWM knowledge, roles of households in

HSWM and the limiting factors in solid waste management. On the other hand, the secondary information was collected by reviewing reports, policies and regulations related to solid waste management and environmental protection.

3.4.2 Data collection tools and method

In this study, documentary review, questionnaires and an interview guide were employed. Before actually collecting field data, the researcher pretested the data collection tools to confirm their validity and reliability by comparing them to questionnaires that had been used in previous studies. The study participants' answers to a four-part, self-administered semi-structured questionnaire on their level of knowledge of solid waste and SWM were used to gather data for the study. Unstructured questions gave study respondents the chance to express themselves in writing while structured questions only allowed for 'Yes/No' answers. Age, gender, education level, and length of stays at the place of residence were the four demographic variables of the survey respondents that were covered in the first section.

3.4.2.1 Survey Method

The questionnaire survey was administered to household heads. A Swahili written semi-structured questionnaires was developed by the researcher as the main data collection tool on solid wastes generated at households, measure levels of knowledge and awareness about solid waste management strategies, determine roles of households in solid waste management and identify factors limiting solid waste management among the household members. Kiswahili language was preferred for easy understanding by the respondents.

3.4.2.2. Interview method

Three key informants' interviews with the ward executive officer and health officer were used to collect qualitative information. This method was used to collect official data such as policy issues and clarification on the matters raised from the households related to SWM. The questionnaire preceded the key informant interviews because it was the main tool for data collection as it involved a large sample as compared to key informant interviews. A Swahili key informant interview guide was used to guide the interview section. Both ward executive officers and ward health officers were consulted as the KIIs because they are always in the community and one of

their daily life activities is to ensure cleanliness and environmental sustainability in their area. The KIIs chosen were very useful in providing the needed information with respect to household waste management and sustainable environmental protection at Njoro ward Moshi Municipality, Tanzania.

3.4.2.2 Documentary review

In order to concretize the findings, the researcher made use of different documents on the environmental protection, solid waste management, community participation on environmental management, country research priority areas and National Environmental Conservation Council policies, procedures and strategies on how to deal with household solid wastes.

3.5 Data Analysis

The qualitative data were analysed using thematic analysis in understanding respondents' views particularly key informants. The analyses helped in interpreting respondents' views as well as giving them themes and detailed explanations. The percentages were developed from the calculation based on the expected scores. Descriptive statistics was used whereby frequencies and percentages were computed with the aid of Statistical Package for Social Sciences (SPSS) software**.** Binary logistic regression was used to analyse objective 1-3 in the study**.** P-value was used to test hypotheses at 5% level of significance. If p-value is less than 0.05, an alternative hypothesis was accepted and rejected the null hypothesis. To ensure an accurate understanding and analysis of the regression model, it was critical to test for normality, homoscedasticity, multicollinearity and linearity.

Binary regression model:

$$\text{Logit}(P_i) = \log \frac{p(x)}{1-p(x)} = \alpha\ \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots\ \beta_p x_p + \varepsilon \quad \text{Equation (1)}$$

Where:

Logit (Pi)	=	Y is a binary and represents the probability of protection (1) or no protection (0) into environment
α	=	intercept of the equation
$\beta 1$ to βp	=	predictor variables regression coefficients
x1 to xp	=	predictor variables
ε	=	error term

Table 1 : Definition of model variables

Variable	Variables definitions and unit of measurement
Dependent Variable	
Protection of the environment	Binary: protection (1); no protection (0)
Independent Variables	
Methods (X_1)	SWM Methods (1= Applied, 0= Not applied)
Roles (X_2)	Role of households (1= roles, 0= no roles)
Limitations (X_3)	Factors limiting households (1=affect, 2=not affect)

3.6 Validity and Reliability

To assure the validity and accuracy of the information provided by the study respondents, the researcher employed the triangulation approach to collect data (semi-structured questionnaires and individual in-depth interviews). Before sharing the research instruments with the supervisor and the study's subject matter for professional assistance, including input, deletion, and correction, the researcher for this study produced the research instruments by benchmarking research instruments from prior studies.

To ensure the validity of the data, transferability, and generalizability of the study findings, the tool was checked for content, linguistic accuracy, clarity, and the study respondents' ability to understand the information. Before using it in the field, the researcher pre-tested it for reliability with the help of Moshi Co-operative University statisticians, research experts, and supervisors. The tool's capabilities to provide the desired findings were tested in a pilot study with 15 willing participants at Karanga Ward, a site outside the sampled study region. After having them at their homes and receiving a brief instruction on how to complete them, the 15 copies of questionnaires were presented to the sampled study respondents during the pilot project. Some complex sentences and other items were deleted, while others were added. Additionally, grammatical errors were corrected appropriately, and the text was proofread once more.

Utilising the Statistical Package for the Social Sciences (SPSS) software program version 21, scale analysis was used to the pilot study's findings. Since no items were removed from the scale and the Cronbach Alpha value was 0.72, it was statistically determined that the instrument was reliable and could be utilised to collect data for this study.

CHAPTER FOUR
4.0 FINDINGS AND DISCUSSIONS

4.1 Overview

Study findings are organised based on study objectives and sub-themes. The discussion of the findings was guided by the critical review of various literature and reports from libraries and the internet. The discussion of the data collected through the questionnaire survey method and in-depth interviews were linked with the secondary information to develop a scholarly interpretation and synthesis of the information. In the annex, some pictures illustrate some of the arguments discussed in the discussion section. The organisation of this chapter follows the research objectives/question. Discussion of the findings are in line with the research objectives/questions and related literature sources or citations from chapters one and two.

Information presented in this chapter were collected and analysed using qualitative and quantitative techniques. This chapter is divided into four sub-sections i.e. descriptions of the respondents' profiles, household methods and knowledge on solid waste management for sustainable environmental protection, household roles on solid waste management for sustainable environmental protection and household solid waste management limitations for sustainable environmental protection.

4.2 Socio-demographic Characteristics of Respondents

4.2.1 Socio-demographic characteristics of the respondents

A total of 102 households were surveyed in the study area. In the survey, there were questions that intended to capture respondents' profiles like sex, age, marital status, education level and family size. Such description enabled the researcher to understand the background of the respondents from which data were drawn.

Table 2 : Respondents' Profiles (n = 102)

		Frequency	Percent
Sex Category	Male	53	52.0
	Female	49	48.0
Age Category	20-29	33	32.4
	30-39	23	22.5
	40-49	24	23.5
	50-59	13	12.7
	Above 60	9	8.8
Marital	married	63	61.8
Condition	single	32	31.4
	Widow	7	6.9
Education level	Primary	40	39.2
	Secondary	48	47.1
	Certificate	2	2.0
	Diploma	6	5.9
	Bachelor	5	4.9
	Masters	1	1.0
Household size	1-3	34	33.3
	4-6	40	39.2
	7-10	24	23.5
	above 10	4	3.9

Table 3 presents a summary of the findings of respondents' profiles. The findings on sex distribution revealed that 52% of the respondents in the study area were males and 48% were females. This agrees with the finding by Mnyaki (2014) in Kinondoni Municipality who assessed solid SWM where he found that the majority (76%) of the respondents in that area were male while females were only 24%. These statistics imply that the majority of males stay at home longer than females. During data collection, the researcher started noticing this trend and asked the Ward Executive Officer (WEO) why during data collection almost all of the household members found at home were males. He replied that most females in Njoro are petty traders. They do not stay home the whole day, so if you need to find them at home it is better to visit their households early in the morning before 9.00 am. This implies that males are more responsible in SWM. This is because during the survey time the researcher observed that the SW collection vehicles pass in the streets between 10.00 am to 4.00 pm therefore, males remind the children to make sure that they dispose of the waste to the vehicles or dumping area for collection.

Moreover, the findings on the age category, as shown in Table 2, indicate that the majority (32.4%) of the household members interviewed from the Njoro ward were matured young people with an average age category of 20-29 followed by an age

category of 40-49 and 30-39 which was about 23.5% and 22.5%, respectively. The age category of 50-59 and 60+ were 12.7% and 8.8%, respectively. In totality, these statistics show that the majority (78.4%) of the heads of households in the Njoro ward fall between the age categories of 20 to 49 which is similar to finding by Mnyaki (2014) who revealed that the majority of the respondents were adults in the age group of 21 to 40. This age category is regarded as the energetic age category that can be very active in managing solid waste produced in their localities and their households. However, the interview conducted with one elder in one household revealed that the role of managing especially (collecting and disposing) of solid waste is the responsibility of the entire household members regardless of their ages. These findings agree with the findings by Mbwilo (2018) who revealed that children especially those who have started schooling are also involved in managing solid waste as they believe that involving children in SWM will make them grow up with a good habit of SWM.

Further, the study findings on education level in the study area as shown in Table 2 shows that the majority (47.1%) of the household members interviewed had a secondary level of education followed by a primary level (39.2%). It was also revealed that only 13.8% have an education level above secondary school which is college or university levels. The study finding is contrary to the findings by Mbwilo, 2018 from Mbeya city which indicates that the majority (43%) of the respondents had primary level followed by 33% secondary level while above secondary level was 34% respectively.

In addition, findings on the marital status of the respondents as shown in Table 3 revealed that the majority (61.8%) followed by a single (31.4%) while the widow were 6.9%. During data collection, the researcher noticed that the trend of meeting married respondents was increasing therefore she decided to ask a question from two different respondents who were married whether there is any difference in the effectiveness of SWM from being married and not being married. The responses were as follow:

> *"…yes, there is a difference between being married and not being married as far as the effectiveness in SWM is concerned. For example, after being married I have tried much to maintain hygiene in my compound and reduce producing solid waste in my house to avoid injuries and diseases that may affect my children…also most of*

> *unmarried residents do not produce many solid waste as they mostly use their consumables out of their homes* (Njoro Ward, March, 2021).

On the other hand, a married male respondent stated that, \

> *"… I cannot tolerate having improper solid waste disposal in my compound because I have a wife and children and their main responsibility is to make sure the compound is clean…. I also remind them every morning to clean and make sure they dispose of generated wastes in the dumping areas for collection by the municipal vehicle"* (Njoro Ward, March 2021).

The above quotations demonstrate that there is a relationship between being married and effectiveness in SWM though it was not statistically proved. It also gives a picture that wives and children are more responsible for waste disposal, which is the order from the husbands or father.

The findings on the household size revealed that the majority (39.2%) of the households' members were 4-6 followed by 1-3 family size which was 33.3%. The family members in the category of 7-10 and above 10 were 23.5% and 3.9% respectively. This description was very important as it gave a researcher to confirm the conclusion made by Gumbi (2015) that the higher the number of household members the higher the production of SW. Although there was no statistical analysis to test it, the observation made by the researcher during data collection revealed that there is a close relationship between household size and SW production and SWM in the study area. The households with many members were found to have improper SW disposals especially food waste like fruits remnants, eggshells and food leftovers.

4.2.2 Study area profile and SWM status

Moshi municipality is one of Tanzania's major coffee processing hubs. The residents engage in horticulture and grazing cattle, goats, pigs and poultry. The area of land used for urban agriculture is 120 hectares. However, the Municipality is rich in natural assets including Njoro Forest, Njoro Spring, Rau River, Rau Forest and Karanga River among others. Environmental protection and management is one of Moshi municipality's biggest issues. Before 2006, the council was the provider of solid waste services with residents not seeing waste. As a way of prioritising, the council ran a consultation with their citizens to ascertain how individuals could

contribute to a vision of environmental cleanliness. At the policy level, in 2000, the council committed to a process to clean the municipality, promulgating an environment and cleanliness by-laws.

Moshi has been Tanzania's leading council in health and environmental sanitation for the past many years. However, Moshi Municipal did not win the 2018- 2019 competition. After that, Moshi municipal council introduced a similar competition at the ward–level to promote good performance in waste collection and cleanliness, offering a money prize to the winners. Some wards also run the competition at the sub–ward levels where the winners receive Tanzanian Shillings 500 000. However, for competition at the ward level some wards did not win prizes, for example, Njoro ranked in the 20th position out of the 21 wards in Moshi Municipal Council.

Also, some wards are saving funds to buy or maintain trucks for the ward, especially the Njoro ward boundaries; the current one is shared by all wards. One truck is estimated to cost about 400 000/= hundred shillings per day to maintain and Moshi municipality planned to promote waste recycling and continue with a greening campaign which would consist of tree planting and the beautification of the Municipality.

Moshi Municipality is among the fast-growing towns in terms of its population and economic activities which imply that the generation of solid waste is among the expected challenges that would have affected the environment. Njoro ward is growing fast in terms of population and economic activities, especially industrial activities. The council consistently educates the community to comply with the by-law and, therefore, to keep the environment clean. Environmental awareness campaigns and clean–up or sanitation day events encourage residents. For example, if someone is found littering, another individual can report them and penalise them with a Tshs. 50,000/= fine. The person who administers the fine submits it to the local ward council and may keep 50% of the fine.

