

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF ZOOLOGICAL SCIENCE



**Municipal Solid Waste Management Practice in Burayu Town,
Oromia Regional State, Ethiopia**

By: Tesfaye Alemu Welfana

Addis Ababa, Ethiopia

October, 2021

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF ZOOLOGICAL SCIENCE

**Municipal Solid Waste Management Practice in Burayu Town,
Oromia Regional State, Ethiopia**

**A thesis Submitted to Addis Ababa University in partial fulfillment of the
requirements for the degree of Masters of Science in Biology**

By: Tesfaye Alemu Welfana
Id.No GSK/0228/08

Advisor: Habte Jebessa Debella (PHD)

Addis Ababa, Ethiopia

October, 2021

Addis Ababa University
School of Graduate Studies
Department of Zoological Science

We, the undersigned, hereby that have read and examined this thesis paper prepared by Tesfaye Alemu entitled “**Municipal Solid Waste Management Practice in Burayu Town, Special Zone in Oromia Regional State, Ethiopia,**” which is submitted in partial fulfillment of the requirements for the degree of Masters of Science in Biology (M.Sc.), and recommend to the school of graduate studies for acceptance of the thesis.

Approved by Board of Examiners

_____	_____	_____
Advisor	Signature	Date
_____	_____	_____
Internal Examiner	Signature	Date
_____	_____	_____
External Examiner	Signature	Date

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university and that all sources of materials used for the thesis have been duly acknowledge.

Declared by:

Name: Tesfaye Alemu

Signature: _____

Date: _____

Confirmed by Advisor:

Name: Habte Jebessa (PhD)

Signature: _____

Date: _____

ACKNOWLEDGEMENTS

I wish to express my sincerest appreciation to my advisor Dr. Habte Jebessa for his professional guidance, patience, motivation, critical comments, corrections, and encouragement in the preparation of this thesis paper starting from proposal writing to end of the work. I also would like to thank the Ethiopian Ministry of education for providing me with financial support that I required for my study.

I would like to thank the Sanitation and beatification team leader of Burayu town Ato Gabbisa Alemu, head of environmental protection office Ato Seifu Bedada, and all Burayu town Municipality staff workers.

Special thanks also go to my fellows and friends, Dr. Zewdie kassa, Eng. Fikadu Alemu, Eng Kidanu Urgessa, Eng. Fistum Sereke, Eng. Firomsa Jibitu, Gezu and Wondafrash Yilma, who have accompanied and helped me in my Msc journey through their friendship, support, constructive feedback and generous sharing of ideas.

Finally, and most importantly, I wish to thank my husband and my parents who always encourage me and comfort me with deep love and unequivocal support.

ABSTRACT

“The Solid Waste is Gold if it is Properly held”

This study is aimed at the overall assessment of municipal solid waste management practice of Burayu town. Specifically, the study focused on objectives which include estimate per-capita household solid waste output per day of selected household or generation rate waste disposal system of the town, identify environmental and health impact of dumping site and evaluate the level of awareness and attitude of the communities towards solid waste management practices in Burayu town. The survey was worked in Gefersa Burayu, Gefersa Guje and Gefersa Nono kebeles. The primary data were gathered through interviews, questionnaires, group discussion and field observations. The secondary data were also gathered from journal, different website, and book, published and un published sources. A stratified random sampling technique was used to select the study units. A total of 410 respondents (370 households (HHs) and 40 key informants purposively sampled) participated in the study. The total family from the sample households divides the overall waste produced from the sample households over the collection time, which was 2 months (7-consiquetive workday). In this case, the total family from the sample households was 2184 and the number of waste collected over a two months from all households was 4486.5 Kg. Waste generation of Burayu town was 0.293Kg/cap/day. These values point out every resident in the town generates 0.293 kg/cap/day of solid waste. However, a 0.293kg/cap/day of waste generation per capita is very low compared to about the per capita waste generation of developed nation. Generally the investigation of this study suggest that the present status of Burayu town solid waste management is powerless and uncontrollable in terms of spatial coverage, technical, management facility, awareness or consciousness creation and service delivery at both municipality and household level. Finally, the study forwarded some relevant or crucial recommendations towards improving the solid waste management training.

Key words: Disposal system, Generation rate, Solid Waste and Solid waste Management.

ACRONOMYS

BC	Before Christ
CSA	Central Statistical Agency
ETB	Ethiopian Birr
EPA	Environmental Protection Agency
GHG	Green House Gases
GC	Gregorian calendar
HHs	Household Heads
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
MSSE	Micro and Small-Scale enterprise
SB	Sanitation and Beautification
SBPDD	Sanitation Beautification and Park Development Department

TABLE OF CONTENT

ACKNOWLEDGEMENTS	I
ABSTRACT	II
ACRONOMYS	III
TABLE OF FIGURES	VII
TABLE OF TABLES.....	VIII
CHAPTER ONE.....	1
1. INTRODUCTION.....	1
1.1 Background of the study.....	1
1.2. Statement of the problem	2
1.3. Objectives of the study	3
1.4. Research Question.....	3
1.5. Scope and Limitation of the study.....	3
CHAPTER TWO.....	4
2. REVIEW LITRATURE	4
2.1. Concept of solid waste	4
2.2. Historical origins of Solid Waste Management	4
2.3. Characteristics of municipal solid waste	5
2.4. Type and sources of municipal solid waste.....	5
2.5. Municipal solid waste generation rate.....	5
2.6. Hierarchy of waste management	6
2.7. Municipal Solid Waste Management (MSWM) in developing countries.....	8
2.8. Factor that affecting solid waste management	9
2.9. Environmental impacts and health hazards from Solid waste.....	12

CHAPTER THREE	14
3. RESEARCH METHODS	14
3.1. Study Site	14
3.2. Socio economic Characteristics of the Town	16
3.3. Research Design	17
3.4. Methods of Data Collection	19
3.5. Methods of Data Analysis	19
3.6. Ethical Consideration	20
CHAPTER FOUR	21
4. PRESENTATION AND INTERPRETATION OF FINDINGS	21
4.1. Introduction	21
4.2. Response Rate	21
4.3 Bio-data of Respondents	21
4.4 Generation Rate	26
4.5. Municipal Solid Waste Management System of Burayu Town	29
4.6. Impact of Disposal Site	41
4.7. Awareness and Attitudes of the Community Towards Solid Waste Management in Burayu Town	45
CHAPTER FIVE	46
5. CONCLUSION AND RECOMMENDATION	46
5.1. Conclusions	46
5.2. Recommendations	47
REFERENCE	49
QUESTIONNAIRE	53
Appendix 1: Form prepared for sample households in Burayu town	53

Appendix 2: Questions for Focus Group Discussion	57
Appendix 3: Interview Questions Prepared for Head of SB Department of Burayu Town	58
Appendix: 4: Interview questions prepared for sanitation and Beautification workers of Burayu town	59
Appendix 5: Household Waste Generation Rate.....	61
Appendix 6: Photo From Field Surve.....	74

TABLE OF FIGURES

Figure 1:Step of Waste Management Hierarchy	8
Figure 2 :Map of study area	15
Figure 3: Family Size of Respondents	26
Figure 4. Partial view of daily household solid waste generation and measurement.....	28
Figure 5:Solid waste Storage Material	30
Figure 6: partial views of solid waste storage materials of households: Source field survey, 2020	31
Figure 7: Transfer Station.....	33
Figure 8: street sweepers and transfer station	37
Figure 9: Practice of solid waste disposal in Burayu town	38
Figure 10: Final Disposal Site at Burayu Town	41
Figure 11: Impact of Disposal Site.....	43

TABLE OF TABLES

Table 1: Climatic condition.....	16
Table 2: Sample Size.....	18
Table 3: Response Rates.....	21
Table: 4 Age, Education Level and Gross Monthly Income of Respondents	23
Table 5: House ownership condition, marital status, duration of stay in the town, family size of the respondents.....	25
Table 6 : Transfer station of municipal solid waste of three-selected Keble's of Burayu town	32
Table 7: Households solid waste separations activities.....	34
Table 8: Households that get service from Micro and small enterprises	35
Table 9 : Practice of solid waste disposal in Burayu town.....	38
Table 10: Availability and location of container placement	39
Table 11:Top ten disease in last three years in 2010-2012 E.C	44

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the study

Municipal solid waste in this paper is outlined as any materials that are generated from different areas, like home, public place, hospitals, streets, offices, shop and industries((Beliyu, 2015). The activities of solid waste management (SWM) are essential element of environmental infrastructure in human being settlements. The practices cover all activities undertaken from the purpose of waste generation up to the ultimate disposal site. In most of developing countries of urban areas, Solid Waste Management is totally a responsibility of Municipal Councils whereas, in most cases of rural areas the waste are collected and disposed at the home level (Nshimiyimana, 2015). Most human activities produce waste, particularly since the economic revolution in the mid-18th century. The number of waste created inflated dramatically from the time to time round the world (Meaza, 2016).The growth of urbanization that has been happening throughout the mid of 20th century layout the planet in to the society of cities and faced similar challenges on environmental problems with in which most of them are addressed internationally (Horro, 2018).

In developed countries, the standard of living of individuals will generate bigger quantity of solid waste than developing countries. However most a part of developed country are efficient in handling system of waste when put next to developing countries due to their technologically advanced, institutionally economical and price effective waste management systems (Horro, 2018). “In Federal Democratic Republic of Ethiopia, the rise of solid waste generation is resulted from fast urbanization and population booming. The number of solid waste in Addis Ababa and other fast growing areas in the country has been increasing over time, largely attributed to rapid population growth rate” (Dinka, 2017) .

In several components of Ethiopia, the municipality administration is to blame for waste assortment. However, there's a large variation in performance in relevance waste assortment in cities of Ethiopia. According to the authors it's become a standard business apply to possess home waste to be pre-collected by people who are organized through formal informal association. It also says that the pre-collected waste is transferred into containers then, collected from there by municipalities. Within several Cities, there aren't enough containers to hide the population and vehicles are typically under

maintenance or out of service for long period, also some of them are put in appropriate place (Tesfaye, 2015).

Burayu town, that is found in Oromia special Zone Surrounding Finfine, as alternative town in Federal Republic of Ethiopia, has poor solid waste management apply, that is one amongst the key drawback that have an effect on each humans and surroundings. Most of solid waste that generated within the town remains uncollected and easily drop on open areas, roadsides and in ditches. For example, due to lack of adequate public toilets, residents use the encompassing open area, roadsides, open drainages and around fences for open defecation. Households additionally use to dump their wastes either solid or liquid in the open drainages and any open areas. Seeable of this, it's worthy to assess municipal solid waste management practices in Burayu town. This study will be used as a concrete for any studies to be conducted in the future included with solid waste management system and other issues with the town.

1.2. Statement of the problem

Burayu characterized by fast population increment due to migration from different rural area of the countries. The environmental and hygienic conditions of the town become additional serious problem facing from time to time, and people are suffering from living in such waste management on one hand and steady growth of solid waste drawback on other aspect are yet the main indicators of the town (Beliyu, 2015). “The fast increase of Population and the increasing economic growth of the town combined brought an oversized quantity of solid waste. The piles of waste dumped lawlessly on open areas, in gullies, river courses are undisputable evidences of the poor solid waste management system of the town that has ultimately caused a foul-smell, obstruction of drains and destroying the aesthetics of the town” (Zerihun, 2018). The prevailing literatures concentrate on generation rate, physical properties, and composition. However, these literatures did not give much emphasis on the attitude of communities towards solid waste management practice, environmental and health impact of solid waste management. Therefore, this study is aimed to fill the gap under study on SWM in the town. It is also important that this research conducted in such a critical period when solid waste management seems stagnant and worst condition in the town. Therefore, these situations necessitated thesis work to assess the issues in the study area closely and deeply in order to give clear description of status, constraints inhibiting in such areas impacts of problems and indicate solution to improve solid waste management in the town.

1.3. Objectives of the study

1.3.1. General objectives

The overall purpose of the study is to assess municipal solid waste management practices in Burayu town.

1.3.2. Specific objectives

- ✚ Estimate per-capita household solid waste output per/day of selected households.
- ✚ Explore waste disposal system of Burayu town.
- ✚ Identify environmental and health impact of dumping site in the town.
- ✚ Evaluate the level of awareness and attitude of the community towards SWM practices in the town

1.4. Research Question

- ❖ What is the estimate per capita household output per day of individual households?
- ❖ What is waste the waste management system in the Town?
- ❖ What is the impact of disposal site on human health and the environment?
- ❖ What is the attitude towards community participation in solid waste management in Burayu Town?

1.5. Scope and Limitation of the study

Some of the limitations of this study were absence of enough secondary data regarding SWM in the town, insufficient budget during data collection, respondent's reluctance to provide accurate and detail information, current world problem including our country about COVID 19, Political instability and lack of well-documented evidences in the town's municipality. However, with standing all the limitations, it was possible to minimize the problems and come up with reasonable findings.

CHAPTER TWO

2. REVIEW LITRATURE

2.1. Concept of solid waste

Hajkowicz et al. (2006) cited in (Kebede, 2017) “defined waste as any item or material that is generated and disposed of or intended to be disposed of by an individual that has custody of it. However, additionally concern of legal nature and geographical location of generation, completely different definitions of waste exist based on conditions underneath that they generated”.

According to Rouse (2008), cited in (Ashenafi, 2011) “Solid waste is outlined as material that no longer has any price to its original owner, and that is discarded. The most constituent’s solid wastes in urban areas are organic waste (including room waste and garden trimmings), paper, glass, metals and plastics. Ash, dust and street sweepings may also kind a major portion of waste”. Another authors outline solid waste management(SWM) as the techniques of controlling different waste in a manageable area which may in compose; waste collection, recycling, treating and dispose to reduce their effect on environment as well as on health in accordance with the agreed national or international standards (Horro, 2018). In another meaning “the purpose of municipal solid waste management are to market the standard of the urban environment, generate employment and income, and protect environmental health and support the efficiency and productivity of the economy” (Ogwueleka, 2009).

2.2. Historical origins of Solid Waste Management

Humans are mass-producing solid waste since the primary formed non-nomadic societies around 10,000 BC. Historically, public health issues, security, insufficiency of resources, and aesthetics acted as central drivers for waste management systems (Louis, 2004); (David, 2007).

Small communities managed to bury solid waste simply outside their settlements or eliminate it in near rivers or water bodies; however, as population densities increased, these practices now not prevented the spread of foul odors disease (Alamrew, 2018) . As waste accumulated these growing communities, individuals merely lived amongst the filth. There have been exceptions; an organized SWM method enforced within the ancient city of Mahenjo-Daro in the Indus Valley by 2000 BC (Worrell & Vesilind, 2012). The Greeks had each issued a decree forbidding waste disposal within the streets and arranged the western Worlds’ initial acknowledged ‘municipal dumps’ by 500 BC.

In America, the urban population lived in similar putrid conditions. Several initiatives were enforced to clean up the streets, however all were short-lived as a result of the poor were centered feeding themselves and also the rich were opposed to paying to clean up for the poor (David, 2007). However, insufficiency of resource ensured several things were repaired and reused, and the waste stream was totally scavenged (Woodward, 1985). Once SWM progress finally began, it absolutely was driven by five principal factors: public health, the environment, resource scarcity and the value of waste, climate change and public awareness and participation.

2.3. Characteristics of municipal solid waste

According to (Rushbrook & Pugh, 1999) cited in (Zerihun, 2018) “Waste characteristically refers to the quantity, composition and type of solid wastes. For effective and economic management of solid wastes produced in a particular specific city, a considerable knowledge and data regarding the characteristics of the solid wastes of the respective city is a necessity. In order to decide the types and quantities of facilities required for solid waste management and best disposal options needed in a particular city, needs precise information about the quantities (generation rate) and the nature of constituents of the solid wastes produced in the city. Even to plan for future provision of facilities, projected increases in quantities of each waste source should be estimated”.

2.4. Type and sources of municipal solid waste

In order to classify Municipal Solid Waste the interesting thing are to know their source from which the waste come, their components as well as the type and nature. “Based on the nature of items that in compose solid waste, they can be categorized in to combustible and non-combustible, decomposable and non-decomposable” (Edelman, 1997, and G/ Tsadkan, 2002) cited in (Horro, 2018). According to their source, the author again classified solid waste in to residential, institutional, street sweepings, Commercial areas, and construction as well as demolition debris (Horro, 2018). In these sources, there are different types of solid wastes.

2.5. Municipal solid waste generation rate

Waste generation refers to “any or all activities of identification of materials as no longer being important and so are either thrown away or collected for disposal” (Zerihun, 2018). Whereas Solid Waste generation rate refers to the “amount of waste disposed throughout a given period of time and therefore the quantification of it involves totally different methods: by measurement at the point of generation, through use of vehicle survey and by examination of records at the disposal facilities”

(UNEP, 2009 and Zebeay, 2010) cited in (Horro, 2018). “The calculable amount of municipal solid waste (MSW) generated worldwide is 1.7-1.9 billion metric tons per year creating cities a threat to the environment” (UNEP, 2013). Which means, “the speed of solid waste generated in a very given town/city determined by demographic growth, seasonal variation, geographic location, economic development and people’s attitude towards waste” (Dinka, 2017). In keeping with (Nashiimirimana 2004) cited in (Horro, 2018) also explained “ the influence of economic development by comparison gross national product of developed and developing countries with their waste generation rate and he conclude that the higher the gross national product of a country result the higher the generation of waste”. According to the author, people’s attitude towards waste may handle their interest in waste reduction and degree that they refrain from indiscriminate disposing and littering.

2.6. Hierarchy of waste management

Waste hierarchy may be an instrument used in the analysis of processes that shield or protect the surroundings resource and energy consumption from most useful/ efficient to least useful/efficient actions. “The hierarchy of waste management is reducing the use of materials and reusing them to be the environmental friendly and Sources reduction begins with reducing the amount of waste generated and reusing materials to prevent them from entering the waste stream” (Vandana et.al, 2017). As stated by (Daniel & Perinaz, 2012) “the earliest known usage of the ‘waste management hierarchy’ appears to be Ontario’s pollution probe in the early1970s. First the hierarchy begin as the ‘three Rs’-reduce, reuse, recycle but the other the fourth R is added-recovery. The hierarchy establishes most popular program priorities based on property (Hansen & Christopher, 2002). “In several developing countries, some aspects of this hierarchy are already insitu, since traditional practices revolving around waste prevention re-use and recycling is prevented. In keeping with (Shaukat and Sajjad, 2016) cited in (Endalkachew, 2018) this solid waste management hierarchy” includes:

2.6.1. Reduction/ Prevention

“The highest priority choice in SWM hierarchy is to stop or reduce the solid waste generation at the supply. Waste reduction might occur through the designing, producing, and packaging of products with minimum harmful content, minimum volume of fabric, or extended useful life” (Endalkachew, 2018).

2.6.2. Reusing

“Reducing and reusing are the fore most effective ways in which to stop generation of wastes. It’s known that the maximum as 95% of a product’s environmental impact happen before it discards, largely throughout its manufacturing and extraction of virgin raw materials” (Vandana et.al, 2017).

According to the author, recycling requires a separated stream of waste, whether source separated or separated later on after the collection. This method also helps in minimizing the number of waste made as product, saves the natural resources and reduces the prices related to the production and manufacturing. Municipal solid waste generation may be reduces through reusing the things that aren’t any longer needed by someone.

2.6.3. Recycling

“In addition to reuse, recycling is also an obvious solution of solid waste drawback. It’s an important method of collecting solid waste materials and turning them into helpful products, which will be sold within the market place. Such material may be reprocessed in two ways: primary and secondary. Many people are impelled to recycle as result of environmental concern” (Yohanis & Genemo, 2015). “Waste recycling can help the economy by recovering and reusing valuable materials. They reduces the amount of waste needed to be collected, transported and disposed of, and extends the life of disposal facilities, which saves money to the agency” (Ogwueleka, 2009).

2.6.4 Processing and recovery

“This functional element includes all techniques, equipment and facilities used each to improve the efficiency of other functional elements and to recover usable materials, conversion products, produce energy and compost from solid wastes. Additionally, it also provides several benefits. First, it will serve to reduce total volume and weight of waste material that need collection and final disposal. On other aspect, it also reduces total transportation cost of waste to its final disposal site” (Yohanis & Genemo, 2015). The author again stated that Solid waste processing and recovery has been carried out starting from separation and processing of wastes at the sources.

2. 6.5 Incineration

Incineration is the system of control and complete combustion of solid waste. Reduction of the original volume of combustible solid waste by 80-90% is one of the most indicator features of “incinerator” that can be used (Nguyen, Duc Luong et, al., 2013).

“This method is waste reduction, not waste disposal through following incineration ash should still be disposed. It is recognized as a practical method of disposing of certain hazardous waste materials (such as medical waste)” (Yohanis & Genemo, 2015).

2.6.6. Land filling

According to Yirgalem Mahiteme (2001) cited in (Bjerkil, 2005), “the most common disposal method for solid waste in Africa is open landfills, with no environmental control and many of these landfills are almost full and in most cases the environmental condition are very poor”. Historically, the landfill is firstly used along with the formation of cities, crude dumping is original method of landfill. Still, as living standards increase so does the demand for improved environmental advantage, crude dumping of waste become increasingly unacceptable to a more extremely educated and well-informed public. Today, the tendency to minimize the use of landfill in most of western countries as a result of the importance of energy and raw material recovery as well as rational land use has been gradually realized by people (Bridgwater & Lideren, 1981). Generally waste management hierarchy has the subsequent steps, from most favored option to least favored diagrammatically.

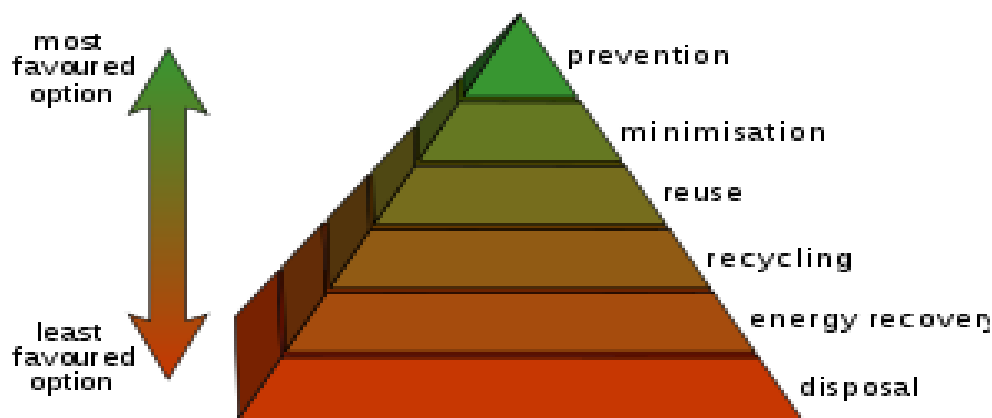


Figure 1: Step of Waste Management Hierarchy (Hang, 2016).