The provision of SWM services is decentralised to ward level, whereby wards can collect revenue via service collection fee and spend it on service providers such as payment for labour, administration, equipment, stationery, repair or maintenance and truck fuel. The development of the by-laws contributed significantly to the rapid change of Moshi's image especially, Njoro ward. According to the 2012 National

Census, Njoro ward has a population of 14 692. Among the 21 wards of Moshi Municipal council, Njoro ward grows fast in terms of population and economic activities, especially industrial activities and microfinance. Njoro ward council is improving on SWM through the provision of skip baskets for solid waste collection, and storage in strategic areas throughout the ward.

4.3 Household solid Waste Management Methods in Njoro Ward

The objective of analysing the methods used in solid waste management for sustainable environmental protection was achieved by first analysing types of solid waste generated in the study area. The multiple responses in Table 3 indicate the main solid wastes generated at the households in Njoro ward.

Table 3 : Common solid wastes generated (n=102)

Types of HSW	Percentage (%)
Papers	63
Plastics materials	89
Metallic Materials	24
Food Waste	82
Glasses	11
Others	7

Table 4 illustrates the percentage of the types of solid wastes generated in Njoro ward. It was revealed that plastic, food and paper wastes are the common wastes generated in Njoro ward. During the data collection, it was observed that the plastic materials mentioned were plastic bags, plastic bottles and containers that are not automatically decomposable. Most of the plastic wastes were seen being disposed of around the streets. The main food wastes which were found were the fruits and banana leftovers. It was revealed that not all households surveyed had dustbins for disposing of the mentioned food wastes. The few households with dustbins some of them were observed to dispose of wastes in the containers though it was not properly disposed of as some of them were disposed of besides the containers.

It was also observed that the available containers in some households were not covered or closed which attracts many flies and bad smells in the household compounds. The study findings also revealed that waste material in the form of papers followed after plastic and food waste scored 63%. Paper wastes were also rampantly disposed of. It was, however, observed that the paper waste materials of

this nature were decomposable materials like newspapers, air time cards, magazines and brochures. The study findings further revealed that waste materials in the form of metals and glasses had the least responses of 24% and 11% respectively.

During the survey, the researcher thought of asking one household member why metal wastes are not common like papers and plastics. He replied that "*Chuma ni pesa, pesa haiwezi tupwa tupwa hovyo*", meaning that metal materials have a monetary value that cannot be disposed of rampantly. This statement implies that if all wastes can be valued as metal materials our environment would be clean and safe for human health. It was finally found that other forms of waste scored 7%. The other forms of solid waste material which were observed in the area were mobile phone covers, batteries and wooden materials. Study findings implies that all solid waste that have monetary values are taken as more precious than those without monetary value.

Use of various methods of solid waste management

Respondents were asked to indicate their frequency of using various SWM methods in their residents. This question was very important to answer objective one because households are expected to apply various methods in SWM as part of the municipal regulation. Surprisingly, many SWM methods are not used by many households in the study area as shown in Table 5.

Table 4 : Frequency of using various methods of solid waste management (n=102)

SWM Methods	Often	Occasionally	Never used
Reduce	8 (7.8%)	3 (2.9%)	91(89.2%)
Recycle	13 (12.8)	11(10.8%)	78 (76.4)
Burn	83 (81.4%)	15 (14.7%)	4 (3.9%)
Sorting	4 (3.9%)	21(20.6%)	77 (64.2%)
Burying	3 (2.9%)	9 (8.8%)	90 (88.2%)
Dumping in the dump sites	90 (88.2%)	9 (8.8%)	3 (2.9%)
Reuse	7 (6.9%)	24 (23.5)	71 (69.6%)
Resale	6 (5.9%)	29 (28.4%)	67 (65.7%)

Assessment of the methods used to manage generated solid waste by households in the study area revealed that out of 8 recommended methods only 2 methods were used oftenly. Thus, 88.2% and 81.4% of the surveyed households use the waste in the dumping site and burning methods very often respectively. Many (6 out of 8)

methods have shown a high rate of never being used; reduce (89.2%), recycle (76.4%), sorting (64.2%), burying (88.2%), reuse (69.6%) and resale (65.7%). Previous studies (Kazuva and Zhang, 2019; Adogue *et al.,* 2014) has also reported low usage of the similar methods though at Njoro ward non-usage rate to the mentioned methods is higher than that of the previous studies.

However, this difference could be reflecting socio-economic differences between the study areas, instructional regulations and technological differences. It was commented by one member of the surveyed households that low usage of some methods is due to lack of skills and awareness of the mentioned methods. At the study area, the ward health office has been attempting to run seminars on SWM although it has never been very successful in terms of attendance as the majority of the household never shows up.

Despite the general findings on the applied SWM methods showing low usage of many methods, the study findings on methods used based on the type of solid waste generated have shown different results as shown in Table 5.

Table 5 : SWM Methods used per type of solid waste generated (n = 102)

	Applied SWM Methods (%)								
Type of HSW	**Reduce**	**Recycle**	**Sorting**	**Burn**	**Burry**	**Dump in the dumping sites**	**Reuse**	**Resale**	**Others**
Papers	23	8	0	63	57	18	0	0	11
Plastics materials	10	22	4	71	0	13	21	9	27
Metal materials	0	0	24	0	0	0	0	35	3
Food Waste	6	0	0	0	0	56	0	0	14
Glasses	3	0	0	0	11	68	0	0	0
Average	**9**	**6**	**5.6**	**26.8**	**13.6**	**31**	**4.2**	**8.8**	**11**

The findings in Table 5 illustrate the average of the applied SWM methods in the Njoro ward. The finding indicates that dumping the wastes generated to the skippers is the main method used with an average of 31% followed by burning and burying the generated wastes with an average of 26.8% and 13.6%, respectively. The least method applied is reuse and sorting with an average of 4.2% and 5.6% other methods because the municipal authority collects those wastes for proper disposal in the main

dumps. However, during the survey it was observed that the dumping styles in the skippers were not done properly as the dumping points had scattered solid wastes such as papers and fruits leftovers. Also, despite the burning and burying methods being used as the second and third methods in SWM, various studies including Stiftung (2016) and Mbwilo (2018) advise that these methods are not environmentally friendly as they cause air and land pollution.

This implies that burning and burying are not good methods for sustainable environmental protection. This study concurs with the previous studies by adding that these methods might also cause injuries and health problems to the residents around the areas where they are burned or buried. The other methods such as reduce, reuse, recycle, resale and sorting scored the lowest average. The findings in the study are contrary with the recommendations made by other studies including Kazuva and Zhang (2019) and Drogue *et al.* (2014) that they are the best methods for sustainable environmental protection. This implies that there is a need for more intervention to create awareness on the use of these methods which scored the lowest average while they are environmentally friendly. Among the challenges for low application of these methods is the low capacity of the households in the study area in SWM. "*The capacity and skills of our household members is low that is why they don't use these methods*" argued a Njoro Ward WEO.

The argument on low capacity brought a need to analyse the capacity of the households in managing the produced solid wastes around the streets of Njoro ward. The study findings in table 6 on the capacity of the households in managing the solid waste produced in Njoro ward revealed to be unsatisfactory as majority 57.8% responded that their capacity to manage solid waste around their street and their households was low and 11.8% were not capable at all. To confirm why their capacity is low, respondents claimed that people do not have enough knowledge and some of the methods need some money for their implementation. For example, the use of recycling methods for plastic or metallic solid waste needs knowledge and money to recycle them.

To confirm such a statement, the researcher made a telephone conversation with the WEO and asked if there is any SWM capacity building program needed or conducted. In the conversation, it was revealed that there is no SWM capacity

building program implemented rather than awareness creation programs from the municipal council, wards and street officials to the households and the whole community members.

Table 6 : Capacity of the Households in SWM (n = 102)

Capacity	High capacity	Not Capable	Low Capacity	Total
Frequency	31	12	59	102
Percentage	30.4	11.8	57.8	100

The study examined the effectiveness of the applied methods and the challenges facing effectiveness of the applied SWM methods. In order to understand the effectiveness of the household SWM methods that led to sustainable environment protection, each respondent was asked to state the SWM implementation challenges. Four challenges were identified including poor disposal management system, ineffectiveness of the strategies, improper handling of solid waste and effective practices as shown in Table 7. Majority (60%) of the respondents argued that SWM challenges which limit effectiveness of the SWM methods such as recycling, reusing, reducing, burning, dumping, burying and avoiding the generation of a large number of solid wastes are household income, size of the household members, leadership strictness, education and household members awareness of the SWM strategies. It was also revealed that SWM in households residing in remote areas to be poor compared to the households in planned areas due to the reasons shown in Table 7.

Table 7 : SWM challenges (n = 102)

Variables	SD%	D%	N%	A%	SA%	Mean	Std deviation
Poor disposal management system	3.1	3.1	16.9	43.1	33.8	4.02	1.976
Ineffectiveness of the strategies	1.5	6.2	7.7	40	44.6	4.20	2.990
Improper handling of the generated solid waste	1.5	7.7	18.5	33.8	38.5	4.00	0.026
Ineffective practices	3.1	1.5	27.7	36.9	30.8	3.91	0.984

The binary logistic regression was conducted whereas, the overall significance of the model was assessed using an Omnibus tests of model coefficients which produced a log likelihood 29.325 and omnibus tests of model coefficients (Chi-square 244.655,

sig. 0.000), Nagelkerke R Square= 0.932; Cox and Snell R Square = 0.566 indicating a strong relationship between the challenges and environmental protection; Hosmer and Lemeshow Test (Chi-square= 15.330; sig. = 0.056), the two measures together indicate that the model on practices influencing environmental protection was more suitable to the data. The following results in Table 8 were obtained:

Table 8 : The household SWM challenges in Njoro Ward (n = 102)

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Disposal management system	2.601	0.782	11.075	1	0.001*	13.483
Effectiveness of the strategies	0.567	0.359	2.501	1	0.004*	1.764
Proper handling of solid waste	2.300	0.555	17.174	1	0.000*	9.971
Effective practices	7.387	8.555	15.063	1	0.002*	14.064
Constant	16.655	4.117	16.369	1	0.000	0.000

Omnibus Tests of Model Coefficients (Chi-square = 244.655; sig. = 0.000); Log likelihood= 29.325[a]; Cox & Snell R Square = 0.566, Hosmer & Lemeshow Test (Chi-square= 15.330; sig. = 0.056); Nagelkerke R Square = 0.932

Regarding the effectiveness of the strategies, the study revealed that it was found to be significant at p= 0.004, Wald = 2.501 and Exp (β) = 1.764. The model produced a Wald statistic of 2.501 which predicted that effectiveness of the strategies contributes significantly to influencing environmental protection activities. Effectiveness of the strategies increase the probability of environmental protection by 1.764 causes the odds to be 1.567 which indicates that effectiveness of the strategies are 1.567 likely to be influenced in protection of the environment. Disposal management was found to be a challenge with a strong influence on the applied methods for environment protection. The results were statistically significant at p= 0.001, Wald = 11.075, and Exp (β) = 13.483. Moreover, a Wald statistic of 11.075 shows that the disposal management system of respondents contributed highly to environmental protection.

The findings further indicated that effective waste management practices among the respondents was another strong positive significant influence of environment protection activity at p= 0.002, and Wald statistic of 15.063 and an Exp (β) of 14.064. A Wald statistic of 14.064 demonstrated that effective practices significantly influenced environmental protection. Exp (β) value indicated that an increase in the

effective practices, the odds ratio is 7.387 implying that effective practices were 7.387 more expected to protect the environment. The positive significant influence explains that the higher effective practices the higher probability for environment protection.

Proper handling of solid waste was also found to be a factor with a strong positive significance influence on the methods of environment protection at p= 0.000, Wald = 17.174, Exp (β) = 9.971 indicating that when proper handling of solid waste increase by 9.971 the odd ration is 2.300 times as large and therefore proper handling of solid waste are 2.300 times more likely to environmental protection. Based on Logistic regression outputs (p values) showing significant influence, the null hypothesis that household SWM methods have no influence on sustainable environmental protection was rejected.

4.4 Roles of Households on SWM for Sustainable Environmental Protection

The study findings revealed that the majority (81.4%) of the respondents in the study area were aware of their roles in SWM.

In analysing the roles played by the household in SWM respondents were asked to respond to the question which aimed to ascertain they actively participate well in SWM in their localities. Table 10 results indicate the findings on the ways in which the household participates in ensuring effective SWM. Among the roles mentioned by many respondents include ensuring the availability of waste containers (87.3%), tightening the waste containers properly (91.2%) and reminding the household members on proper disposals of the wastes (80.4%). The rest of the roles as shown in Table 9 were not effectively practised by the households in the Njoro ward.