2.7. Municipal Solid Waste Management (MSWM) in developing countries

Municipal solid waste management is a worldwide serious challenge especially in developing countries due to restricted resources, an exponentially increasing population, fast urbanization and worldwide industrial enterprise.

2.7.1. Municipal Solid Waste Management in Africa

As stated in (Abdelnaser & Gavrilescu, 2008), “in most developing countries, open dumping with open burning is the norm. A typical SWM system in a developing country shows an array of issues, which in compose low collection coverage and un constant collection services”. Because of various different factors, Waste management issues in our continent are sophisticated.

Some of the factors include economic factor, political factor, technical and infrastructure, organization/ management problem and challenges to be addressed (Endalkachew, 2018). The author also describe that MSWM has frequently been an intractable (stubborn) drawback in recent time’s far side the capacity of most state governments. According to (Mwesigye et. al, 2009) cited in (Endalkachew, 2018), this has resulted in refuse heaps (lots) being dumped within the urban landscape in heavily populated cities as usually solely concerning 40 to 50% of waste is reportedly being collected.

2.7.2. Municipal Solid Waste Management in Ethiopia

Solid waste management quality affects the urban areas of developing country in critical ways, with impact on their environment and public health (World, Bank, 2018). Like different developing countries, in our country the increment of solid waste (SW) generation resulted from fast urbanization and population growth (Dinka, 2017). “Therefore, solid waste management (SWM) could be an essential part and resource inside urban sanitation and it is additionally one amongst the foremost necessary and resource intensive services provided by municipalities and other nongovernmental organization” (Endalkachew, 2018). In most major town and cities of Ethiopia solid waste that are generated don’t seem to be fittingly handled and managed, mainly because of institutional, regulatory, financial, technical and public participation problems (Lemma, 2007); (Dereje, 2009); (Mekonnen, 2012). “Collection of municipal solid waste in most of the cities is tough and sophisticated as a result of the generation of residential, commercial and industrial waste could be a diffuse process takes place in each house, each building and every commercial and industrial facility” (Endalkachew, 2018). In addition as in the streets, parks and even within the vacant areas offered inside the community.

2.8. Factor that affecting solid waste management

“A typical solid waste management system(SWM) in a developing country displays an array of issues, as well as low assortment coverage and irregular collection services, crude open dumping and burning due to technical, financial, institutional and social factor” (Abdelnaser & Gavrilescu, 2008).

According to (Abdallah et. al, 2015), “scarcity of modern technology, equipment for separation at a sources, solid waste management policy as well as their enforcement, lack of education and awareness, income of individuals are factors that affect solid waste scenario. The author states that the knowledge of the present status of waste disposal options and level of awareness of solid waste management will help the government and sectors involved in the waste management to take action to establish and reinforce waste collection and disposal option and environmental education and awareness on waste management”.

Generally, the most factors that affect solid waste management in developing countries fall into four major categories. This includes:

2.8.1. Technical/Operational Factor

As stated in (Ashenafi, 2011), technical skill, and training are the most important thing for the improvement of solid waste management operations. But most developing countries, there are inadequate human resources at each the national and local levels with technical expertise necessary for solid waste management, notably at the local level, have very little or no technical background or training in management. This can be a main reason for a scarcity of comprehensive waste management designing in developing countries. He also state that, assortment and analysis of solid waste knowledge are typically, not given adequate attention. As a result, there are few opportunities for waste management director to become experts and to formulate and implement plans that are tailored to the particular situation in their country. This in turn makes it very tough to license or developed technologies that are best suited to the local conditions (Solomon, 2011).

2.8.2. Financial/Economic Factor

“Waste management is an expensive service and need substantial investments in physical infrastructure and long-term operations. The author also state that SWM services are also essential to both physical and economic society and are also often a priority budget item for city or town. The largest financial problem for different city or town of most developing countries is usually the coverage of operational expenditures for fuel, labor and maintaining of the equipment” (World, Bank, 2018). Generally, solid waste management in both developed and developing country encounter large problem connect with the finance starting from budgeting to the end of the plan for the users. I.e. Especially MSWM in developing country are weak in terms of managing finance, planning and their designing.

2.8.3. Institutional Factor

Many agencies at the national level are typically concerned a minimum of partially in solid waste management. However, there are typically no clear roles perform of the varied national agencies outlined in relevance solid waste management and no single agency selected to coordinate their projects and activities. The lack of coordination among the relevant agencies usually leads to totally (different) agencies turning in to the national counterpart to different external support agencies for different solid waste management cooperative comes while not being conscious or aware of what different national agencies are doing.

This results in duplication of efforts, wasting of resources and global organization property over solid waste management programs. (Zurbrugg, 2009), added that solid waste collection schemes of cities in the developing world typically serve solely a restricted a part of the urban population. The folks remaining without waste collection services are sometimes the low-income population living in peri-urban areas. One in all the most reasons is the lack of economic resources to address the increasing quantity of generated waste by the fast growing cities. This indicated that apart from financial constraints that have an effect on the supply or property of waste assortment service, operational inefficiencies of solid waste services such as deficient management capacity of the institutions and inappropriate technologies have an effect on effective waste management.

2.8.4. Social Factor

Out of many factors that influence solid waste management, social factor are the other constraints. In most developing country solid waste management, behavior may also be affected by lack of knowledge and awareness or attitudes. Social norms were not important in recycling, reusing and reducing behavior because there is little or no social cost to people in not participating (Eeda & Siong, 2016).

Totally, “Social status of solid waste management employees is usually low each in developed and developing countries, but a lot of sever in developing countries than developed countries. Such people’s perception leads employees to disrespect their work and successively produces poor quality of their work. The existence of waste pickers (scavengers) creates usually associated an obstacle to the operation of solid waste assortment and disposal services” (Solomon, 2011).

2.9. Environmental impacts and health hazards from Solid waste

2.9.1. Environmental Impact of solid waste

“Waste management has become serious environmental and public unhealthiness worldwide, significantly in developing countries. Dynamical economic trends, bigger growth of urban agricultural and industrial activities stimulated by fast growth turn out solid and liquid wastes that pollute the environment and destroy resources and complete solid waste management” (Ramachandra, 2006). According to (Ernest, 2017), un controlled solid waste dumping exposes urban residents, to potential risks from polluted water particularly those living to dump sites, unhealthy food sources, air, land and vegetation pollution. He states that “Uncontrolled Solid Waste disposal system create a variety of environmental impact, i.e. Weak Solid Waste disposal and handling of wastes leads to environmental degradation, ecosystem destruction and high risks to public health. Such accumulation of solid wastes are health hazard not only to urban residents but threaten to the environment.” He also describes that the environmental problems associated to solid waste ranges health hazards, water pollution and soil offensive odor and responsive sight.

Generally the outcomes of this all is degradation of our environmental quality (Ernest, 2017). Anaerobic respiration of bacteria produce methane, and these bacteria thrive in landfills with high amounts of wetness. This Methane concentration will reach up to 45-50% of the composition of the landfill gas at maximum anaerobic decomposition (Pervez & Ahmade, 2013). They also states that the “second down side with these gasses is their contribution to the improved greenhouse gas impact and global climate change.”

2.9.2 Impact of Solid Waste on the health of community

Uncontrolled solid wastes are potentially hazards to the health of the communities. That means wastes from various sources can inter human bodies through different ways. Among them inspiration or inhalation, absorption and ingestion are the main one. These toxicants can be found everywhere. For instance they can be found in water body, soil and air (Mulumebet, 2018). She also states “that there are a various health related problems due to improper solid waste management system in urban areas, some of them are skin disorders, respiratory abnormalities, abdominal and intestinal problems, dental disorders, ear infection, skeletal muscular system problems, central nervous system impairment, eye infections, blood disorders, malaria chicken pox, septic wounds and congenital abnormalities, cardiovascular disease, water borne disease and lung cancer.” Such incidence of diseases puts further

burden on the scanty health services available in resource in poor developing countries. Inhalation of bioaerosols and of smoke and fumes made by open burning of waste can cause health issues.

Additionally, the exposure to air-borne bacteria is infectious. Toxic materials present in solid waste are determinants for metastasis and medicine issues, eye infections and low life span. Sewers and drains clogged by solid waste are breeding grounds for mosquitoes (Vandana et.al, 2017)

CHAPTER THREE

3. RESEARCH METHODS

3.1. Study Site

Prior to development of early settlements, Burayu was lined with dense forest. Because the town, Burayu was based in 1954 G.C by owner named Girazmatch Robi Kalacha. The name Burayu is reported to own derived from one the indigenous tree of the region. The term “Burayu” is Afan Oromo word, which means “Tiqure Inchet” in Amharic. Its scientific name is *Prunus Africana* (Hook. F. Kalm.) In 1996, the municipality of Burayu town was established over the area between Keta and Gefersa. Throughout this time, the population was not over 900 households. In 2005, the administration become unified and reformed to be administrated by a municipality (Girma, 2018).

Burayu is found within the western part of Addis Ababa, on the Addis Ababa-Ambo road at regarding 15km from the middle of Addis Ababa and 27 km east of Holeta Town. Astronomically the town extends between 9° 02' to 9° 02' 30''N Latitude and 38° 03' 30'' to 38° 41' 30''E Longitudes. It is bounded by Addis Ababa City in the East, sululta District within the North, Welmera District within the West and Sebeta Hawas District within the South and North West (Girma, 2018). The author also states that administratively, the town is under the special Zone of Oromia surrounding Finfine in Oromia National Regional State. In keeping with rank given by Oromia National Regional State to all urban center of the region, the town is the 1st grade town in the region starting from 2006 and possesses its master plan in December 2007. The overall space that's lined by the current topographic map of the town is calculable to lies on 90.57 square kilometers and shared more than 15 kilometers of boundaries with Addis Ababa City Administrations. Presently the town is one of the “Leading Cities” and a rapid growing in Oromia National Regional State, consists of six major kebeles together with, Gefersa Burayu, Burayu Keta, Laku Keta, Gafarsa Guje, Melka Gefersa and Gefersa Nonno (Girma, 2018).

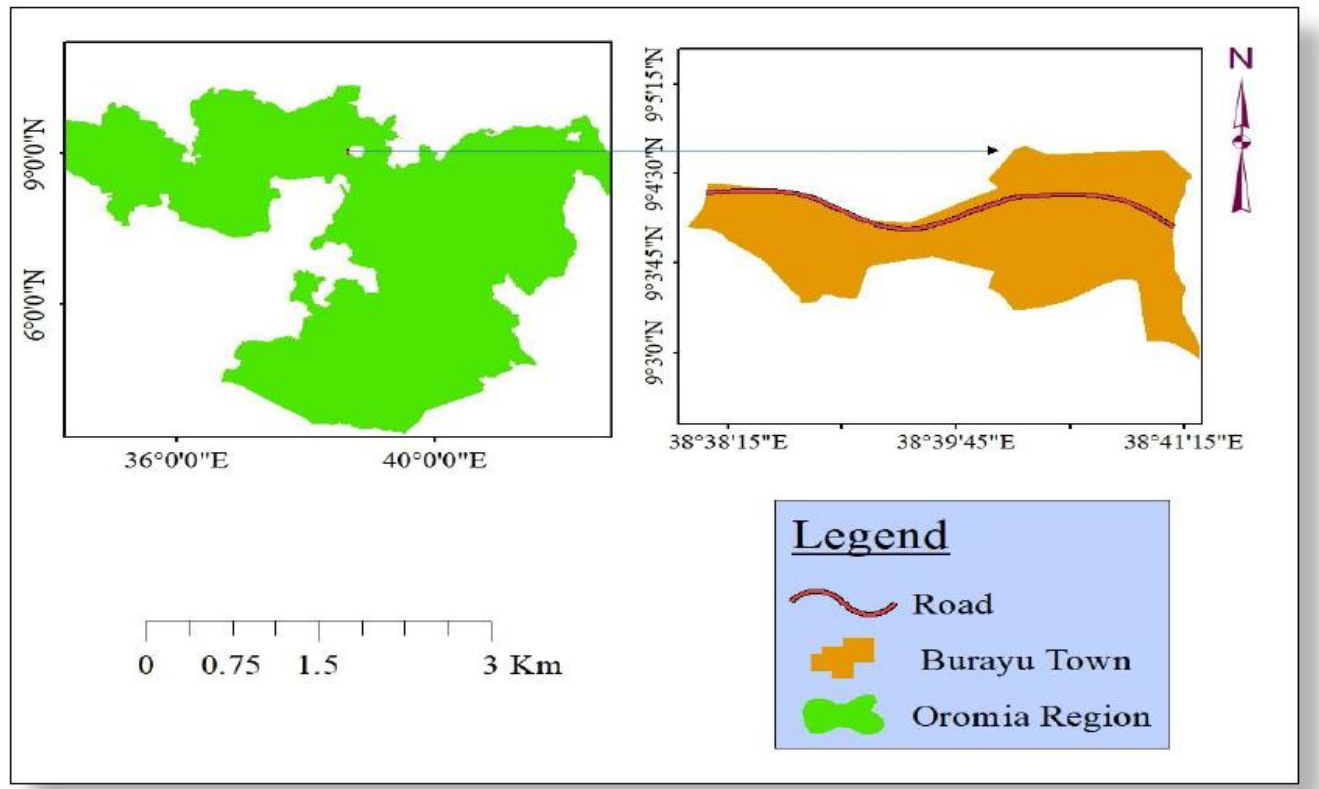


Figure 2 :Map of the study area (Source: Generated by the researcher)

As the town is situated at the southwestern foot of Entoto, most of the existing built up areas of the town lies on land profile with steep slopes, deep streams or river valleys with steep gradients, deep river banks, gullies and ridges with limited flat lands. Altitude of the town ranges between 2450- 2560 meters above mean sea level. Climatically, the town is classed within temperate (local name Badda Daree/Weyna Dega) zone that has constant general climatologically characteristics as that of Addis Ababa. The following table shows the summery of climatic condition of the study areas:

Table 1: Climatic condition

No.	Climate	Values	Description
1	Temperature	14 ⁰ c /mean annual temperature/ 22 ⁰ c /mean annual maximum/ 6 ⁰ c /mean annual minimum/	The temperatures of Burayu area lays in the temperate Weyna Dega Climatic zone with a temperature range of 6 ⁰ c to 22 ⁰ c. This shows that it is a characteristic of a warm temperate.
2	Rainfall	1,188mm/ mean annual rainfall/	The majority of rainfall in the area is obtained during the Ethiopian summer time (i.e. June, July, August and September, which covers 70% to 80% of the total annual rainfall.
3	Humidity	79% in August to 49% in December/mean monthly relative humidity/	Values shows that the study area is very suitable for human life

Source: (Wubshet, 2015)

3.2. Socio economic Characteristics of the Town

3.2.1. Demographic Characteristics

Burayu town is one of amongst quickest growing towns in Oromia National Regional State of Ethiopia. The population of the city is rapidly growing from year to year at a mean rate shows 15.5% per annum. Supported 2007 census, projected population of the town and estimated by town administration depend up on population rapidly growing and rural urban migration, the population size of the town is estimated 280,000 in the year 2017 (Girma, 2018). The study units of the study were households. There are totally, 31,428 households. Most of the residents of the town engaged in several trade activities and others are employed in different governmental Organizations and factories, Agriculture is additionally another economic activity in the urban area of the town.

3.3. Research Design

The research design that has been utilized in the study, is descriptive research methodology. For this, each quantitative and qualitative data is employed. Qualitative methods are utilized in order to generalize the findings of the study (Nshimiyimana, 2015).

3.3.1 Sources of Data

Data collected through primary and secondary data sources. The primary data is collected from household's respondents, field observation and key informants. The study was additionally conducted primary data sources from sample households using structured questionnaire by applying face-to-face interview to reduce non-response rate and incompleteness of data. The secondary data for this research is gathered from related published and unpublished materials, books journals, various research papers, governmental publications, website and report from environmental protection and healthy station.

3.3.2 Sampling Technique

For this study, purposive sampling and stratified random sampling are taken from households of three selected kebeles, based on population density, availability of infrastructures and geographical location. The kebeles are Gefersa Burayu from the commercial center/population density, Gefersa Nono from residential area / infrastructure area as well as Gefersa Guje from rural kebeles of town.

For the purpose of the survey, from list of households of selected kebeles systematic sampling used to select respondent. There are 31,428 households resided in these three selected kebeles of town according to office of finance and economic development of town. Hence, by dividing total household population of selected for sample size $(31,428/385) = 81.63$. Therefore, 81 is k and the first household are selected based on simple random sample and fall on the 10th households. The rest households were selected by adding k , which are 81 on consecutive households from the lists of households from three kebeles, which are 81, 91, 101 etc.

3.3.3 Sample Size

To make the sample representativeness and data quality, reasonable variety of representatives as a sample from a total population has been taken. The target population of the study area has different industries like food, textile and institutions. The resident of those kebeles might provide intended information about this solid waste management in the city administration. To select respondents among six kebeles of the Burayu town, the sample kebeles is selected using purposive sampling technique based on population density, residential and placement. Supported the data obtained from Burayu town

Finance and Economic Development Office; the households of the three kebeles by the year 2017 was 31,428(Gefersa Burayu 15,536 from population density/commercial center, Gefersa Nono 6,071, residential areas Gefersa Guje, 9821 City outskirt). For the population greater than or equal to 10,000 use formula which is developed by Kothari (2004) used in (Dinka, 2017).

If N is larger than 10,000($N > 10,000$) using the formula of:

$$n = \frac{z^2}{d^2}pq \quad (\text{Kothari, 2004})$$

When, n=sample size

N=the standard normal variable at 95% confidence level=1.96

P=Estimated characteristics of target population

q=1-p, non-estimated characteristics of target population

d=level of statistical significance or margin of error (5%)

The research worker used the above formula to get the desired sample size (n) when $N > 10,000$ with 95% confidence level, if there is no estimated characteristics of target population, 50% used then, $p=0.5$ and $q=1-p=0.5$. Moreover, z statistics is 1.96 (95% confidence level) and the desired accuracy at the 0.05 level of significance. Based on the above explanation the sample size is calculated as follow:

$$\frac{(1.96)^2(0.5)^2}{(0.05)^2} = 385$$

With regard to the sample households 385 respondents was selected using random sampling as shown in table 2 below.

Table 2: Sample Size

Kebeles	No of household	Sample of household from each kebeles	
		Frequency	Method of selection
Gefersa Burayu	15536	$(15536/31428) \times 385 = 190$	Systematic random sampling
Gefersa Guje	9821	$(9821/31428) \times 385 = 120$	Systematic random sampling
Gefersa Nono	6071	$(6071/31428) \times 385 = 75$	Systematic random sampling
sub total	31428	385	

3.4. Methods of Data Collection

3.4.1. Data collection Instruments

3.4.1.1. Questionnaires

A questionnaire is outlined as set of question sent by mail although sometimes delivered by hand (Ahuja, 2001). The hand delivery is at home, institution or organization office. This study used questionnaires as a result of permit respondents to provide information with in the absence of a research worker with independent mind in taking decision (Oso & Onen, 2008). The most instruments used for data collection was a structured form designed to handle specific objectives of the study. The questioner was having two parts. The first part of the questionnaires was consisting of questions related to respondent's profile. The second part of the questionnaires was incorporate question related to municipal solid waste management practice that affects municipal solid waste management practices. The questionnaires were also including both open and close-ended questions. Data enumerators file the questioners by asking sample respondents from the selected three kebeles.

3.4.1.2 Interview

To supplement the data collected through questionnaires the research worker conjointly conduct structured interview with different stakeholders. Interview schedule was selected because of its advantages like chance of obtaining in depth data related to the issues.

3.4.1.3. Field Observation

(Ahuja, 2001), asserts that observation is an instrument of research where a research worker uses vision as a means of data collection. The observation method was the most commonly used techniques in collecting primary data.

Questionnaires and interview set in English, translated, and administered in Afan Oromo, the local language in the study area. Photographs are taken during field observation for 'hotspot' waste dumping site.

3.5. Methods of Data Analysis

The qualitative data mainly obtained using open-ended questionnaire and semi structured interview including the researcher's observation is analyzed, described and interpreted in the form of narration. Quantitative method was used for close-ended questions and interview. It includes percentages, tabular analysis through excel software. In addition, qualitative techniques are cause and effect relationships, inductive and deductive. Questionnaires analysis by using quantitative methods.

3.6. Ethical Consideration

All necessary effort is taken to make the research process to follow up professional and ethical principle to this end. The investigator was try clearly inform to the respondent and to all participant about the purpose of the study which was purely academic as the investigator introduced it at the preamble part of question, interview guide, the investigator was not personalized any of the response of the respondent during data presentation, analysis and interpretation.

CHAPTER FOUR

4. PRESENTATION AND INTERPRETATION OF FINDINGS

4.1. Introduction

This chapter presents the finding of the study. It starts with the response rate, bio-data of respondents, generation rate, characteristics of MSW in Burayu town, MSWM system of Burayu town, impact of disposal site, and awareness and attitude of the community towards SWM in Burayu town.

4.2. Response Rate

Three hundred eighty five questionnaires are organized and distributed; the return and the not return response are presented in Table 3, of this chapter.

Table 3: Response Rates

Categories of questions	Frequency	Percentage
No. of return	370	96
No. of non-return	15	4
Total supplied	385	100

The primary information presented in table 3, shows that 385 questionnaires were supplied to respondents, out of these 96 percent were returned while only 4 percent were not. However, it was convincing that 96 percent that were returned is enough to give accurate significance to the study.

4.3 Bio-data of Respondents

The bio- data of respondent is presented by gender, age, level of education, house ownership condition, duration of stay in the town, marital status, monthly income and family size. The study begins with gender as presented in the bar chart 3, of this chapter.