Table 9 : Roles played by households in SWM (n = 102)

SWM Roles Played in the Households	Yes		No	
	Frequency	Percentage	Frequency	Percentage
Sorting the wastes to ensure proper disposal	23	22.5	79	77.5
Ensuring availability of waste containers	89	87.3	13	12.7
Reusing, Recycling and Reducing (3Rs) waste generation in the household	17	16.7	85	83.3
Paying for waste collections	64	62.7	38	37.3
Tighten properly the waste containers to avoid improper scattering of the wastes	93	91.2	9	8.8
Reminding the household members and neighbourhoods on proper disposals	82	80.4	22	19.6
Collecting and transporting the wastes to the disposal points (Skip tanks)	23	22.5	79	77.5
Reporting illegal and improper disposals to the waste management authorities	37	36.3	65	63.7

The findings in Table 10 illustrate the roles played by the households in managing generated solid wastes. The findings on the sorting practices revealed that the majority (77.5%) of the respondents do not sort wastes before disposals. This implies that households in the Njoro ward do not separate the types of wastes generated during disposal, thus might cause injuries to waste collectors and improper disposal. During the survey, it was observed that in the skipper tanks there was a mixture of several types of wastes which proved that residents in Njoro ward do not sort their wastes before disposals. Lack of sorting makes the skippers generate bad smells and attract flies which might cause diseases to the residents.

Further, the findings also revealed that the majority (87.3%) of the households in Njoro play major roles in ensuring that there are waste containers in their households for collecting the wastes generated. It was however observed that most of the wastes containers in the household were not durable nor strong as a majority they use old buckets and sacks which are used to pack grains to put their wastes. The use of the

sacks and old buckets makes it easy for them to be worn out by dogs and cats and cause scattering of the stored wastes. Considering that the majority of the respondents do not sort the waste generated, it was observed that most of the sacks and available old buckets had a leakage as a result of decomposition of the food waste which was mixed by other forms of wastes.

The study also observed that the surveyed households with old buckets do not seal them. However, it was revealed that residents were aware of the benefits of using hard and closing the waste vessels as well as the impact of using sacks. One of the respondents explained that:

> *"...If we keep waste in grain bags and open vessels attract flies, mosquitoes as well as producing odours and may cause diseases to the household members. Also, it makes our streets dirty because animals and wild birds throw away those wastes."* (Njoro Ward, March, 2021)

The respondents were also asked whether they play any roles in reusing and reducing waste generation in their households. The question aimed at revealing whether the residents play roles in reusing, recycling or reducing the generation of wastes. It was found that the majority (83.3%) of the respondents do not play this role effectively. Some of the respondents said that they burn and bury wastes instead of reusing them. When one respondent was asked why they burn and bury some wastes which could be reused he said they lack knowledge of how they can reuse and recycle as well as reduce generating more wastes. They lamented that the waste authorities do not educate them on such approaches. When the respondents who said they use the 3Rs were asked to explain how they use it, they mentioned that 3Rs is common to plastic containers, shopping bags and empty bottles of water and other beverages. They said they use those wastes for domestic purposes like storing sugar, cooking oils and planting flowers.

They also said that they reduce the number of wastes by using the packaging materials such as friendly environmental bags over and over again until it becomes torn on its own, they call for the collectors of food leftovers and the plastic materials such as empty bottles and they minimise the use of materials which are not decomposable. In the process of finding more information on 3Rs, the WEO explained that he will advise the street officer to create an awareness on 3Rs in all

households. Furthermore, he said that all residents have to reduce generation and reuse the generated wastes such as bottles and fruit peel for animal feedings.

The study findings also revealed that the majority (62.7%) of the households play a role in SWM by paying fees for waste collection. The amount paid by every household is 12 000 Tsh per annum. The interview with WEO revealed that the residents with commercial apartments such as shops, hotels, industries, garages, bars and groceries are entitled to the payment of solid waste collections ranging from 60 000 to 780 000 based on the size and type of commercial enterprises. The inquiry from interview and KIIs affirmed that people are willing to continue paying for waste collection in the study area as their role to help the households reduce the time of transporting the waste to the skippers which are far from their households.

The findings on whether the household plays a role in properly tightening the waste containers, it was revealed that the majority (91.2%) of the respondents play such a role. The study observations during data collection revealed that people do not tighten the containers properly especially those households which use sacks in keeping the household wastes. Most of the sacks found in the households and around the gates waiting for the waste tracks were loose or not tied up properly (Figure 3). Some of the wastes were in the open boxes, some were scattered as a result of not tightening them well. It was also revealed that the household waste containers, especially the old buckets, were not sealed and they were leaking leaving the waste material scattered and attracting flies and odours. It was also found that domestic animals like dogs and cats had access to the waste containers that cause improper scattering of the wastes due to poor seals or tight containers.

Figure 3 : Loose waste containers leading to the scattering on the wastes on the environment

Furthermore, findings revealed that the majority (80.4%) of the households remind the neighbours and other household members on collection and disposal of the wastes. One respondent from the household said that they usually remind each other especially on the days which the trucks are passing for collection or when the waste collection tracks arrive in the neighbourhoods. Inquiries from the KIIs, revealed that it is very rare for the households to remind each other when someone disposes of the waste improperly like disposing of the waste out of the containers or out of the skipper tanks. They also do not remind each other to seal the waste containers even on how to reuse, reduce and recycle the wastes generated in the households.

The findings on whether household members play a role in collecting and transporting the wastes to the disposal points (skip tanks) revealed that the majority (77.5%) do not play such roles. It was revealed that most of the households in Njoro ward collect the wastes and put them around their gates waiting for the waste collection trucks to pick those wastes. The interview with one household revealed that the waste collection trucks pass twice a week. Therefore, they keep the waste

outside waiting for such days. Such a scenario is taken as a health risk to the households as these wastes attract flies, mosquitoes and other diseases. It was observed that the minorities who collect and transport the waste to the skippers are the people in the market areas and those households which are very near or close to the skippers. It was lamented by one respondent that:

> "…*The municipal waste collection tracks need to collect the waste more often, even daily as the rate of the wastes generated tends to increase as a result of increasing population in their residential area*." (Njoro Ward, 2021).

The study findings on whether household members play roles in reporting illegal and improper disposals to the waste management authorities revealed that the majority (63.7%) of households never reported such practices to the respective authorities. During the interview with one household, members were asked why many households never reported such practices despite being in existence. They explained that such practices are done overnight and early in the morning so it is difficult to notice the responsible person whom to report. Some others explained that most of the people protect each other as they are close friends so reporting them will tarnish their friendships and neighbourhoods.

The study findings revealed that to ensure the households play their roles on SWM effectively, the Njoro ward prioritises public education on health and building a culture of valuing a clean environment. Some initiatives on community activation and environmental education included a monthly clean-up campaign which is well attended by the community participating in cleaning their surroundings and voluntarily paying a solid waste collection fee. The ward council is divided sub-ward-wise to enable provision of SWM services. Ward council structure includes community leaders, the households, chairperson, health officer, ward counsellor, environment committee and a ward development committee (WDC) which is responsible for planning, arrangement of activities and implementation.

The official roles and responsibilities played by Njoro ward in collaboration with the Moshi municipal council are planning, supervision, coordination and monitoring of the performance of winner wards, provision of solid waste collection trucks and other equipment and management of the disposal sites. The ward council development committee facilitates the collection of solid waste trucks and site

disposal by community/household or private entities using the trucks provided by the Moshi Municipal Council. The ward council collects the solid waste service fees from businesses, industries, residents, households and uses 20% of the funds to pay collectors, fuel the municipal trucks and cover other administrative costs.

Njoro ward has four sub–wards; it is at this level that planning takes place, and people are incentivized to keep their areas clean. Many wards take the efforts of this decentralisation approach further and encourage sub-ward involvement. A new program at the national level added further motivation for Municipal Councils to invest in an effective waste management system. Identifying the relationship between poor environment and diseases, the national health and environmental sanitation competition started in 2008; and assessed municipal councils against a checklist of environmental infrastructure and process indicators ranking councils by best performance.

The study revealed that SWM roles in Njoro ward differ from one street to another. The difference is due to a lack of common understanding, a disposal management system based on the neighbourhoods, relationships and financial capacity or resources for efficient and effective waste management. It was also revealed that waste storage containers like plastic and sucks were used in one way or another. Most of them were kept near the gates and others in the kitchen. It was also observed that the public waste bins were far from the households which weakened the effectiveness of SWM roles. It was revealed that only 25% said they can reach these bins for proper waste disposal.

The study also revealed that only 42% of the households had basic information on SWM best practices. Such a low level of knowledge leads to poor implementation of SWM roles such as proper handling of the solid waste, sorting and disposing of the waste generated. To ensure that households have sufficient information on SWM practices, Poswa (2017) suggested that the organisation and the council responsible for environmental protection should increase and improve public awareness and understanding on SWM practices through brochures, seminars, social media and fact sheets. This implies that increasing public knowledge on SWM practices can be used as a strategy of ensuring effectiveness of the households' roles for enhanced sustainable environmental protection.

The findings revealed that about 75% of the interviewed respondents are highly concerned with the roles of proper handling of solid waste by using proper SWM practices. This implies that the majority (75%) of the households have a sense of consciousness about environmental protection. This evidence shows that people have great concern and are responsible for their homes and their surroundings. This also shows that people are willing to participate in environmental protection and management. Their willingness is also shown in their readiness to contribute funds for transporting the wastes generated in their households.

The theory of Human Interaction with the Environment proposed by Hammond (199)5 states that effective implementation of any community roles is highly influenced by their interactions and attitudes. In order to determine households' attitudes towards SWM roles on sustainable environmental protection, respondents were provided with four statements to indicate their level of agreement as shown in Table 10. The findings show a positive attitude towards households SWM roles on sustainable environmental protection since the majority (94.2%) indicated agreed or strongly agreed implying that their environment would be sustainably protected if they could play their roles fully. Similarly, a great number (92.2%) of the respondents agreed or strongly agreed that they can sustainably protect their environment if households become serious in implementing their roles.

On the other hand, over half (66.7%) of the respondents disagree that implementing all roles by households would sustainably protect their environment. This implies that respondents do not believe that applying all roles at once is an essential approach to ensuring sustainable protection of their environment. These findings are in agreement with McAllister (2015); Adogu *et al*. (2015); Mnyaki (2014) who noted that it is not possible to apply multiple SWM approaches or roles at once due to social, economic, technological and geographical factors.

Table 10 : Households Attitudes towards SWM roles (n = 102)

Statement	Strongly agree	Agree	Disagree
I feel that our environment would be sustainably protected if we could play our roles fully	79 (77.5%)	17 (16.7%)	6 (5.9%)
We can protect our environment if households become serious in implementing their roles	73 (71.6%)	21 (20.6%)	8 (7.8%)
If given an opportunity to recommend roles to be played by households for sustainable environmental protection I would recommend all roles	15 (14.7%)	19 (18.6%)	68 (66.7%)

4.5 The SWM limitations towards Sustainable Environmental Protection

Possible SWM limitations that households encounter in managing generated solid waste were provided on a five likert scale ranging from Strongly Disagreed, Disagreed, Neutral, Agreed, and Strongly Agreed as shown in Table 12. Seven constraints were examined including public education on SWM, strategies used or applied in SWM, fines/penalties and fees for solid waste disposal, fences in the disposal areas, awareness on SWM, knowledge on 3Rs and waste management programs in media. The findings revealed that six limiting factors were found to have above 50% of the responses that they affect SWM in Njoro ward. These factors include public awareness on SWM, SWM strategies, availability of fences in disposal areas and knowledge on 3Rs. The findings also revealed that out of the seven factors analysed, only one factor (fines/penalties/fees for disposal) was found to have low responses in limiting SWM in Njoro ward. A detailed discussion of the factors is presented hereunder.

The study findings revealed that public education on SWM has a great effect on SWM in the study area as the majority of the respondents agreed that public education on SWM is low. Table 12 indicates that 52.9% of the respondents agreed and 47.1% strongly agreed that public education on SWM is low and therefore, it

limits their ability in managing generated solid waste in their streets. One respondent was asked whether he has ever tried to learn or educate his household members on SWM on his own especially in sorting, recycling or reusing produced solid waste; the reply was " *I have never done so*" . When he was asked why he never does that, he said he does not have any knowledge on the mentioned ways of SWM. The respondent was also asked whether providing public education on SWM would bring any significant impact on SWM. His response was that; *"Providing public education on SWM will bring significant impact because the knowledge you told me like that of sorting, recycling and reusing of solid waste is good and people will know the value of recycling and reusing*" (Njoro Ward, March, 2021)

The respondent emphasised that people need to be educated on SWM and specifically waste sorting, recycling and reusing through media such as radio, TVs, social media and even using seminars in public gathering like markets, religious institutions and schools

Further, the findings revealed that in managing solid wastes, the ward officials and the municipality applied various strategies (Table 12). The applied strategies include engaging community members, local leaders, providing waste disposal tanks for disposal and even providing waste collection trucks. The respondents were asked about the adequacy and effectiveness of these strategies in SWM in their localities. The majority (93.3%) of the respondents replied that the applied strategies are neither adequate nor effective as still the streets have plentiful waste which is rampantly disposed and uncollected.