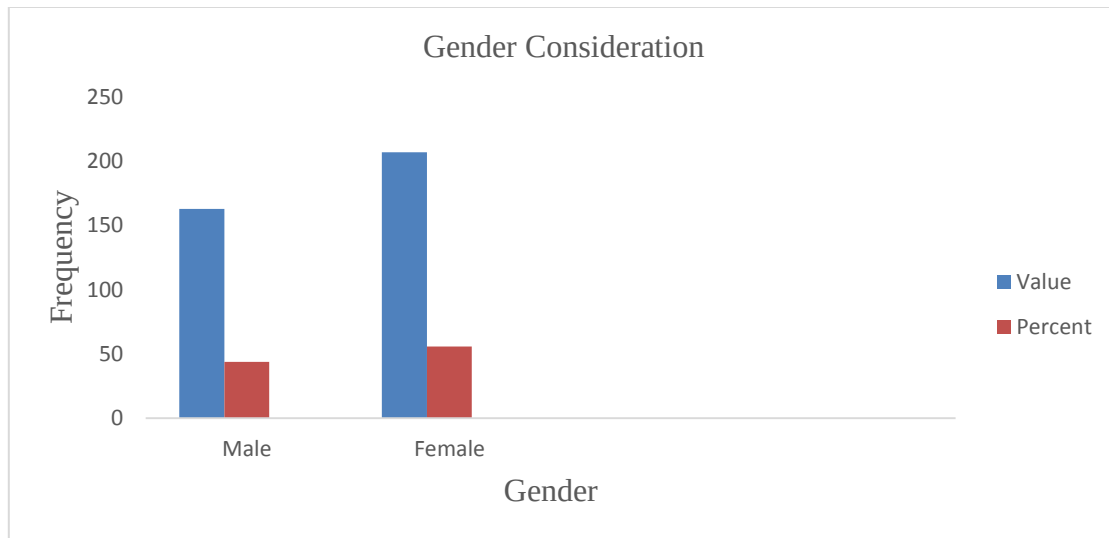


Figure 2: Gender Consideration

Source: Field survey, 2020

As presented in the bar chart 3, the sex composition of respondents indicate that the significant number of respondents 207 (55.95%) were female while 163 (44.05%) were male. This is, due to the reason why most of females are stay-at home rather than working outside equally with male. Even, in the sampled household where both sex family members were found; females were voluntry to respond the questions than male family members. This is happened because of household solid waste management is taken as the responsibility of female family members. Such dominance of women is appreciated and important for this research since women have better knowledge than men on residing solid waste and its handling (Solomon, 2011). Age, education level and monthly income were yet another feature to describe the respondents as presented in Table 4 of this chapter.

Table: 4 Age, Education Level and Gross Monthly Income of Respondents

Age	Frequency	Percentage
18-30	111	30
31-40	163	44.05
41-50	59	15.95
51-60	22	5.95
Above 61	15	4.05
Total	370	100
Level of education		
No formal education	29	7.83
Primary school	88	23.78
Secondary school	66	17.83
Diploma	68	18.34
First degree	82	22.2
Second degree and above	37	10
Total	370	100
Gross monthly income		
Less than 1000 ETB	89	24.05
1001-1500 ETB	40	10.81
1501-2000 ETB	39	10.54
2001-2500 ETB	44	11.89
2501-3500 ETB	23	6.22
3501-4500 ETB	74	20
More than 4501 ETB	61	16.48
Total	370	100

Source Field survey, 2020

As stated in the table 4, out of the total respondents about 274(74.05%) of the sampled respondents are belongs to adult age group (18-40). This also contributed good part for accuracy of the information to be gathered. Also out of the total sample about 96(25.95%) of the respondents are belongs to holder age group. Furthermore, with respect to level of education of respondent as shown in table 4 above, the respondents with no formal education, attended primary school and secondary school account for 7.83%, 23.78% and 17.83% respectively. In addition, those respondent who have diploma, first degree, second degree, and above account for 18.34%, 22.2% and 10% respectively. The data set distribution was due to the fact that majority of the respondents came from groups that normally collect solid waste and transport it to disposal centers. Significant number of respondents were able to write and read as well as attend primary school and above. It is obvious that the attitude and level of awareness toward solid waste management have prominent effect on solid waste handling and concept of solid waste minimization. Education is a gateway to shape the attitude and raise awareness of the society; as a result, attending a formal education will create a fertile ground for the awareness creation activity. Income levels of the respondents are also illustrated on the above table. Regarding monthly income, 24.05% respondents have a monthly income of less than 1000 birr, 21.35% of the respondents receive about 1001-2000 birr, 18.11% of the respondents receive about 2001-3500 birr, and 20% of the respondents earned about 3501-4500 birr and the remaining received above 4501 birr. Therefore, it is well known that annual income of the household had an impact on municipal solid waste.

Table 5: House ownership condition, marital status, duration of stay in the town, family size of the respondents

House Ownership condition	Frequency	Percentage
Kebele rental house	15	4.05
Private rental house	143	38.65
Private house	212	57.3
Total	370	100
Marital status of respondents		
Married	281	75.95
Single	64	17.3
Divorced	16	4.32
Widowed/widower	9	2.43
Total	370	100
Duration of stay in the town		
≤ 2 years	59	15.95
3 -5 years	118	31.9
6-10 years	104	28.1
Above 10 years	89	24.05
Total	370	100
Family size of respondents		
≤ 2	23	6.21
3-5 households	145	39.2
6-8 households	172	46.49
9 and above households	30	8.1
Total	370	100

Source Field survey, 2020

When considering house condition of the respondent, households only 15(4.05%) households are living in Kebele rental house, 143(38.65%) living privet rental house and the majority 212(57.3%) have their own house. Regarding marital status of the respondents, 9(2.43%) were widowed, 16(4.32%) were divorced, 64(17.3%) were single and the majority of the sample households 281(75.95%) were married. Furthermore, with respect to duration of stay in the town of the respondents, 59(15.95%) were live up to two years, 118(31.9%) were live between three-five years, 104(28.1%) were live between six-ten years and 89(24.05%) were live above ten years. From this, it can be conclude that the majority of the respondents know the town very well.

Concerning the family size, majority, 172 (46.49%) of the respondent reported 6-8 family members, 145 (39.2%) respondent reported 3-5 family members, 30 (8.1%) respondent reported greater than or equal to 9 family members and only 23 (6.21%) respondent reported less than or equal to 2 family members found in the HH. The following pie chart shows the family size of the respondents.

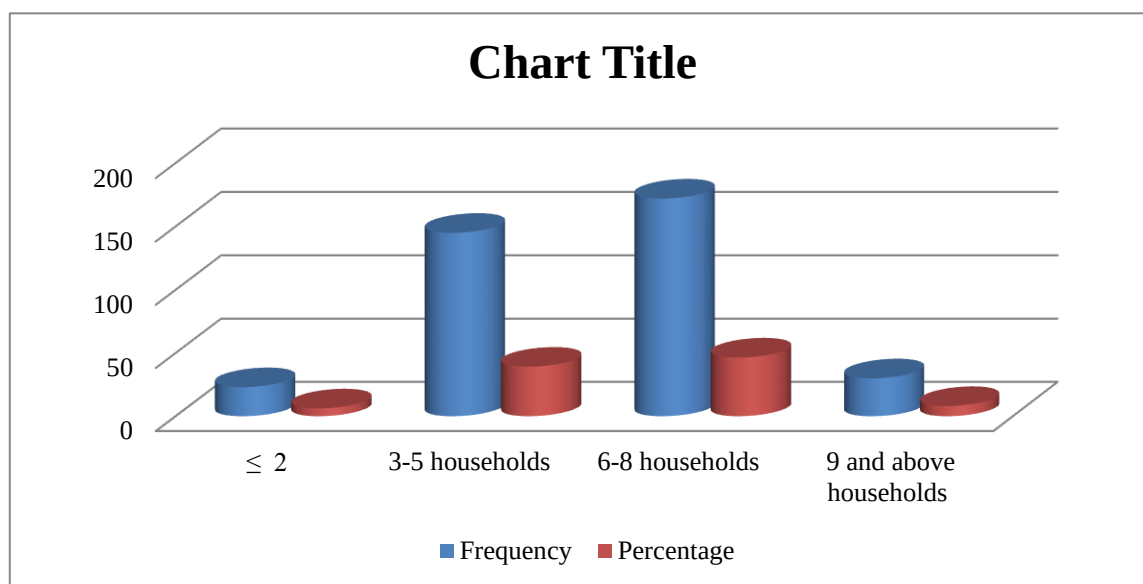


Figure 3: Family Size of Respondents

4.4 Generation Rate

4.4.1. Per -Capital Solid Waste Generation Rate

All terms concerned with Solid Waste Management like; collection frequency or quantity of collection vehicles, quantity of storage containers, and capacity of disposal site, workforce size, and the amount of budget required in a particular urban area are mainly the function of the rate of generation of solid

wastes of respective urban area. As the rate of Solid waste generation from households increases, so does the attention required to manage all solid waste generated from residents. To calculate per capita solid waste generation rate, the total family from the sample households divides the overall waste produced from the sample households over the collection time, which was 2 months (7-consiquetive workday). In this case, the total family from the sample households was 2184 and the number of waste collected over two months from all households was 4486.5 Kg. Waste generation of Burayu town=
$$\frac{4486.5\text{kg}}{7 \times 2184} = 0.293\text{Kg/cap/day}$$
. These values point out every resident in the town generates 0.293 kg/cap/day of solid waste. However, a 0.293Kg/cap/day of waste generation per capita is very low compared to about the per capita waste generation of developed nation. Quits it is very low when compared to low- income countries.

According to the World Bank sponsored international studies, where the average rates of solid waste generations of the lower income countries of the world lies between 0.4 and 0.6 kg/capita/day (Rushbrook & Pugh, 1999).

A latest study in a global review of solid waste management study by the (World Bank, 2012)indicated that Sub-Saharan Africa countries have an average of 0.65kg/cap/day generation rate. Still the generation rate of Burayu town is very less even when compared with the World Bank study for other Sub-Saharan countries, which is 0.65kg/cap/day. Thus, many reasons may be behind the low generation rate of the town; among consumption behavior and type of waste generated might be the reason for low generation rate. A study conducted in Jimma, which has relatively the same economic and demographic situation as Burayu town indicated that the household solid waste generation rate per capital is 0.57kg/day. According to (Nigatu et al., 2011) Addis Ababa city, the household solid waste generation rate per capita is 0.25kg/day.

An evaluation of the characteristics of the solid waste generated across popular and economically significant cities of Africa, namely Egypt, Nigeria, South Africa and Kenya indicated that the average per capita waste generation is 0.7kg/day (Emenike, 2013). It can be clearly seen that Burayu town generation rate 0.293kg/cap/day) is relatively closer to other cities/town in Ethiopia but significantly lower than other African cities.

4.4.2 Household Solid Waste Generation Rate Based on Income Level

Economic status of household is one of the major factors, which has direct impact on solid waste generation rate of the specific house. Household were classified in to higher income, middle and lower income based on their ownership status of household residence, housing condition and monthly income. Based on the criteria's listed above among the 370 sample households, 155 houses were a low-income group, 132 houses were middle-income group and 83 houses were from high-income group. The result from the study showed that the living condition or socio-economic condition of households directly affects the waste generation. The average generation rates of the groups, the higher income, middle income and lower income groups are 0.333kg/cap/day, 0.326kg/cap/day and 0.290kg/cap/day respectively. This clearly shows that solid waste generation rate varies significantly with socio-economic condition, particularly economic status of the households. The higher income groups generate relatively larger quantities of solid waste than the lower income households do. In addition, the middle-income group, which generates 0.326kg/cap/day, falls in between the higher and lower income groups. Although the higher income group generates 0.333kg/cap/day which is larger figure with compared to average value of 0.293kg/cap/day.



Figure 4. Partial view of daily household solid waste generation and measurement.

Source: Field survey, 2020

4.5. Municipal Solid Waste Management System of Burayu Town

Municipal solid waste management is an activity of planning and implementation of solid waste management components such as collection, transfer and transportation, recycling, resource recovery, and disposal of MSW under jurisdiction of local government (Solomon, 2011). Waste handling, separation, storage, processing, collection, transport, and final disposal are some of the important practices done for sound solid waste management (Solomon et al., 2014). Under this section, current state of MSWM of Burayu is discussed.

4.5.1. Solid waste storage materials and its handling

Storage is a method for keeping materials after they have been discarded and prior to assortment and final disposal. Storage of waste at a source is a very important element of solid waste management due to its health and environmental impact. This functional element of SWM constitutes the activity, which is performed by solid waste generator. Studying solid waste storage materials and their handling has significant impact for betterment of MSWM activity. This is from the point of identification of the type and quantity of the storage material to be used, appropriate location of it, deciding the collection method to be used and avoidance of health, environment aesthetics impact of storage materials (Mohammed, 2015). As the result, the researcher collected information about solid waste storage and handling practices of Burayu town and briefly explains in two different categories. The first categories constitute primary storage facilities of households, while the second categories comprise secondary storage facility of the town. The detail information of both storage materials is described in the next section

4.5.1.1 Primary solid waste storage materials and its handling

Residents of Burayu town used various types of storage materials in their compound. In order to assess type of storage materials of residents of the town, 370 households were asked. The result implies that the majority of household use primary solid waste storage materials which is around 289(78.1%) and only 81(21.9%) have no storage materials. The actual evidence of this set up is shown in the figure 6

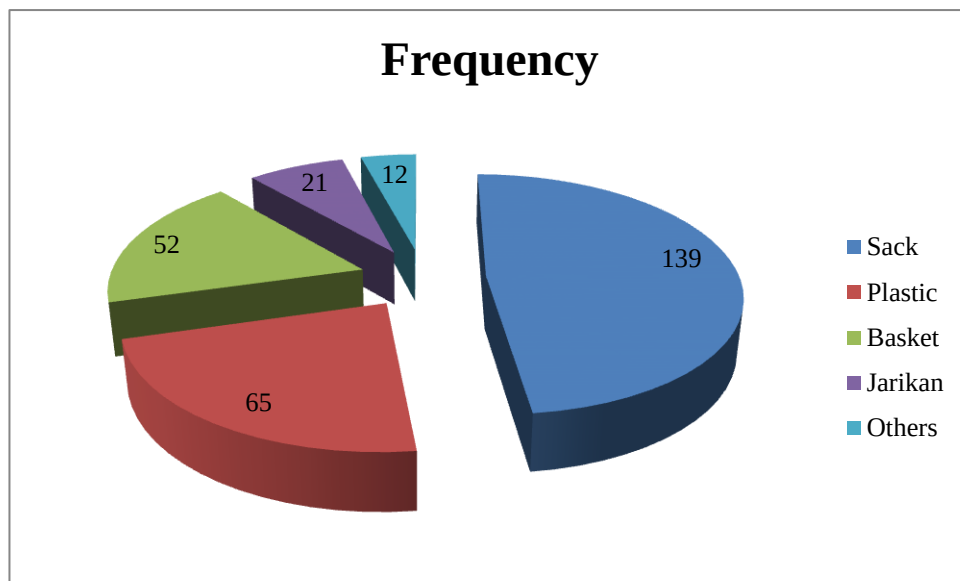


Figure 5: Solid waste Storage Material

As it clearly observed in figure 8, the majority of households 137 (37.57%) stock up their solid waste in sack, this is highly related with least cost, easily availability, in the market, its suitability for holding large volume of solid wastes, spatial coverage of door-to-door solid waste collection service and low frequency. Next to sack, about 65(17.57%) of the respondent use plastic bag followed by basket 52(14.05%) because of their frequent but low generation of waste and economical power to utilize replicable storage materials such as: plastic bags. Following these there are households that use jerry can 21 (5.68%) and 12 (3.24%) of the household use other storage materials such as metallic container, but it is difficult for transportation, high cost and low access in market.



Figure 6: partial views of solid waste storage materials of households: Source field survey, 2020

4.5.1.2. Secondary solid waste storage materials and handling.

Secondary storage materials refers to different type of solid waste containers which involve keeping solid waste generated from different households at a central point from where collection vehicles can pick it and transported to final disposal site (Endalkachew, 2018), (Solomon, 2011). Municipality of the town provides these materials, which is responsible for management of the solid waste. Burayu town sanitation beautification department have 150 containers, but there is no site to put container. Therefore, Burayu town SB put 55 public solid waste containers in different areas of the town where frequent illegal dumping of waste was mostly occurred and in areas where high population density assumed to exist. Residents around those containers areas were highly exposed and affected by different solid waste caused diseases. This is mainly due to lack of lifter truck, some of them are out of service, absence of frequent collection of those public solid waste containers and misuse of the society. However, for solving problems of secondary storage facilities, the town sanitation beautification prepared different communal solid waste transfer stations. Transfer stations are intermediate place where solid wastes deposited and stored until transported to the final deposal site. However, they are not given due consideration in solid waste management system of Burayu development plan. The collected wastes are stored at roadsides and other corners of the town until they transported to the town's disposal site. Presently they are located in the following areas:

Table 6 : Transfer station of municipal solid waste of three-selected Keble's of Burayu town

N_o	Kebele	No container	Transfer site
1	Gefersa Burayu	24	Dire Condominium, Stadium, in front of high tension, Mabrat hayil, Karton, Sarem industry, Behind mariam church, at Hanee dima road
2	Gefersa Guje	12	Behind China camp, in front mesgid, and at the entrance of Guje health center, behind kella polis station, At Sariti sefar,
3	Gefersa Nono	19	Behind shaka moll, Near Gabriel Church, New sefar, Condominium, Diaspora sefar,

Source: Burayu SB Department

Those transfer station are not well designed, not protected from sun and rain. They are just roadside open dumps without any health and aesthetic impact considerations and optimum travel distance of beneficiaries. Therefore, those stations are created bad smell, ugly urban picture, and deterioration of the neighborhood. According to the FGD with municipality staff members and head of health office, those transfer stations gives service only to MSSE workers who collect solid wastes from households, commercial areas and institutions. They stated that in order to use transfer stations one should have to accumulate wastes by using sack and also he/she should load his/her accumulated waste by waiting municipality truck it comes. In addition, they are 40 dustbins, which are used to collect walkers' solid wastes like paper, napkins, remains of fruits such as banana, orange and plastic etc. Those dustbins are located at major roads, recreational areas, institution and market areas, but some of them are out of service and few are stolen currently there is only dustbin in the town.



Figure 7: Transfer Station

4.5.2. Solid waste sorting processing and recovery activities

In this study solid waste separation, processing and recovery activities at source and by the town refers all activities or efforts of separation of recyclable, reusable and compostable wastes to sell or to recover resources by themselves. Practicing these types of activities is very necessary to waste generators as well as town since it minimizes cost of disposal, generates revenue, and prolongs lifespan of disposal site. This is one of the reasons why solid waste managers in many parts of the world are now exploring ways to reduce flow of biodegradable and recyclable materials to landfill sites (Endalkachew, 2018) (Solomon, 2011). As we observed from households' solid waste separation activities in the town, only solid wastes that are sold to Quraleos, exchangeable to liwach and to some extent organic wastes are separated by few households. Response sample respondents showed that about 132(35.68%) of them separately store solid waste and 238(64.32%) of them do not separate solid wastes. A subsequent question asked to those respondents that what the reason behind for not practicing waste separation. Based on the question, respondents gave their respective answers as 121(32.7%) do not have understanding about waste separation, 43(11.62%) of the respondents believe that it is not their responsibility, 74(20%) of the respondent told that they do not visualize the importance of separation. The following table shows the summery of solid waste separations activity of the respondents.

Table 7: Households solid waste separations activities

Practice of separation at household level	Frequency	Percentage
Yes	132	35.68
No	238	64.32
Total	370	100
Purpose separating solid waste at HH level		
To reuse	43	32.57
To sell/ exchange	61	46.21
To recycle	16	12.12
To help waste collectors	8	6.06
Others	4	3.03
Total	132	100
Reason for not separating solid waste		
I do not have understanding about waste separation	121	50.84
I did not think, it is not my responsibility	43	18.06
I did not visualize the importance of separation	74	31.09
Other	-	-
Total	238	100

4.5.3. Solid waste collection and transportation systems in Burayu town

Collection and transportation of solid waste involves the process of picking up of waste from place of generation, taking it to nearby public solid waste containers or transfer station, and finally dumping it to disposal site. This functional element is very decisive and mandatory component of MSWM because productivity and efficiency of this service is highly determined by it (Solomon, 2011). Currently there are two methods of solid waste collection in Burayu town. These are door-to-door collection and transfer station to disposal site and street sweeping.

4.5.3.1. Door to door Solid Waste Collection and Transportation System in Burayu Town

About 173(46.75%) of the households are served by the door-to-door solid collection, transportation and final landfill disposal services. They receive this service by paying the fee from households. About 197(53.25%) of the household do not get the service because of the location of their house.

Respondents who have not been served by designated MSEs, they were participated indiscriminately dump their waste in open space, ditches, and roads. The responsibilities of SW collection are carried out by the town SBPDD. The department was responsible for overall SWM in the town while there are 5Micro, small enterprises collect door-to-door wastes, the other 3 Micro, and small enterprises collect waste around the container, 8 micro, and small enterprise that-operates the street sweepings and open ditch cleaner. However, comparing with the total number of households the services of MSEs is reached to very small number of residents. Beside, Households were asked a question if they have access of collection service given by MSEs. Based on the question, the following result was observed from the response of the sample households.

Table 8: Households that get service from Micro and small enterprises

Access to door to door waste collection from MSEs	Frequency	Percentage
Yes	173	46.75
No	197	53.25
Total	370	100
Frequency of micro and small enterprises collection per week		
1-3 days	27	15.6
4-7 days	32	18.5
8-15 days	25	14.45
16-30 days	34	19.65
Above 30 days	20	11.56
As available	35	20.23
Total	173	100
Amount of payment for the MSEs service of solid waste collection per month		
50 birr	107	61.85
60 birr	16	9.25
70 birr	7	4.05
100 birr	43	24.85
Total	173	100

As indicated in Table 8, above, 27 (15.6%) of the respondent said that MSEs collect solid waste between 1-3 days intervals, 32 (18.5%) indicated that MSEs collect solid waste between 4-7 days interval, 25(14.45%) indicated that MSEs, collect solid waste between the interval 8-15 days, 34 (19.65%) indicated that MSEs collect solid waste between the interval 16-30 days , 20 (11.56%) of the respondent said that MSEs collect solid waste on monthly basis and the majority of the respondent, 35 (20.23%) said that MSEs, collect solid waste based up on their availabilities.

Referring to Table 8, 107(61.85%) of respondent said that MSEs get 50 birr/month, 16(9.25%) respondent said that MSEs get 60 birr/month, 7(4.05%) responded 70 birr/month, and 43(24.85%) responded 100 birr/month were paid for the service.

According to the researcher personal observation and the respondent general comment, challenges currently faces in solid waste collections. Those are: scarcity of equipment or material, shortage of collection car and transfer stations together with weak controlling mechanism of municipality for time wastage absents of the skip loader, loader, and dozer.