During the survey, one respondent from the commercial street replied that usually, waste trucks pass in their street once a week though waste is produced every day, which causes poor disposal around the street. He also said that sometimes they leave all wastes outside their gates for easy collection by the waste trucks, but if the truck comes late, they find dogs and cats have dispersed the wastes rampantly. It was however observed that most of the wastes placed outside the household gates were not tightened, which is why the dogs and cats found it easy to disperse them.

It was also observed that despite the availability of the waste skip tanks and waste collection trucks, one of the respondents complained that the skip tanks and taking the waste to the roads for easy disposal and collection seem to be the problem for

many people due to the congestion of the houses, distance to the roads and the skip tanks. The distance was found to cause people to rampantly dispose of solid wastes to the water trenches and on the street roads.

On the other hand, during the interview with the WEO, she explained that the Moshi municipal council has few trucks which visit all 21 wards that is why they pass once a week each ward though the situation is not the same to all wards as it depends on the population and amount of waste produced in the respective wards. He further said that the most problematic wards where the population is large and waste are generated in large quantities, the trucks may pass even twice or thrice a week and that is why Moshi municipal council particularly in the town centre poor waste disposal cannot be found. The Municipal clerk declared that what they are emphasising at the council level is to encourage and promote voluntary compliance to proper waste disposal, self-carrying of the waste by households to the disposal points, proper disposing into the available waste tanks in each ward and ensuring regular availability of the trucks to all wards.

On the fines, penalties and fees charged for waste disposal, the findings revealed that the majority (74.5% and 25.5%) of the respondents strongly disagreed and disagreed respectively that this strategy does not limit their SWM practices (Table 12). The finding implies that people find the fines and penalties not effectively charged that is why they do not bother to comply with proper disposals. The study findings revealed that, when people are caught poorly disposing of waste, the officials demand corruption which was complained by many respondents. The WEO explained that fines and fees are legally imposed to enhance compliance. He further said that fees are paid though the penalties are not much charged because, currently people have started understanding the importance of voluntary compliance and proper disposal and collection of the wastes in the respective waste points. The WEO was also asked to rate the compliance level in terms of payment to the waste collection fees and said that almost 85% of the households are complying, paying for the waste collection fees.

The findings revealed that the absence of fences in the waste's disposal points has been responded by the majority (54%) of the respondents that it limits SWM in the Njoro ward (Table 12). One respondent said that the areas where the waste skip

tanks are placed are not fenced which allows the entrance of dogs, cats and even the entrance of people who collect some wastes like bottles for sale while scattering the collected wastes in the respective points. The researcher visited one skip tank and found that there were dogs and mentally ill men nearby the tanks and even the wastes were not disposed well in the tank rather being disposed outside the tank. It was however noted that fencing the skippers is not a solution rather the solid wastes from households and commercial shops should be tightened properly and heavily that would not allow dogs and cats to reopen them easily.

The findings revealed that the majority (53%) of the respondents are not aware of the SWM policy of the Moshi Municipal Council. The responses indicate that 47.1% and 11% agreed and strongly agreed (Table 12) that lack of awareness of such policy affects SWM in the Njoro ward. It was observed that even the SWM regulations and by-laws in the ward offices were not available for easy access by the residents. These documents were only available in the municipality offices.

The findings revealed that the non-use of the 3Rs approach has a significant limitation on SWM. The findings in Table 12 indicate that 59.8% and 40.2% agreed and strongly agree respectively that the use of this approach would have a positive impact on SWM. The researcher interviewed three respondents who were asked whether, in their localities, there are solid wastes that can be recycled, reused and reduced; they all said yes. This implies that residents in Njoro ward are aware that solid waste can be recycled or reused. The three respondents were requested to mention some waste generated in Njoro ward that can be recycled or reused and how they can be reused or recycled. Sacks or bags used for sugar, grains, flowers, etc. were mentioned by the respondents and said that instead of disposing of them, they resale to other traders who reuse them for other activities. Also, the big sacks are nowadays re-made in small bags which are sold to customers who buy small items after the use of the plastic bags. Food and fruits leftovers as well as their peelings were also mentioned as the solid wastes that are reused. They said that food and fruits leftovers, as well as their peelings like banana, mangoes, pineapples and avocados are sold to people who buy them for animal feeding, especially pigs.

The study revealed that lack of SWM programs in the media has been ranked among the limiting factors for effective SWM. Findings in Table 12 indicate that 53.9% and

46.1% of the respondents agreed and strongly agreed that the lack of SWM programs in Media is the main stumbling block towards effective SWM. Two respondents were asked on how the media programs may help in SWM: *"…People are social beings who have a nature of forgetting easily, therefore, need to be reminded often. The media program will act as the reminders to them therefore, will help in proper SWM". …the media programs are potential to SWM as it will act as the educator, reminder and sensitizer to the community on benefits of proper disposal and ill effects of improper disposal of the generated wastes ...."*. (Njoro Ward, March, 2021)

Table 11 : Factors limiting Households in SWM towards Sustainable Environmental Protection (n = 102)

Variable	SD%	D%	N%	A%	SA%	Mean	Std. Deviation
Public Education	0	0	0	52.9	47.1	4.56	0.599
Solid Waste Management Strategies	0	0	0	93.3	6.7	4.73	0.816
Fines, Fees and Penalties	0	0	0	74.5	25.5	4.62	0.656
Awareness of the SWM policy	0	0	0	53	47	4.78	0.618
Solid waste management programs in the media	0	0	0	53.9	46.1	4.52	0.589
Knowledge of 3Rs	0	0	0	59.8	40.2	4.76	0.786

SD=Strongly Disagreed, D= Disagreed, N=Neutral, A= Agreed, SA= Strongly Agreed

In order to understand the significant influence of the limiting factors binary logistic regression was conducted as shown in Table 12.

Table 12 : Factors Affecting Households in SWM towards Sustainable Environmental Protection (n = 102)

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Public Education	2.604	0.754	11.658	1	0.002*	13.564
Solid Waste Management Strategies	0.786	0.323	2.532	1	0.001*	1.876
Fines, Fees and Penalties	2.231	0.563	17.453	1	0.000*	9.654
Awareness of the SWM policy	7.885	8.213	15.876	1	0.003*	14.754
Knowledge of 3Rs	7.423	7.856	10.324	1	0.002	9.342
Solid waste management programs in the media	2.765	7.856	9.654	1	0.004	8.745
Constant	16.655	4.117	16.764	1	0.000	0.000

Omnibus Tests of Model Coefficients (Chi-square = 224.734; sig. = 0.000); Log likelihood= 29.756[a]; Cox & Snell R Square = 0.557, Hosmer & Lemeshow Test (Chi-square= 15.321; sig. = 0.052); Nagelkerke R Square = 0.943

The overall significance of the model was assessed using Omnibus tests of model coefficients which produced a log likelihood 29.325 and omnibus tests of model

coefficients (Chi-square 207.423, sig. 0.000), Nagelkerke R Square= 0.845; Cox and Snell R Square= 0.646 indicating a strong relationship between factors affecting households that led to environment protection; Hosmer and Lemeshow Test (Chi-square= 13.453; sig. = 0.050), the two measures together indicate that the model on factors affecting households that led to environmental protection was more suitable to the data. The following results were obtained:

Public Education was found to be a factor with a strong influence on environment protection. The results were statistically significant at p= 0.002, Wald = 11.658 and Exp (β) = 13.564. Moreover, a Wald statistic of 11.658 shows that public education of the respondents contributed highly to environmental protection. Results further indicated that when public education of the respondents increases by 13.564, the odds ratio is 2.604 inferring that public education of the respondents are 2.604 more likely to engage in environment protection. This is because as public education of the respondents increases, they tend to have more responsibilities thus, they engage in environment protection in order to provide its sustainability.

Regarding the solid waste management strategies, the study revealed that it was found to be significant at p= 0.001, Wald = 2.532 and Exp (β) = 1.876. The model produced a Wald statistic of 2.532 which predicted that solid waste management strategies contribute significantly to influencing environment protection activities. Solid waste management strategies increase the probability of environment protection vending by 1.876, it causes the odds to be 1.567 which indicates that solid waste management strategies are 1.876 likely to be influenced in protection of the environment.

The findings further indicated that fines, fees and penalties among respondents was another strong positive significant influence of environmental protection activity at p= 0.000, and Wald statistic of 17.453and an Exp (β) of 9.654. A Wald statistic of 17.453 demonstrated that effective practices significantly influenced environmental protection. Exp (β) value indicated that an increase in the effective practices, the odds ratio is 2.231, implying that effective practices were 2.231 more expected to protect the environment. The positive significant influence explains that the higher effective practices the higher the probability for environment protection.

Awareness of the SWM policy was found to be a factor with a strong positive significance influence on environment protection vending at p= 0.003, Wald = 15.876, Exp (β) = 14.754 indicating that when awareness of the SWM policy increase by 8.213 the odd ration is 8.213 times as large and therefore, awareness of the SWM policy are 8.213 times more likely to environment protection.

Based on Logistic regression outputs (p values) showing significant influence, the null hypothesis that factors affecting households do not have an effect on SWM towards sustainable environmental protection was rejected. This implies that households' factors affect SWM towards sustainable environmental protection due to several factors including public education, solid waste management strategies, fines, fees and penalties, awareness of the SWM policy, knowledge of 3Rs and solid waste management programs in the media.

The study revealed that limiting factors for effective SWM leads to several impacts to the community. This study investigated whether households were aware of the side effects. In examining the effects associated with improper household SWM, three main aspects regarding the effects of improper SWM were examined. The three aspects analysed were awareness of the impact of improper solid waste management on health, environmental and social impacts. The findings in Table 13 indicate the level of households' awareness of the said three aspects regarding improper SWM.

Table 13 : Households' awareness on the impact of improper SWM (n = 102)

Awareness aspects regarding improper solid waste management practices	Yes (%)	Uncertain (%)	No (%)
Awareness on health impact			
Improper management of the wastes is the health threats to the households and the community in general	87.3	3.9	8.8
Improper solid wastes management has been causing an outbreak of diseases in our households and community in general	25.5	13.7	60.8
Improper solid wastes management attracts rodents, animals and birds to scavenge waste containers and spread diseases	82.4	1.0	16.7
Households with improper solid waste management are suffering from odours which cause health problems	52	4.9	43.1
Average on health impact	**61.8**	**5.9**	**32.4**
Awareness on environmental impact			
Do you know that improper solid waste management practices contaminate water sources?	68.6	6.9	24.5
Do you know that improper solid waste management practices cause air pollution?	20.6	11.8	67.6
Do you know that improper solid wastes management practices eradicate important species such as trees?	59.8	18.6	21.6
Do you know that improper solid waste management causes land infertility and degradation?	57.8	14.7	27.5
Average on environmental impact	**51.7**	**13**	**35.3**
Awareness on social impacts			
Improper solid waste management is the social threats to the households and community in general	62.7	8.8	28.4
The quality of social life of the households and the society is affected by proper solid waste management	52	7.8	40.2
Improper households solid waste management practices cause bad relationships with neighbours and the society	66.7	6.7	26.5
Improper solid waste management practices affect the social status of the households	67.6	3.9	28.4
Improper solid waste management practices tarnish the social image of the households from the general public	56.9	12.8	30.4
Average on social impacts	**61.2**	**8**	**30.8**
Average on the three aspects	**58.2**	**9**	**32.8**

Findings in Table 13 on the households' awareness of the effects of improper SWM indicate that an average of 58.2% of the households is aware of the effects of improper SWM on health, environment and social life in general. It was found that only 32.8% of the households said they were unaware of the effects of improper SWM while 9% were neutral. However, the findings in Table 14 indicate that households are more aware of the effects of improper SWMon health with an average of 61.8% followed by social effects with an average of 61.2% then

environmental effects with an average of 51.7%. This finding implies that people's motive for proper SWM is influenced more by health and social consciousness than environmental consciousness.