4.5.3.2 Street Sweeping Activities in Burayu Town

In addition to collection of solid waste from transfer stations, street sweeping is also included in municipal solid waste management service offered by SB department of Burayu town. Street sweeping takes place every day morning from 11:30-1:30 and afternoon from 11:30-12:00 since it need to be done more frequently because of there is only some street dustbins and regular generation of solid wastes. The street sweepers separately spaced on streets, and clean roads using brooms that gifted from the SB department. After cleaning, they used wheelbarrows to collect piles of solid wastes from streets, load into municipality truck if it comes while doing their work, or else store it in sack and placed in transfer station. Most of street sweepers take place around the center of the town where streets are busy with many activities. However, from my own observation and interview made with the town SB head there is street sanitation problem.



Figure 8: street sweepers and transfer station

4.5.4. Solid Waste Disposal System in Burayu Town

Waste disposal is one of the fore most vital management activities that require to be rigorously planned. So as to realize the target of the study relating to the identification of the common disposal system dominantly practiced by the community of the study area, and to examine the disposal methods commonly practiced by the community in relation to their impact, each on the surrounding environment and on the health of the community of the study area questionnaires were distributed to sample households. As a result, the only solid waste choice of majority households is restricted to two choices; the primary one is simply burning, burying, and spreading in their compounds and the second choice is throwing of solid waste at roadsides, open fields, nearby rivers, bridges and gullies. Therefore as to assess the routine technique of solid waste disposal practices of households, research worker asked sample respondents about their common disposal system. The response of sampled households on the main point SW disposal methods practiced by the community of the study area illustrated using the underlying table and figure.

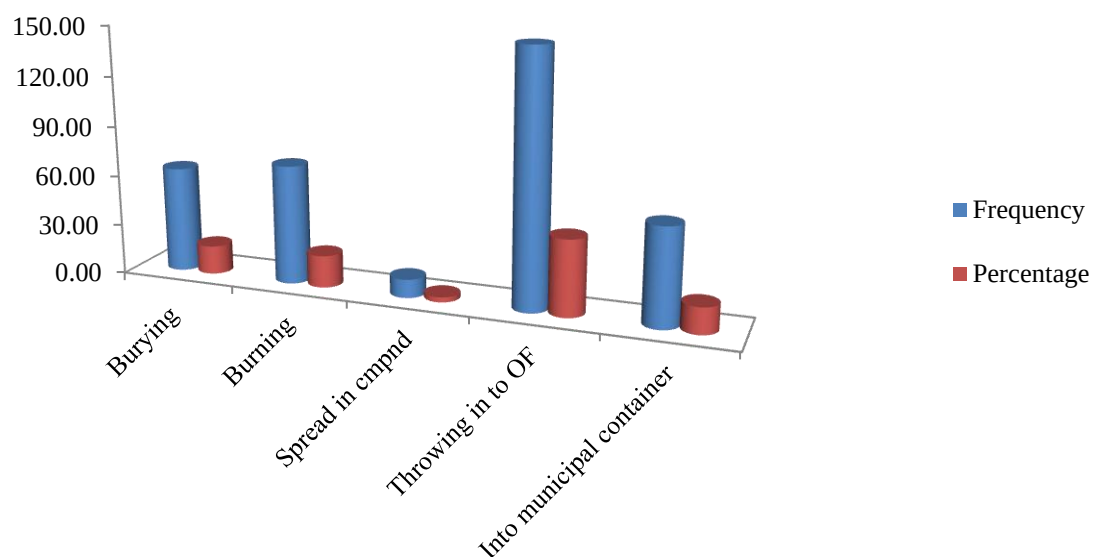


Figure 9: Practice of solid waste disposal in Burayu town

Table 9 : Practice of solid waste disposal in Burayu town

No.	Practice of SW disposal system of the town	Frequency	Percentage	Remark
1.	Burying in their compound	63	17.03	Illegal
2.	Burning in their compound	71	19.19	Illegal
3.	Spread in their compound	11	2.97	Illegal
4.	Throwing of SW nearby open field, roadside, into river courses and ditches	167	45.14	Illegal
5.	Into municipal container	58	15.67	Legal
6.	Total	370	100	

From the table 9, it is clear that the majority of 45.14% population of Burayu town disposed waste illegally or lawlessly into watercourses and ditches, nearby open field and roadside. While 19.19% of the

respondents reported that, they practiced burning of waste inside their compound. Such observe practice possess high risk on the local environment. The other 17.03% of the respondents reported that, they practice burying of waste inside their compound illegally. However, 15.67% of the respondents reported that they collected and place solid waste into the prepared container legally. Few households (2.97%) reported that they practiced spreading of the waste inside their compounds illegally.

In addition to this, sample households were asked about the availability of solid waste communal containers in their respective surroundings to check the provision of appropriate solid waste collection and transportation services. Accordingly, the following result was obtained.

Table 10: Availability and location of container placement

Category	Variable	Frequency	Percentage
Availability of SW disposal container in your neighborhood	Yes	82	22.16
	No	288	77.84
	Total	370	100
Distance of the container from home location	20-50 meters	11	13.41
	51-100 meters	17	20.73
	101-200 meters	23	28.05
	201-500 meters	31	37.8
	Total	82	100

As shown in table 10, above, 288 (77.84%) of sample respondent were explicit or stated that communal solid waste container isn't available and also the left 82(22.16%) of the respondent stated that they have public solid waste container. Additionally, the accessibility of solid waste storage container was asked to understand the typical distance between communal container and a residence so, a container is found between 20-50 meters radius for 11(13.41%) of households, between 51-100 meters radius for

17(20.73%) of households, between 101-200 meters for 23 (28.05%) of the households, between 201-500 meters for 31 (37.8%) of households.

4.5.5. Final Disposal Site of Burayu Town

Unfortunately, at present municipal of Burayu town have no landfill. These days there's only one open dumping site where the waste collected by municipality is disposed. It is set in Laku Kata Kebele. It covers an area of 3 hectares. Both domestic and industrial wastes are dumped at the site without any form of special treatment, and the wastes are not covered with soil to prevent the harboring of disease vectors, odors, and air pollution. There is no doubt that the dumpsite in Burayu town is improperly managed. It attracts different types of disease-spreading insects. The site is no longer at periphery of the town. Moreover, the town gradually extended towards the site and many residential neighborhoods now surrounded the dumpsite.





Figure 10: Final Disposal Site at Burayu Town

4.6. Impact of Disposal Site

According to minimum requirements for any waste disposal system, site selection is the fundamental step in the development of a landfill. This step has far-reaching economic, environmental and public acceptance implications. The landfill site selection process is only complete once the department has found a site feasible based on a feasibility study. Solid waste management facilities to be accepted they should be environmentally friendly, economically sound, and socially acceptable. However, when it comes to Burayu town, the town does not have an advanced landfill site; rather an open dumping site is where all the waste is thrown away. The waste disposal site of the town is found right in the middle of the town in Laku Kata Kebele where quite a large number of communities live nearby the waste disposal site. Even when compared to other Ethiopian and African cities, where the disposal site are located outside cities in order to reduce its social and environmental impacts, Burayu town dumping sites is located near residential houses. This clearly indicates that the communities living nearby the site are prone to both social and environmental effect brought by the disposal site. The dumping location has a very steep or sloppy geographic condition where the waste which is dumped at the top of the site gradually move downward by gravity. This type of dumping by itself is difficult manage to the location of the waste.





Figure 11: Impact of Disposal Site

4.6.1. Impact of Disposal Site on Health

There are potential risks to environment and human health from improper handling of solid wastes. A total of 40 volunteer households, municipality staff, health extension office and environmental office participated in the interview and FGD about the health impact of the dumping site to them. These households are found adjacent to the dumping site, which will make them prone to the direct health impact of the disposing site. The data from Burayu town health office indicated the majority diseases that affect the community were related with improper solid waste management (Table 11).

Table 11:Top ten disease in last three years in 2010-2012 E.C

No	Disease	Total number of cases		
		2010	2011	2012
1.	Acute respiratory infection	4578	4122	2712
2.	Typhoid fever	3814	2913	1832
3.	Diarrhea	3795	3721	1933
4.	Skin disease	2716	1734	603
5.	Trauma	1754	2651	765
6.	Dyspepsia	1038	1023	793
7.	Helminthes/worm disease	1013	1087	523
8.	Disease of muscular skeletal system	625	811	291
9.	Infection of urinary tract	845	811	305
10.	Acute febrile illness	104	176	69

Source: Burayu health office

4.6.2. *Environmental Impact of Disposal Site*

It's the effect that people's actions have on the environment.” Improper solid waste disposal affects negatively on the environment. Such impacts embrace disease and safety issue, drainage issues, environmental and air pollution among the others. Taking away waste has huge environmental impacts and might cause serious problem, badly managed landfill sites might attract vermin or cause litter.

Generally, the following are some of the challenges the town administration currently faces in the Solid waste disposal site are:

-  Un-proper disposal site selection
-  Problem of waste sorting
-  Lack of sanitary land for site
-  Lack of responsible body to manage, sort or recycle the disposed waste at the site
-  Improper waste disposal method which cause the breeding site of vectors, pests and stray dogs insects and also cause of un sight vision and bad odor
-  Cause of air, water and environmental pollution
-  Causes of communicable or infectious disease transmission

🚧 General health challenge the community living around since it disposed at nearby town and village

4.7. Awareness and Attitudes of the Community Towards Solid Waste Management in Burayu Town

Public awareness and attitudes to waste can affect the municipal solid waste management system. All step in municipal solid waste management starting from household waste storage to waste segregation, recycling, collection frequency, willingness to pay for waste management services, and opposition to sitting of waste treatment and disposal facilities depend on public awareness and participation. Awareness about the environment is quite low in Burayu. The people have fallen into the habit of dumping waste in the rivers, fields, drains and ditches; this is known to be the only approach possible to deal with waste. To take care of their responsibility for the town as they take care of their homes is missing in the society. The society has not yet perceived the holistic image of the town and the country. It is not understood that each individual is a stakeholder in the well-being of one another and the country as a whole. The intention of the community using waste as potential resource is not a familiar idea because; the well-imbedded approach is to get it out of site. Winning over such habit to be responsible to dispose waste properly and to come to see waste as a resource is going to be challenging since, as any habit is hard to break.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusions

Solid waste management is being a significant agenda in the world since it is a major cause for environmental pollution and human health risks. Largely observed serious issues especially in low-income level countries are inadequate collection, storage, treatment and uncontrolled disposal of solid waste in open dumps that simply expose to harsh hazards like environmental pollution and health problem. Therefore bit like different developing countries, this data and severity of waste related issues are the big concerns of Ethiopia. That is why, so as to improve waste management system, it developed a new solid waste related law (proclamation) in the year 2007 at national level and distributed to all administration units of cities as well as Burayu town.

This study aimed that assess municipal solid waste management of Burayu town and the actors involved. More over the study aimed to estimate per-capita household solid waste output per day of selected households, to explore waste disposal system of the town, identify environmental and health impact of dumping site and lastly evaluate the attitude of the community towards SWM practice in the town.

The result showed that of the sample survey suggested that the waste generation rate of Burayu town is 0.293 kg/cap/day. The result showed that solid waste generation rate varies significantly with socio-economic condition.