The current study also identified awareness as one of the crucial elements that influences whether people have a favourable or unfavourable attitude toward an intervention or program. The current study's researcher was also eager to gauge the level of household awareness regarding solid waste management in the Moshi Municipality's Njoro ward. The results showed that while a small percentage (33.3%) of survey participants (n = 102) were aware of sustainable solid waste management practices, the rest (66.7%; n = 102) were not. One of the heads of house who participated in the interview described their involvement in SWM at the households as follows: "*Solid waste management in our residents has nothing to do with our regular business. Our responsibility as the vendor is limited to paying the city SMW authority or community-based solid waste collection teams money (Tz.30,000 to 50,000/=) for the solid waste collection services since it is often done by the City Council, who also plan and implement it* (Njoro, 2021) " Additionally, one of the heads of home who were interviewed said: "*Since I merely travel through and spend the evening there, I'm less concerned about solid waste management in the neighbourhood. We hold those who provide us with SWM services accountable and liable for it"*

4.6 Strategies for Effective SWM towards Sustainable Environmental Protection

The findings revealed that the majority of the households propose the following interventions to ensure effective SWM: campaigning for public education and awareness on SWM was proposed by 85.3% followed by a campaign for voluntary public participation in SWM which was proposed by 72.5% of the interviewed respondents. It was also revealed that 65.7% of the respondents propose for the SWM programs to be taught in all schools at all levels.

Apart from the mentioned strategies in Table 15, respondents mentioned other strategies such as designing an efficient collection system that makes the collection and disposal of the wastes easy. They said that waste containers used at the household level are very small and not environmentally friendly (Figure 4). They

mentioned that the designed system must contain the following features: keep waste properly that can so as to avoid health hazards, should be simplified or make the collection and disposal easy and it should not be far from the households.

Figure 4 : Improperly disposed wastes

Table 14 : Proposed strategies for effective SWM towards sustainable environmental protections (n = 102)

Proposed strategies	Yes	Uncertain	No
Campaigning for public education and awareness on SWM	85.3	0	14.7
Training the solid waste staff	31.4	16.7	52
SWM education at all school level	65.7	3.9	30.4
Use of multimedia to raise public awareness	27.5	55.8	16.7
Campaign for public participation	72.5	2.9	24.5
Others	3.8	87	38.8

In examining the effectiveness of the SWM strategies at household level, the study revealed several strategies including recycling, reusing, reducing, burning, dumping, burying and avoiding generation of large amounts of solid wastes. It was, however, observed that these strategies differ from one household to another based on household status such as income, size of the household, education and household members' awareness of the SWM strategies. It was also revealed that households in

remote areas are less aware of many SWM strategies compared to the households' strategic locations such as those in planned areas. Thus, those households in remote areas have gross mismanagement of generated solid wastes in their households. Moreover, it was found that waste collection and management authority in the remote areas are less capacitated in terms of facilities to be able to enter those areas and collect generated solid waste easily. This situation was lamented by some households that it weakens the SWM strategies and efforts of protecting their environment.

Apart from the remoteness of the areas which weaken the effectiveness of the SWM in the study area, it was also revealed that are affected by lack of sufficient funds, low SWM and environmental education among the household members, shortage of SWM experts and facilities such as septic tanks, collection vehicles and public dustbins. During the interview with the households, some argued that ineffective SWM strategies need quick intervention to avoid economic and environmental challenges which result from improper solid waste management. The economic activity mainly mentioned to be affected by improper SWM was tourism activities while the environmental challenge was flooding due to blockage of water trenches while the health problem was eruption of diseases such as diarrhoea, cholera, malaria, typhoid and dysentery.

During the interview with one old man in the street he lamented that Moshi Municipality, especially the waste collection department, has failed to provide long lasting and satisfactory SWM services to the households that is why most of the SWM strategies do not work effectively and efficiently. He also argued that, the SWM legal and policy framework in the ward level are not strictly complied by many households due to their weaknesses that is why SWM strategies do not work effectively and efficiently. This implies that there is inefficient enforcement of the legislations related to waste management especially at the household level. It was also revealed that the waste collection personnel were ill equipped, making the SWM strategies ineffective. According to the WEO, the ward needs its own waste collection track and permanent employees that will be available daily in the ward so as to ensure effectiveness of the SWM strategies in their ward. The WEO said that lack of their own waste collection vehicle makes the area to be polluted by the daily generated wastes.

The findings also showed that there is hostile movement in SWM among household members in the study area because of weak follow-ups from the ward officials in the households. It was evidenced that there was no plan or schedule from the WEO to visit and inspect the households just like what has been done by health officers. However, even the health officers also their schedule in inspecting the streets was not regular. Irregular visit or lack of inspections were among the reasons observed to weaken the SWM strategy in the study area.

The other challenge making SWM to be ineffective was lack of knowledge and skills on SWM strategies among the household members. It was learned that lack of knowledge and skills makes the household members and the residents to practise illegal and improper dumping of the generated solid wastes in the study area. Some of the residents and household members were seen to practise open air burning of the household solid waste which is an indicator of lack of awareness on the effect of burning solid wastes to the environment. It was also observed that lack of knowledge and skills among the residents and households leads to SWM abnormalities that lead to improper disposal of solid wastes along the water trenches and roads. This implies that with such practices it weakens the effectiveness and efficiency of the SWM strategies. It was also observed that lack of knowledge and skills weaken the SWM strategies and lead to disposal of the wastes without separation.

Table 15 : SWM strategies towards sustainable environmental protections (n = 102)

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Public education and awareness	2.612	0.594	10.554	1	0.000*	13.765
Training the solid waste staff	0.845	0.543	2.882	1	0.002*	1.992
SWM education	2.845	0.874	17.123	1	0.000*	9.643
Use of multimedia	7.443	8.774	15.876	1	0.001*	14.834
Campaign for public participation	7.886	7.564	10.645	1	0.002	9.976
Constant	16.655	4.117	16.764	1	0.000	0.000

Omnibus Tests of Model Coefficients (Chi-square = 224.734; sig. = 0.000); Log likelihood= 29.756[a]; Cox & Snell R Square = 0.557, Hosmer & Lemeshow Test (Chi-square= 15.321; sig. = 0.052); Nagelkerke R Square = 0.943

In order to understand the SWM strategies affecting sustainable environmental protections, each respondent was asked to state the practices. Five reasons were identified in response as responsible for environment protection. They include public

education and awareness, training the solid waste staff, SWM education, uses of multimedia and campaigns for public participation (Table 16).

Binary logistic regression was conducted between strategies that led to environmental protection. The overall significance of the model was assessed using an Omnibus tests model coefficients which produced a log likelihood 29.085 and omnibus tests of model coefficients (Chi-square 215.475, sig. 0.001), Nagelkerke R Square= 0.864; Cox and Snell R Square= 0.695 indicating a strong relationship between factors affecting households that led to environmental protection; Hosmer and Leme show Test (Chi-square=13.675;sig. = 0.050), the two measures together indicate that the model on strategies that led to environmental protection was more suitable to the data. In this respect, the following results were obtained:

Public education and awareness were found to be a factor with a strong influence on environmental protection. The results were statistically significant at p= 0.000, Wald = 10.554, and Exp (β) = 13.765. Moreover, a Wald statistic of 11.658 shows that public education and awareness of the respondents contributed highly to environmental protection. Results further indicated that, when public education and awareness of the respondents increases by 13.765, the odds ratio is 2.612 inferring that, public education of the respondents is 2.612 more likely to engage in environmental protection. This is because as public education and awareness of the respondents increases, they tend to have more responsibilities thus, engage in environmental protection in order to provide its sustainability.

Regarding the training of the solid waste staff, the study revealed that it was found to be significant at p= 0.002, Wald = 2.882 and Exp (β) = 1.992. The model produced a Wald statistic of 2.882 which predicted that training the solid waste staff contributes significantly to influencing environmental protection activities. Training the solid waste staff increases the probability of environment protection vending by 0.845. Further, it causes the odds to be 0.845 which indicates that training the solid waste staff is 1.876 likely to be influenced in the protection of the environment.

The findings further indicated that SWM education among respondents was another strong positive significant influence of environmental protection activity at p= 0.000, Wald statistics of 17.123 and an Exp (β) of 9.643. A Wald statistic of 17.123 demonstrated that SWM education significantly influenced environmental

protection. Exp (β) value indicated that an increase in SWM education, the odds ratio is 2.845, implying that SWM education was 2.845 more expected to protect the environment. The positive significant influence explains that the higher SWM education the higher probability for environmental protection.

Use of multimedia was found to be a factor with a strong positive significance influence on environment protection vending at p= 0.001, Wald = 15.876, Exp (β) = 14.834 indicating that when using of multimedia increase by 8.774 the odd ration is 7.443 times as large and therefore using of multimedia are 7.443 times more likely to environmental protection.

The findings further indicated that campaign for public participation among respondents was another strong positive significant influence on environmental protection activity at p= 0.002, Wald statistics of 10.645 and an Exp (β) of 9.976. A Wald statistic of 10.645 demonstrated that campaigns for public participation significantly influence environmental protection. Exp (β) value indicated that an increase in campaign for public participation the odds ratio is 7.886, implying that campaigns for public participation were 7.886 more expected to protect the environment. The positive significant influence explains that the higher the campaign for public participation the higher the probability for environmental protection.

Based on Logistic regression outputs (p-values) showing significant influence, the null hypothesis that strategies do not have an effect on SWM towards sustainable environmental protection was rejected. This implies that strategies affect SWM towards sustainable environmental protection due to several factors including public education and awareness, training the solid waste staff, SWM education, uses of multimedia and campaigns for public participation.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Overview

This chapter summarises the findings of the study as analysed and presented in chapter four basing on the study objective(s). This chapter also provides clear recommendations to decide on how the environment will be protected. Furthermore, this chapter presents conclusions based on the study findings, conclusions and recommendations. Finally, the chapter ends-up by proposing areas for further studies.

5.1 Summary of the Major Findings

Findings found that respondents use wastes for domestic purposes like storing sugar, cooking oils and planting flowers. They also reduce the number of wastes by using the packaging materials such as friendly environmental bags over and over again until it becomes torn on its own. After usage, they call for the collectors of food leftovers and the plastic materials such as empty bottles at the same time and they usually minimise the use of materials which are not decomposable. In the process of finding more information on 3Rs, the WEO explained that he will advise the street officers to create an awareness of 3Rs in all households.

Furthermore, he said that all residents have to reduce generation of wastes and reuse the generated wastes such as bottles and fruit peel for animal feedings. It was also revealed that the household waste containers, especially the old buckets, were not sealed and they were leaking leaving the waste material scattered and hence attracting flies and odours. It was also found that domestic animals like dogs and cats had access to the waste containers hence causing improper scattering of the wastes due to poor seals or tight containers. Such a scenario is taken as a health risk to the households as these wastes attract flies, mosquitoes and other diseases. It was observed that the minorities who collect and transport the waste to the skippers are the people in the market areas and those households which are very near or close to the skippers.

Before analysing the factors affecting SWM towards sustainable environmental protection in Njoro ward, the researcher thought of identifying the common

household solid waste (HSW) produced and the capacity of households in SWM. Identifying these solid wastes and understanding the capacity of SWM at the household level was important as it gave room for understanding relevant factors affecting SWM based on the type of solid waste and understanding which appropriate strategy could be applied to enhance SWM capacity.

Normally, waste trucks pass in their street once a week though waste is produced every day, which causes poor disposal around the streets. Sometimes individuals leave all wastes outside the gate for easy collection by the waste trucks, but if the truck comes late, they find dogs and cats have dispersed the wastes rampantly. It was however observed that most of the wastes placed outside the household gates were not tightened, which is why the dogs and cats found it easy to disperse them.

In examining the effectiveness of the SWM strategies at household level, the study revealed several strategies including recycling, reusing, reducing, burning, dumping, burying and avoiding generating of large volumes of solid wastes. It was however observed that these strategies differ from one household to another based on household status such as income, size of the household, education and household members' awareness of the SWM strategies. It was also revealed that households in remote areas are less aware of many SWM strategies compared to the households' in a strategic location such as those in planned areas.

Thus, those households in remote areas have gross mismanagement of generated solid wastes in their households. Moreover, it was found that waste collection and management authority in the remote areas are less capacitated in terms of facilities to be able to enter in those areas and collect generated solid waste easily. This situation was lamented by some households that it weakens the SWM strategies and efforts of protecting their environment. ineffective SWM strategies need quick intervention to avoid economic and environmental challenges which result from improper solid waste management. The economic activity mainly mentioned to be affected by improper SWM was tourism activities while the environmental challenge was flooding due to blockage of water trenches while the health problem was eruption of diseases such as diarrhoea, cholera, malaria, typhoid and dysentery.

5.2 Conclusion

According to this survey, the majority of households in Njoro Ward were unaware of the benefits of solid waste management for long-term environmental preservation. SWM practices in the study were negatively impacted by a number of factors. Household heads were more worried about SWM in their own homes than in their areas or neighbours. The factors that have been researched in solid waste management are directly related to variations in the SWM techniques used in the study area. Additionally, it was noted that in the research area, some of the crucial SWM techniques for long-term environmental conservation were not being used because of a lack of understanding of how to do so.

The study findings show a great concern of the public for the proper SWM practices that may lead to sustainable environmental protection. Thus, public participation in SWM is vital for sustainable environmental protection as it only becomes effective if there is collaboration with the councils. On the other hand, solid waste management methods in Njoro ward differ from one street to another. The roles of the households in managing generated solid wastes for sustainable environmental protection are fair. There are several limitations from the households that affect them towards effective implementation of their roles. Among other challenges is the lack of knowledge and proper techniques for using various SWM methods.

Findings revealed that the main solid wastes generated at the household level were plastics, papers and food wastes. It can be concluded that the majority of the households do not have the capacity of managing the main solid wastes generated at the household level. The majority of the household capacities of managing generated solid wastes are influenced by lack of SWM education and skills, lack of fences in the dumping points, illegal dumping and weaknesses of the applied strategies by the municipal wastes' authority. In examining the effects associated with improper household SWM, three main aspects regarding the effects of improper management of solid wastes were examined. The three aspects analysed were awareness of the impact of improper SWM on health, environmental and social impacts. It is concluded that the household's awareness of the effects of improper SWM is on average. It can also be concluded that the surveyed households are conscious of health and social effects that result from improper SWM.

5.3 Recommendations

The current study recommends that there should be frequent and periodic awareness-raising mentorship sessions among households on sustainable solid waste management, emphasising the need for solid waste management service providers to promptly and consistently provide the services to make the areas clean, appealing, and safe for the wellbeing of residents. There is a major concern shown by the Moshi municipality council and its wards. Also, community members have shown a positive attitude on the management of wastes, particularly solid wastes. However, the findings of this study have found some shortcomings that need to be addressed. Therefore, the following recommendations are provided to address the identified shortcomings in SWM practices in the study area. Illegal and improper dumping of the solid wastes: It is recommended that community members and households should report to the government authorities or officials such as street chairpersons or WEOs without fear as failure to do so may cause several environmental, social and health impacts to the societies. Also, the street and municipal waste authorities should provide formal waste disposal facilities such as skippers near the households and ensure effective compliance to the proper disposal. Another instrument towards enhancing proper waste disposal is raising society's awareness and use of fines and penalties for non-compliance.

Low public participation in SWM: There is low voluntary public participation in SWM which affects the effectiveness of the municipal and ward efforts of making the environment clean and hygienic. To address this, it is recommended to Moshi Municipal Council that there is a need for public education, public awareness raising and even implementing SWM seminars and workshops in all school levels and community gatherings such as religious and political gatherings. Provision of necessary resources and facilities might be among the recommended instruments to address this limitation.

Finally, it is recommended that the Municipal waste unit should ensure that waste collection trucks pass in the street on time to avoid the possibility of animals and birds like dogs, cats and eagles to turn out the waste containers placed on the street waiting for collection. Also, the municipal authority should increase the waste collection trips to the streets at least every day instead of twice a week as the population in the study area is high and the generation of solid waste is also high.

5.4 Area for Further Research

It is recommended that comparable research of this nature be conducted in the other wards of Moshi to come up with more findings that can be compiled together and come with a Municipal model or strategies of managing the generated solid wastes.

Also, research can be done to examine strategies for voluntary public participation on SWM as well as on how the SWM methods can be effectively integrated to the community members to reduce the generation of solid wastes.

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APPENDICES

Appendix 1: A Questionnaire for household heads

MOSHI CO-OPERATIVE UNIVERSITY (MoCU)

P.O. BOX 474

MOSHI, TANZANIA

A Questionnaire for household heads s for Research on:

HOUSEHOLD SOLID WASTE MANAGEMENT AND SUSTAINABLE ENVIRONMENTAL PROTECTION IN NJORO WARD MOSHI MUNICIPALITY, TANZANIA

By **LEOCARDIA J.P MOSWERY**

Master of Business Management of Moshi Co-operative University

SELF INTRODUCTION

My name is **LEOCARDIA J.P MOSWERY**, a Masters student of Moshi Co-operative University. Among other mandates, the University does research on economic, social, political and technological development aspects. This research is about household solid waste management for sustainable environmental protection in Njoro ward Moshi municipality, Tanzania. I hereby request for your time to respond to my questions for the success of my research. I hereby assure you that the information you will provide will be used only for the purpose of this research and will remain confidential.

PART A: INSTRUCTIONS

i) Please tick the appropriate line

ii) Where there are lines please give your views as per the question

iii) Do not write your name in the questionnaire

PART B: RESPONDENT'S PROFILE

Gender Male……Female……

Age: 20-29.…30-39 ……..40-49……50-59…….60 and above……

Marital status: Married…….……..Single…….

Education level:
Primary……..Secondary……..Certificate…….Diploma……first degree…..Master degree……other (specify)……

PART C: Factors affecting household solid waste management practices towards sustainable environmental protection in Njoro ward Moshi Municipality

Please **tick the box** corresponding to your personal opinion indicating Factors affecting solid waste management practices towards sustainable environmental protection in Moshi Municipality. Use the following guide to indicate the extent you agree to the statements in the table below: **Strongly agree – 5; Agree – 4; Neutral – 3; Disagree – 2; strongly Disagree – 1**.

No	Factors	1	2	3	4	5
1	Public Education on solid waste management is low					
2	Strategies being used to manage solid waste are not enough					
3	Low fines/penalties for poor disposal					
4	Lack of fence to the waste disposal					
5	Lack of residents awareness of the solid waste policy					
6	Lack of solid waste programs in the media like on radios, TVs, road shows etc					
7	Lack of knowledge on 3Rs (Reduce, Reuse and Recycle) among community members					

PART D: Household Members' roles towards managing solid waste for sustainable environmental protection in Njoro ward Moshi Municipality.

How do you rate the following household roles on solid waste management for sustainable environmental protection in Moshi Municipality? Please **tick the box** corresponding to your personal opinion indicating the roles played by residents by using the following guide in the table below

No	Members' Roles	YES	NO
1	Do you have any waste containers in your home/shop/stall?		
2	Are there any items from your waste that you reuse?		
4	Do you pay for collection of waste from your home/shop/stall?		
5	Do you tight well waste before disposal?		
6	Do you take waste to the disposal centre every day?		
7	I always use the 3Rs (Reduce, Reuse and Recycle) strategy in managing solid waste		
8	Do you think there are some waste items which can be reused or recycled but no vendors for such waste?		
9	Do you always sort waste before disposing of it?		
10	Do you re-use or recycle some wastes which are in recycling nature?		
11	In future, are you willing to continue paying for collection of the waste that you generate in your home/shop/stall?		
12	Do you think it is necessary for you to work together with other residents/traders/market vendors for better waste management?		
13	Do you think it is necessary for you residents/traders/market vendors to work together with the Town Council in managing waste?		
14	Do you think the residents/traders/market vendors are capable of managing the waste they generate without help from the Town Council?		
15	Have you ever educated others on proper solid waste management?		

PART E: Households Awareness on the Effects Associated with Improper Household Solid Waste Management Practices

Please **tick the box** corresponding to your personal opinion indicating your responses on the a**wareness of the effects associated with improper household solid waste management practices**. Use the following guide to indicate the extent you agree to the statements in the table below: **1= Yes, 0 = Uncertain, 2 = No**.

Awareness aspects regarding improper solid waste management practices	**Yes**	**Uncertain**	**No**
Awareness on health impact			
Improper management of the wastes is the health threats to the households and the community in general			
Improper solid wastes management has been causing an outbreak of diseases in our households and community in general			
Improper solid wastes management attracts rodents, animals and birds to scavenge waste containers and spread diseases			
Households with improper solid waste management are suffering from odours which cause health problems			
Awareness on environmental impact			
Do you know that improper solid waste management practices contaminate water sources?			
Do you know that improper solid waste management practices cause air pollution?			
Do you know that improper solid wastes management practices eradicate important species such as trees?			
Do you know that improper solid waste management causes land infertility and degradation?			
Awareness on social impacts			
Improper solid waste management is the social threats to the households and community in general			
The quality of social life of the households and the society is affected by proper solid waste management			
Improper households solid waste management practices cause bad relationships with neighbours and the society			
Improper solid waste management practices affect the social status of the households			
Improper solid waste management practices tarnish the social image of the households from the general public			

PART F: Proposed strategies for proper SWM practices towards sustainable environmental protections

Proposed strategies	**Yes**	**Uncertain**	**No**
Do you think that campaigning and public education and awareness programmes on SWM will lead to successful solid waste management?			
Do you think that training solid waste staff and educating people will attract their support for an effective solid waste management?			
Do you think that school level solid waste education and campaigning is an effective tool to manage solid waste			
Do you think that campaigning publicly through multimedia will produce less garbage?			
Do you think campaigning for public participation will improve solid waste management?			
Others (Mention)			

Appendix 2: Interview guide for the Key Informant

Assessments of the solid waste management practices for sustainable environmental protection in Njoro ward Moshi Municipality, Tanzania.

Dear respondent

I kindly ask you to assist me by answering a few questions. Please be assured that your responses will be strictly confidential and will be used for the sole purpose of pursuing academic interest.

1. Who is your employer ……and what are your job roles?.....

2. What is the environmental and solid waste mission in your ward?.....

3. Briefly explain the practices of solid waste management practices in your ward?.....

4. What are solid waste management strategies and which ones are used in your ward?..Why this one…

5. Do you think Moshi municipality is using effective solid waste management strategies/policy? Please explain…….

6. Do you recommend any other strategies/policies for the city of Moshi?.....

7. What are the common forms of solid waste generated in Njoro ward?

9. Is the city of Moshi doing anything significant in managing solid waste? Explain……

9. In your opinion, which factors hinder your ward households and the city in general from doing proper in solid waste management?

10. What do you think can be done to ensure that there is proper solid waste management in Njoro and Moshi in general?

11. What are the practical/evidenced effects of improper SWM in your ward?

12. How do the Households in Njoro play roles in SWM? ……explain…….

13. What are the ward and city future plans for solid waste management practices?

14. Is there any donor support for solid waste management in your ward? What is their support?

15. Do you have employees available who deal with Solid waste management? Are they enough?

16. What facilities do you have? Compactors …Tractors…. Tippers…. Skip trucks…. Front End loader…. Landfill compactor…. Dozer …. What is their condition?….are they enough? ..What else do you need to facilitate SWM in your ward?

17. What are your recommendations for proper solid waste management towards sustainable protection of the environment in Njoro and Moshi?

Appendix 3: Operationalisation of the Variables

Type of Variable	**Variable**	**Indicators**	**Scales**	**collection tool**	**Type of Analysis**
Independent variable	SWM methods	Number of methods applied	Ordinal	Questionnaire	Descriptive/ binary
	Household Roles	● Rate/frequency of participation in solid waste management ● Willingness to participate, Readiness of paying waste collection fees. ● Frequency of reminding neighbours on proper solid waste management	Ordinal	Questionnaire	Descriptive/ binary logistic regression
	Solid waste management limitations	● Frequency of providing solid waste management education and awareness. ● Level of compliance to laws and penalties on improper solid waste management. ● Number of solid waste management programs provided	Ordinal	Questionnaire	Descriptive/ binary logistic regression
Dependent variable	Environmental protection	● Reduced volume of generated solid wastes ● Reduced number of health cases and level of household hygiene conditions ● Reduced cases of environmental pollution cases	Ordinal	Questionnaire	Descriptive

Appendix 4: Sample Size Table

Size of Population	Sample Size (n) for Precision (e) of:			
	±3%	**±5%**	**±7%**	**±10%**
500	a	222	145	83
600	a	240	152	86
700	a	255	158	88
800	a	267	163	89
900	a	277	166	90
1000	a	286	169	91
2000	714	333	185	95
3000	811	353	191	97
4000	870	364	194	98
5000	909	370	196	98
6000	938	375	197	98
7000	959	378	198	99
8000	976	381	199	99
9000	989	383	200	99
10000	1000	385	200	99
15000	1034	390	201	99
20000	1053	392	204	100
25000	1064	394	204	100
50000	1087	397	204	100
100000	1099	398	204	100
>100000	1111	400	204	100

a = Assumption of normal population is poor (Yamane, 1967). The entire population should be sampled.

Source: Israel (2008)

Solid Waste Management Approaches and Sustainable Environmental Protection in Njoro Ward, Moshi Urban Municipality Kilimanjaro Tanzania

LEOCARDIA J.P MOSWERY[1]
&
Dr. Faustine Panga[2]
Dr. Prosper Kimaro[3]
[1]Moshi Co-operative University
[2] Departments of Procurement and Supply Management Moshi Co-operative University
E-mail: leomosery@gmail.com

1.0 Abstract

Inappropriate solid waste management procedures pose a serious hazard to household and public health because they result in a drop in living standards. Appropriate solid waste management practices are required to ensure long-term environmental protection. The goal of this study was to discover household Solid Waste Management approaches for long-term environmental protection. By employing a questionnaire and key informant interviews, data was collected from 102 households in the Njoro ward of Moshi Urban. Data was analyzed using both qualitative and quantitative methods. Plastic, food, and paper wastes were discovered to be the most common wastes generated in the research area. Only two of the eight recommended solid waste management approaches were found to be employed frequently: dumping in a landfill and burning methods. Reduce, recycle, sort, bury, reuse, and resale are six of the eight ways that have a high rate of rare adoption. Despite the rare adoption, the study found that integration of all approaches to be significant, with p=0.004, Wald = 2.501, and Exp (β) = 1.764. The effectiveness of integrating all approaches raises the chances of environmental conservation. The disposal management system was discovered to be a challenge with a significant impact on the approaches used to safeguard the environment. In addition, good solid waste management was discovered to have a considerable favorable influence on environmental protection approaches. The study concludes that applied approaches were important for long-term environmental conservation, however not all options were implemented successfully. It was advised that the public get education, training, seminars, and awareness about solid waste management approaches. By performing routine surveys and monitoring, the Municipal Waste Unit should ensure that solid waste management approaches are willingly adopted by all households and public members.

2.0 Introduction

Increased solid waste output has become a global issue because it produces environmental contamination, which poses a threat to humanity's survival and long-term growth (Nanda and Berruti, 2021; Mbwilo, 2018). It is mostly caused by population growth and urbanization (Das *et al.,* 2019; Warunasighe and Yapa, 2016).Domestic, industrial, economic, and social activities all contribute to solid waste production. Increased solid waste production has resulted in improper and inappropriate disposal, posing serious social, economic, and environmental difficulties such as habitat loss, air pollution, decline of environmental aesthetic value, and destruction of water bodies (Nanda and Berruti, 2021; Abdallah *et al.,* 2020). Governments and environmental agencies must implement effective Solid Waste Management (SWM) approaches to solve the issues posed by solid waste, particularly in densely populated areas such as metropolitan and peri-urban areas, for long-term environmental protection and economic development (Wang *et al.,* 2021). Environmental conservation and better human settlements require effective SWM (Kwizera *et al.,* 2018).The SWM includes all actions from the point of solid waste generation to the point of final disposal (Yukalang *et al.*, 2018).

This study assumes that only good and careful management approaches for the generated solid waste can guarantee sustained conservation and protection of the environment under the fast expanding population and urbanization, especially in developing nations. Poswa (2017) backed up this claim, arguing that good SWM approaches mitigate environmental damage while conserving limited resources. According to Agenda 21 of the Rio Declaration on Environment and Development, waste management is one of the primary environmental concerns in sustaining the quality of the Earth's environment, particularly in terms of sustainable development and environmental sustainability (UNDESA, 2020).

Growing cities generate an estimated 2.01 billion tons of solid waste (SW) annually, which equates to 0.74 kg per person per day (Sharma, and Jain, 2020). Solid wastes created by families in Russia, notably in the city of Kostomuksha, have remained a burden for the past 30 years due to high output, which is estimated to be 840kg per household yearly (Xiao *et al,* 2020). In many Asian countries, managing solid waste generated at the household level is a concern because most households do not fulfil

their SWM tasks successfully (Xiao *et al.,* 2011). According to Management and Handling (2010), the ordinary Indian generates roughly half a kg of solid garbage every day, but the volume is enormous. According to the Central Pollution Control Board, the generation of SW in India in 2047 is expected to exceed 260 million tons due to the fact that many households do not recycle their waste and instead dispose of it outside their homes or on the streets (CPCB, 2018). However, only in the last few years SW issues risen to the top of the country's development agenda and attracted significant attention. Kwizera *et al.,* (2017) argue that environmental stakeholders' (government and community) actions and urgent systems must be integrated to support effective SWM practices for long-term environmental protection in fast growing cities.

Infection transmission, physical harm, non-communicable diseases, emotional and psychological consequences, and an increase in management and disposal costs may all occur if SWM approaches are not adequately implemented. This problem, in addition to the socio-economic and environmental consequences of generated solid waste, may obstruct the success and achievement of Sustainable Development Goals (SDGs) three and six, which deal with good health and wellbeing, and eleven, which deal with sustainable cities and communities. Tanzania's Moshi municipality is one of the fastest-growing, requiring more sustainable SWM approaches and initiatives to manage generated solid waste for long-term environmental protection (Mbwilo, 2018). Moshi municipality was regarded as the fastest growing city in Tanzania, and it has won the urban sanitation prize multiple times. However, there were few empirical researches on SWM applied approaches at the household level in Moshi municipality, which could serve as a model for other Tanzanian fast-growing towns. It was hypothesised that there is no positive significant association between solid waste management approaches and sustainable environmental protection.

2.1 Theory underpin the study: Human Interaction with the Environment

Hammond first offered this theory in 1995. Four interactions between human activities and the environment are described in the theory. These are the source, sink, life support, and human welfare implications. As a result, people derive minerals, energy, food, fibers, and other natural resources used in economic

activities from the environment, possibly depleting these resources or damaging the biological systems (such as soils) on which they rely for continued production.

Sink: Industrial operations transform natural resources into products (such as pesticides) and energy services that are utilized or dispersed before being abandoned or dissipated, resulting in pollution and wastes that flow back into the environment until regenerated. Life support: The earth's ecosystems, particularly unmanaged ecosystems, provide essential life-support services ranging from the breakdown of organic wastes to nutrient recycling, oxygen production, and biodiversity maintenance; as human activity expands and degrades ecosystems, the environment's ability to provide such services may be reduced. Furthermore, the impact on human welfare: Polluted air and water, as well as tainted food, have a direct impact on human health and welfare.

This theory describes how human actions leave their mark on the environment. While this theory covers the full of human actions, comprehension of the theory's interacting variables improves understanding of possible approaches and results for various behaviors in the environment. Human-environment interaction (HEI) is important because it provides a framework for bringing together knowledge with both disciplinary depth and interdisciplinary scope to investigate past, present, and future social and environmental change in various parts of the world. Mbwilo (2018) used this theory and stated that human interaction theory is the best theory for understanding the causal relationship between SWM approaches and long-term environmental sustainability, especially in fast increasing cities.

2.2 Household Solid Waste Management Approaches

Empirical study on families' source separation behavior and solid waste disposal options in Ghana, (Alhassan *et al.,* 2020) discovered that household SWM approaches include collection, recycling, treatment, and disposal of household solid waste. The study concluded that instead of trying to cope with the ever-increasing amounts of waste through treatment and disposal, city managers should pursue the paths of Integrated Solid Waste Management (ISWM) and the 3Rs of waste management (Reduce, Reuse, and Recycle), which prioritize waste prevention, waste reduction, and waste recycling. Such ideas will assist local governments in reducing the financial burden of trash management while also reducing the demand

on the environment. According to Adipah and Kwame (2019), the internationally recognized best waste management practices are as shown in figure 1. It demonstrates the importance of entirely preventing waste formation in order to safeguard the environment; this may be accomplished by avoiding the use of non-biodegradable products and encouraging the use of biodegradables. If the population cannot avoid non-biodegradable garbage, it is prudent to reduce the amount of waste produced. To prevent waste landfills from blooming, this reduced waste should be utilized and recycled. This includes reusing garbage that can be reused before being discarded as waste. When recycling and garbage recovery fail, it is necessary to treat all waste to avoid the release of harmful compounds into the environment. Following treatment, the trash can be safely disposed of at a landfill rather than a dumpsite where it will be poorly managed.

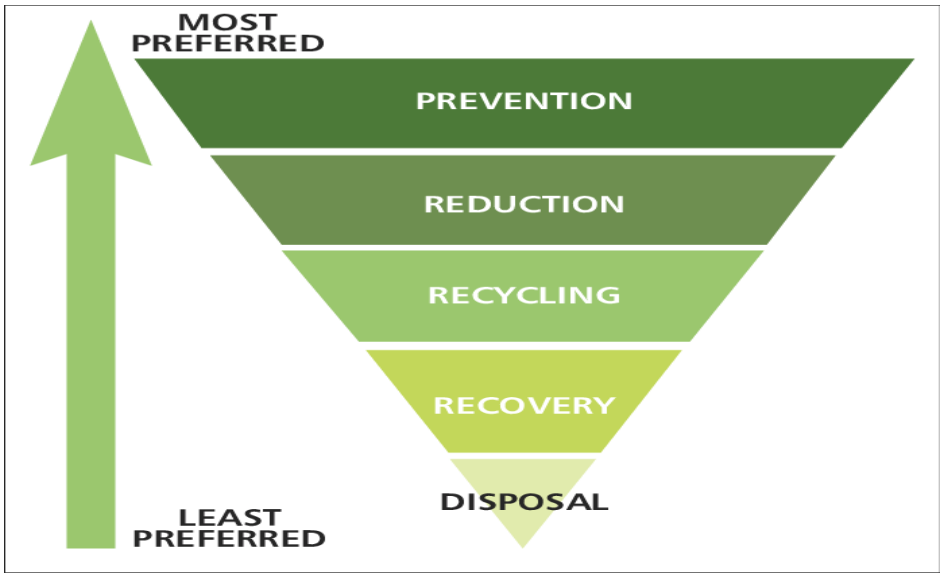

Figure 1 : Proper Household Solid Waste Management

Source: (Edith Cowan University, 2008)

3.0 Methodology

This study used a pragmatic research design that allowed data to be collected utilizing multiple data collection methods at the same time. The study design was beneficial for both describing and determining the link between variables (Bailey, 2008). It also allowed for the collection of both qualitative and quantitative data while taking into account limited resources such as funds and time. In comparison to

adopting a single strategy, the combined approach gave a thorough grasp of the study problem. The research was carried out in the Moshi municipality. For the past four years, Moshi has served as Tanzania's top health and sanitation council (URT, 2020). Moshi Municipal, on the other hand, did not win the 2018-2019 competition. Following that, the Moshi municipal council launched a similar competition at the ward level to encourage improved waste collection and cleanliness performance by awarding cash prizes to the winners. The competition is also held at the sub–ward level in some wards, with the winners receiving 500 000 Tsh (MMC, 2019). However, several wards did not receive rewards in competition at the ward level; for example, Njoro was ranked 20th out of 21 wards in Moshi Municipal Council.

The households in Njoro ward, estimated to be 14,692, were the study's target population (MMC 2019). The study included 102 houses in the Njoro ward as participants. Yamane's mathematical procedure (1967) was used to determine this sample sze. The sample size is also within Israel's (2008) standard, which states that for populations under 100,000, a sample size of 51 to 100 respondents is recommended. With the support of the local executive officers, the study used a basic random sampling technique to pick members of the households (for the survey). The respondents' socio-demographic characteristics, SWM approaches were all obtained via a questionnaire and key informant interview. The qualitative data was analyzed using content analysis to better understand the perspectives of respondents, especially crucial informants. The analyses aided in analyzing the responses and providing them with themes and thorough explanations. In terms of quantitative data, descriptive statistics were used, with the Statistical Package for Social Sciences (SPSS) software being used to calculate frequencies, percentages and regressions. The study aim was then analyzed using a Binary Logistic Regression. At a 5% level of significance, the P-value was utilized to test hypotheses. It was necessary to test for normalcy, homoscedasticity, multi-collinearity, and linearity in order to provide an appropriate understanding and interpretation of the regression model.

Binary regression model:

$$\text{Logit}(P_i) = \log\left[\frac{p(x)}{1-p(x)}\right] = \alpha\ \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots\ldots\ldots\ \beta_p x_p + \varepsilon \ldots\ldots \text{Equation (1)}$$

Where:

Logit (Pi)	=	Y is a binary and represents the probability of protection (1) or no protection (0) into environment
α	=	intercept of the equation
$\beta 1$ to βp	=	predictor variables regression coefficients
x1 to xp	=	predictor variables
ε	=	error term

4.0 Findings and Discussions

4.1 Socio-demographic Characteristics of Respondents and the Study Area

In the research area, 102 households were surveyed. The survey included questions about sex, age, marital status, education level, and family size to capture respondents' characteristics. The researcher was able to comprehend the respondents' backgrounds as a result of this description. The findings on gender distribution found that males made up 52% of the respondents in the study area, while females made up 48%. According to the findings, 32.4%t of the household members interviewed in the study area were matured young people, with an average age category of 20-29, followed by age categories of 40-49 and 30-39, which accounted for 23.5 % and 22.5% respectively.

The study also found that 47.1% of the household members interviewed had a secondary level of education, followed by 39.2% who had a primary level of education. It was also discovered that only 13.8% have completed high school. The findings of the study contradict those of Mbwilo, 2018 from Mbeya city, who found that the majority of respondents (43%) had primary level, followed by 33% secondary level, and 34% above secondary level. The respondents' marital status revealed that 61.8% were married, followed by 31.4% who were single, and 6.9% who were widows. The findings on household size revealed that 39.2% of households had 4-6 persons, with 33.3% having 1-3 members. The percentages of family members aged 7 to 10 and over 10 were 23.5% and 3.9% respectively. This

description was crucial since it allowed a study to confirm Gumbi's (2015) finding that the bigger the number of household members, the higher the solid waste generation. Despite the lack of a statistical analysis to back it up, the researcher's observation during data collecting demonstrated a strong link between household size and solid waste generation.

4.2 Solid Waste Management Approaches in Njoro Ward

The goal of analyzing SWM approaches for sustainable environmental protection in the research area was accomplished by first assessing the types of solid waste generated. The various replies in Table 1 show the most common solid wastes generated in the study area.

Table 1: Common solid wastes generated

Types of HSW	Percentage (Rank)
Papers	63 (3)
Plastics materials	89 (1)
Metallic Materials	24 (4)
Food Waste	82 (2)
Glasses	11 (5)
Others	7 (6)

Plastic, food, and paper trash were discovered to be the most common wastes generated in the study area. During the data collection, it was discovered that the plastic materials specified were not automatically decomposable plastic bags, plastic bottles, and containers. The majority of the plastic debris was spotted being discarded in the streets. Fruits and food leftovers were the most common food wastes discovered. It was discovered that not all of the households examined had dustbins for disposing the food wastes specified. Some of the few families with dustbins were witnessed disposing wastes in the containers, despite the fact that it was not properly disposed. It was also discovered that some families' accessible containers were not covered or closed; attracting a large number of flies and emitting foul odors. The study also indicated that waste material in the form of papers came in second, with 63%, following plastic and food waste.

Paper garbage was also discarded in large quantities. The paper waste products of this sort, however, were decomposable materials such as newspapers, air time cards, periodicals, and brochures. The study also discovered that waste materials in the form of metals and glassware received the lowest responses, with 24% and 11%, respectively. During the survey, the researcher considered questioning one household member about why metal garbage is not as frequent as paper and plastic waste. "*Chuma ni pesa, pesa haiwezi tupwatupwa hovyo*," he said, implying that metal materials have a monetary worth that cannot be discarded carelessly. This statement implies that our world would be clean and safe for human health if all wastes could be valued as metal materials. Other types of garbage were finally discovered to have a 7% score. Mobile phone covers, batteries, and wooden items were among the various solid waste products found in the area.

4.3 Applied Solid Waste Management Approaches

Respondents were asked how often they used various SWM approaches in their residents. This question was critical in answering the study objective because households are required by municipal regulations to employ various SWM approaches. Surprisingly, as indicated in table 2, many SWM approaches are not adopted by many households in the study area.

Table 2: Frequency of using various methods of solid waste management (N=102)

SWM Methods	Often	Occasionally	Never used
Reduce	8 (7.8%)	3 (2.9%)	91(89.2%)
Recycle	13 (12.8)	11(10.8%)	78 (76.4)
Burn	83 (81.4%)	15 (14.7%)	4 (3.9%)
Sorting	4 (3.9%)	21(20.6%)	77 (64.2%)
Burying	3 (2.9%)	9 (8.8%)	90 (88.2%)
Dumping in the dump sites	90 (88.2%)	9 (8.8%)	3 (2.9%)
Reuse	7 (6.9%)	24 (23.5)	71 (69.6%)
Resale	6 (5.9%)	29 (28.4%)	67 (65.7%)

The strategies employed by households in the study area to manage generated solid waste revealed that only two of the eight commonly recommended methods were used often. As a result, 88.2% and 81.4% of the studied households employ dumping and burning approaches extremely frequently, respectively. Many strategies (six out of eight) have a high rate of never being used: reduce (89.2%),

recycle (76.4%), sort (64.2%), bury (88.2%), reuse (69.6%), and resell (69.6%). Earlier investigations (Kazuva and Zhang, 2019; Chu *et al.*, 2019) have similarly reported poor use of similar methods; however the non-use rate at the studybarea is higher than in the previous studies. This disparity could be due to socioeconomic inequalities, instructional regulations, or technical variances between the study areas.

One member of one of the questioned households stated that the poor utilization of some procedures is due to a lack of skills and awareness of the approaches. However, the ward health office has attempted to host SWM seminars on various approaches in the study area, but attendance has never been very good because the majority of the household never shows up (commented the Ward Executive Officer). Despite the fact that the general findings on used SWM methods suggest that many approaches are underutilized, the study findings on methods used based on the type of solid waste created have produced various outcomes, as shown in table 3.

Table 3: SWM Methods used per type of solid waste generated

	Applied SWM Methods (%)								
Type of HSW	**Reduce**	**Recycle**	**Sorting**	**Burn**	**Burry**	**Dump in the dumping sites**	**Reuse**	**Resale**	**Others**
Papers	23	8	0	63	57	18	0	0	11
Plastics materials	10	22	4	71	0	13	21	9	27
Metal materials	0	0	24	0	0	0	0	35	3
Food Waste	6	0	0	0	0	56	0	0	14
Glasses	3	0	0	0	11	68	0	0	0
Average	**9**	**6**	**5.6**	**26.8**	**13.6**	**31**	**4.2**	**8.8**	**11**

The findings show that dumping garbage generated to skippers is the most common way, accounting for 31% of the total, followed by burning and burying wastes, accounting for 26.8% and 13.6%, respectively. Because the local authority gathers those materials for proper disposal in the main dumps, reuse and sorting are the least

used options, accounting for 4.2% and 5.6%, respectively. During the survey, it was discovered that the skippers' dumping techniques were not adequately done, since the dumping spots had scattered solid wastes such as papers and fruit remains. Furthermore, despite the fact that burning and burying are utilized as the second and third techniques in SWM, research such as Alhassan *et al*, (2020); Kazuva, 2021; Mbwilo (2018) suggest that these methods are not environmentally beneficial because they pollute the air and soil. As a result, burning and burying are ineffective approaches for long-term environmental preservation.

Poor capacity of the houses in the study region in SWM was one of the challenges for low application of these strategies. "Our household members' capacity and abilities are low, which is why they don't employ these methods," said a WEO from the study area. The issue over limited capacity prompted an examination of households' capacity to manage solid garbage produced in Njoro ward's streets. Table 4 shows that the capacity of households in Njoro ward to manage solid waste created is inadequate, with the majority of 57.8% responding that their capacity to manage solid trash around their street and households is low and 11.8% not capable at all. To explain why their capacity is limited, respondents indicated that people lack sufficient information and that some of the solutions require funding to apply. For example, using recycling processes for plastic or metallic solid waste necessitates both knowledge and funds. To validate such a remark, the researcher called the WEO and enquired if any SWM capacity building programs were needed or being implemented. During the discussion, it was discovered that there is no SWM capacity building program in place, instead of awareness raising activities from the municipal council, wards, and street officials to homes and the entire community. This finding is reinforced by Alhassanet al, (2020) in Ghana, who found that household capacity building on SWM is low.

Table 4: Capacity of the Households in SWM

Capacity	**High capacity**	**Not Capable**	**Low Capacity**	**Total**
Frequency	31	12	59	**102**
Percentage	30.4	11.8	57.8	**100**

The study looked at the success of the implemented approaches as well as the problems they face in terms of effectiveness. Each respondent was asked to explain the SWM implementation problem in order to better understand the success of household SWM strategies that led to long-term environmental preservation. As illustrated in Table 5, four challenges were identified: a bad waste management system, ineffective methods, incorrect solid waste processing, and effective practices. The majority of respondents (60%) believe that household income, household size, leadership strictness, education, and household members awareness of SWM strategies are SWM challenges that limit the effectiveness of SWM approaches such as recycling, reusing, reducing, burning, dumping, burying, and avoiding the generation of a large number of solid wastes. Due to the factors listed in table 5, SWM in households living in remote locations was found to be poorer than in those living in planned areas.

Table 5: SWM challenges in remote areas

Variables	SD%	D%	N%	A%	SA%	Mean	Std deviation
Poor disposal management system	3.1	3.1	16.9	43.1	33.8	4.02	1.976
Ineffectiveness of the strategies	1.5	6.2	7.7	40	44.6	4.20	2.990
Improper handling of the generated solid waste	1.5	7.7	18.5	33.8	38.5	4.00	0.026
Ineffective practices	3.1	1.5	27.7	36.9	30.8	3.91	0.984

4.4 BLR Model Test

The binary logistic regression was conducted whereas the overall significance of the model was assessed using an Omnibus tests of model coefficients which produced a log likelihood 29.325, and omnibus tests of model coefficients (Chi-square 244.655, sig. 0.000), Nagelkerke R Square= 0.932; Cox and Snell R Square= 0.566 indicating a strong relationship between the challenges and environmental protection; Hosmer and Lemeshow Test (Chi-square= 15.330; sig. = 0.056), the two measures together indicate that the model on practices influencing environmental protection was more suitable to the data. The following results in table 6 were obtained:

Table 6: The Household SWM Challenges in Njoro Ward

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Disposal management system	2.601	0.782	11.075	1	0.001*	13.483
Effectiveness of the strategies	0.567	0.359	2.501	1	0.004*	1.764
Proper handling of solid waste	2.300	0.555	17.174	1	0.000*	9.971
Effective practices	7.387	8.555	15.063	1	0.002*	14.064
Constant	16.655	4.117	16.369	1	0.000	0.000

Omnibus Tests of Model Coefficients (Chi-square = 244.655; sig. = 0.000); Log likelihood= 29.325[a]; Cox & Snell R Square = 0.566, Hosmer&Lemeshow Test (Chi-square= 15.330; sig. = 0.056); Nagelkerke R Square = 0.932

Regarding the effectiveness of the strategies, the study revealed that it was found to be significant at p= 0.004, Wald = 2.501 and Exp (β) = 1.764. The model produced a Wald statistic of 2.501 which predicted that effectiveness of the strategies contributes significantly to influencing environment protection activities. Effectiveness of the strategies increase the probability of environment protection by 1.764, it causes the odds to be 1.567 which indicates that effectiveness of the strategies are 1.567 likely to be influenced in protection of the environment. Disposal management system was found to be a challenge with a strong influence on the applied methods for environment protection. The results were statistically significant at p= 0.001, Wald = 11.075, and Exp (β) = 13.483. Moreover, a Wald statistic of 11.075 shows that disposal management system of respondents contributed highly on environment protection.

The findings further indicated that effective waste management practices among the respondents was another strong positive significant influence of environment protection activities at p= 0.002, and Wald statistic of 15.063 and an Exp (β) of 14.064. A Wald statistic of 14.064 demonstrated that effective practices significantly influenced environmental protection. Exp (β) value indicated that an increase in the effective practices, the odds ratio is 7.387, implying that effective practices were 7.387 more expected to protect the environment. The positive significant influence explains that the higher effective practices the higher probability for environment protection.

Proper handling of solid waste was also found to be a factor with a strong positive significance influence on the methods of environment protection at p= 0.000, Wald = 17.174, Exp (β) = 9.971 indicating that when proper handling of solid waste increase by 9.971 the odd ration is 2.300 times as large and therefore proper handling of solid waste are 2.300 times more likely to environment protection. Basing on Logistic regression outputs (p values) showing significant influence, the null hypothesis that household SWM methods have no influence on sustainable environmental protection was rejected.

5.0 Conclusion and Recommendations

5.1 Conclusion

The study concluded that the SWM approaches used in Moshi were important for long-term environmental conservation. They projected that the methods' effectiveness would have a major impact on environmental protection actions. However, not all strategies were implemented successfully. Only proper solid waste management was discovered to have a strong positive significance influence on environmental protection methods, indicating that when proper solid waste management increases by 9.971, the odd ration increases by 2.300, making proper solid waste management 2.300 times more likely to protect the environment. The null hypothesis that household SWM approaches have no impact on long-term environmental protection was rejected based on the results of the logistic regression (p values).

5.2 Recommendations

There is a need to recover high-value recyclable materials at residential places and small industries to ensure proper household solid waste management, using colour-coded bin bags to encourage waste separation at the source. Plastics, glass, paper, cans, and other materials should be clearly labelled in their containers. This makes it easier to gather recyclables and objects that can be reused, and the material will be cleaner to use than if everything is mixed together and then separated at the end of the chain.

Similarly, recycling is not a solution to managing every type of waste materials in fact, recycling approaches are lacking. This makes waste management more

complex. Therefore, it is recommended that, community members and households to be provided with seminars and training on various SWM approaches for more sustainable environmental protection.

In the research area, there is also a need for increased public knowledge and voluntary public participation in SWM practices. This will result in more comprehensive SWM techniques for long-term environmental conservation.

Finally, it is suggested that the Municipal Waste Unit perform routine surveys and monitoring to guarantee that SWM procedures are freely adopted by all families in the study region.

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