From the study results, it was found that solid waste collection system of the town is very weak and lack organization. Additionally to the current, solid waste assortment coverage is very low which means the key portion of the solid waste generated within the town is uncontrolled and improperly disposed that makes unhealthy environment to live and work in. It absolutely was discovered that starting from collection of wastes from households to dumping of waste to dump site; the solid waste management chain is not clearly outlined and organized. Shortage of micro and small enterprises in each kebeles is the main problem in the collection of wastes from households.

It was also observed the mismanagement of transfer station in all kebeles has aggravated the issues. Shortage, distribution and placement of the containers are the most problems related to transfer station with in the town. Transportation of waste to dumping site has also its own drawbacks due to shortage of Hauling trucks.

The result also showed that, residents living nearby the disposal site are at risk of health and social impacts that has created a great crisis to the community. Therefore, it is possible to conclude that the town administration has a lot to do to improve the solid waste management of the town.

The study result identified main factors that restrained the town solid waste management service. The factors that are identified include lack of awareness, illegal dumping, low enforcement of rule and regulation, weak participatory approach, inefficient controlling and monitoring mechanisms, inadequate institutional capacity (in terms of budget, human resource, equipment and vehicles machineries), poor social working condition of street sweeping workers are among others.

5.2. Recommendations

Based on the findings of the research and the conclusion drawn, the researcher has suggested the following recommendations as the solution measures need to be taken by all stakeholders to solve the solid waste management of the study area.

1. Education Related Measures

- ✚ SB department of the town should have to give training and support for the worker on solid waste management and how to use proper safety materials when they enter to work.
- ✚ The resident of the town have low awareness and knowledge about solid waste management. This indicated that the need of wider public awareness creation activities. So that sanitation administration, health office as well as environmental office of the town should deliver adequate training and awareness creation to resident about the side effect of solid waste.

2. Institution Related Measures

- ✚ The institution improve solid waste collection and transportation by increasing the number of different equipment, organize efficient controlling mechanism and sanitation agent to prevent illegal solid waste disposal
- ✚ In order to solve the problems associated with transfer stations, the number of containers in the town should be increased and greater care should be given for sitting (placement) of containers. In addition to these, the allocation of the container distribution should based on the generation rate of each Kebele and there should be a consistent control on the collection frequency of container by their institution.

- ✚ Increase the number of micro and small-scale enterprises in all kebeles for a proper collection of waste from households and provide the proper primary collection equipment like hand push carts for the micro and small-scale enterprises, also increasing the number of hauling trucks and other equipment to facilitate waste dumping.
- ✚ Engage private companies in the solid waste management business especially in solid waste collection and transportation service provision because private companies who have the budget and technical capacity can contribute a lot.
- ✚ Relocation of the dumping site away from residential areas or construction of an advanced landfill site, which is well protected.
- ✚ Employing rule and regulation that penalize individuals who illegally dispose their waste, and strictly enforce under close supervision.

3. Stakeholders Related Measures

- ✚ Recognizing and encouraging the emerging role of handcrafts through reduction of taxes, and providing space and equipment to produce recycled materials and creation market for it.
- ✚ Burayu town sanitation administration opens its door to all stakeholders and ensures their involvement in planning and implementation of SWM activities.
- ✚ Promote and initiate communities of the town in SWM.

REFERENCE

- Abdallah et. al, (2015). The factors that affecting On solid waste generation in Zalingy Town-central Darfur state-Sudan. *World journal of Engineering Research and Technology*.
- Abdelnaser, O., & Gavrilescu, M. (2008). Municipal solid waste management in developing countries:A perspective on Vietnam. *Environmental Engineering and Management journal*.
- Ahuja, R. (2001). Research Methods,New-Dhli:Rawat Publication.
- Alamrew, Z. (2018). Determination of Household Solid Waste Generation Rate And Characterization of its Composition in Diredawa City Administration, Ethiopia. 5-17.
- Ashenafi, H. (2011). Determinant of Effective Household Solid Waste Management Practices: the Case of Ambo Town-West Shoa Zone.
- Beliyu, A. (2015). Assessment of Municipal Solid Waste Management Service in Burayu Town.
- Bjerkil, C. (2005). 'The cycle of plastic waste : An analysis on the informal plastic recovery system in Addis Ababa,Ethiopia'. Master thesis (Norweain University of Science and Technology(NTNU), Departement of Geography.
- Bridgwater & Lideren, K. (1981). Household Waste Management in Europe, Van Nostrand Reinhold Co.Ltd, Great Britain.
- Daniel, H., & Perinaz, B. (2012). What a waste:A global Review of Solid Waste Management.
- David, C. W. (2007). Development drivers forWaste Management:Waste Management and Research. 25(3), 198-2007.
- Dereje, D. (2009). Household generation rate, composition and content analysis for disposal and resource recovery in Hawasa town.M.Sc thesis, Addis Ababa University, Addis Ababa, Ethiopia.
- Dinka, C. (2017). Municipal solid waste management practice in sabatatown,special zone in Oromia Regional state, Ethiopia.
- Eeda, H., & Siong, C. (2016). Social Factors Influencing Household Solid Waste Minimization.

- Emenike, C. (2013). Waste Generation in Africa: An invitation to wealth Generation. Univercity of Malaya, Kuala Lumpur, Malasia.
- Endalkachew, A. (2018). Assessment of municipal solid waste management practices: A case of Bishoftu City Administratio.
- EPA. (2013). "Non-Hazardous Waste Management Hierarchy".
- Ernest, O. (2017). The impact of Solid Waste on Ground and Surface water Quality in Kisii Municipality, Kenya.
- Girma, L. (2018). An assessement of local government service delivery: the case of drinking water supply and sanitation in Burayu town.
- Hang, C. W. (2016). *Municipal Solid Waste*.
- Hansen, W., & Christopher, M. (2002). Waste Policies and Challenges for Local and Regional Authorities.
- Horro, L. (2018). The assessment of Solid Wsate Management in Addis Ababa City:the case of Bole Sub City.
- Kebede, Z. (2017). Household solid waste management practice in the case of chelenko town Oromia National Regional State, Ethiopia. 7-19.
- Lemma, A. (2007). Household Solid Waste generation and composition analysis in Adama Town, MSc thesis, School of Graduate Studies, Addis Ababa University.
- Louis, G. (2004). A historical context of Municipal Solid Waste Management in the United States:Waste Management Research. 22(4), 306-322.
- Meaza, C. (2016). Solid waste management in Addis Ababa. *A new approach to improving the waste management system*.
- Mekonnen, A. (2012). Development of Solid Waste Management Strategy for Hossana town .MA thesis, Addis Ababa University,.

- Melaku, T. (2008). Household Solid Waste Generation Rate and Physical Composition, In Jimma Town Ethiopia. A master thesis presented to the graduate studies Addis Ababa University, Addis Ababa Ethiopia.
- Mohammed, G. (2015). Assessing the current status of Solid Waste Management of Gondar Town, Ethiopia. *International journal of technology research*, 4(09).
- Mulumebet, W. (2018). Environmental and Health Impact of Solid Waste Disposal System in Addis Ababa City: A case Study of Yeka Sub City.
- Nguyen, Duc Luong et, al. (2013). Challenge for municipal solid waste management practices in Veitnam.
- Nigatu et al. (2011). Challenges and Opportunities in Municipal Solid Waste Management: The case of Addis Ababa City, Central Ethiopia. *Journal of human Ecology*, 33(3).
- Nshimiyimana. (2015). An assessment of Municipal Solid Waste Management Practices: Case study: Nyarugenge District, Rwanda.
- Ogwueleka, T. (2009). Municipal Solid Waste Characteristics and Management in Nigeria. *Iranian Journal of Environmental Health Science and Engineering*. 6(3), 173-180.
- Oso, & Onen, D. (2008). General guide to writing Research Proposal and Report, Nairobi: The Jomo Kenyatta foundation.
- Pervez, A., & Ahmade, K. (2013). Impact of solid waste on health and environment.
- Ramachandra. (2006). Management of Municipal Solid Waste Management. Capital Publishing Company, New Delhi.
- Rushbrook, P., & Pugh, M. (1999). Solid Waste Landfills in Middle and Lower-Income Countries: A technical Guide to Planning, Design and Operation. World Bank Technical Paper, Washington.
- Solomon et al. (2014). Municipal solid waste management in Debre Berhan city of Ethiopia. *Journal of Environmental and Earth Science*.
- Solomon, C. (2011). Assessment of solid waste management service in Dessie town.

- Tesfaye, W. (2015). Solid Waste Management Practice in Wayu Town, Jima Rare Woreda, Ethiopia.
- UNEP. (2013). Africa Environmental outlook, 3rd ed. United Nation Environmental Programme.
- Vandana et.al. (2017). A Review on Solid Waste Management Methods and Practices in India.
- Woodward, D. (1985). "Swords into ploughshares": Recycling in pre-industrial England the Economic History Review. 38(2), 175-191.
- World Bank. (2012). A Global Review of Solid Waste Management. Washington DC.
- World, Bank. (2018). What a waste 2.0 :A global snapshot of solid waste management to 2050.
- Worrell, W. A., & Vesilind, P. (2012). *Solid Waste Engineering: Cengage Learning* (2nd Edition ed.). Stamford.
- Wubshet, H. (2015). Investigation on the Engineering Properties of Soil found in Burayu Town.
- Yohanis, B., & Genemo, B. (2015). Assessement of solid waste management practices and the role of public participation in Jigjiga town, Somali Regional state, Ethiopia. *International journal of Environmental protection and policy*.
- Zebeay, K. (2010). The challenges of solid waste management in Urban areas, the case of Debreworkos Town, Addis Ababa University, Ethiopia.
- Zerihun, M. (2018). Assessment of Domestic Solid Waste Management in Burayu Town.
- Zurbrugg, C. (2009). Urban Solid Waste Management in Low-income Countries of Asia to cope with the garbage crisis. Presented for: Scientific Committee on problems the Environment (SCOPE) Urban Solid Waste Management. Review Session, Durban, South Africa, November 2002.

APPENDIX

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES COLLAGE OF NATURAL SCIENCE ZOOLOGY DEPARTMENT

QUESTIONNAIRE

Appendix 1: Form prepared for sample households in Burayu town

Dear respondent:

This questionnaire is ready as an instrument to conduct an educational analysis (research) for the fulfillment of Master of Science (M.Sc) by Tesfaye Alemu in Addis Ababa University Collage of Natural science, and Department of Zoological Sciences. The general objective of the study is to assess Municipal Solid Waste Management Practice in Burayu town. Therefore, the knowledge you may provide is extremely vital for the research hence you're kindly requested to forward your views and experiences as fastidiously as potential every of your answer has high contribution for the completeness of the thesis. Furthermore, the information you provide are used for only the academic research. The information that you simply provide me are unbroken confidential.

I agree to participate in this study

Thanks beforehand for your cooperation.

General Directions

- Please answer the questions by circle your most suitable option from the provided alternatives.
- Give your comments on the space provided for open-ended queries.
- There is not any would like of write name on the form.

Name of enumerator: _____

Name of Advisor: _____

Kebeles _____

I. Personal profile of the respondent

1. Sex of the household head A. Male B .Female

2. Age range A. 18-30 B.31-40 C.41-50 D.51-60 E.61-70 F. above 71

3. Kebeles_____
4. Level of education of respondent: A. No formal education B. Primary school C. Secondary School D. Diploma E. First-degree F. Second-degree G. PHD
5. House ownership condition: A. Kebeles rental house B. Non public Rental house C. Non public house
6. Duration of stay in the town: A. less than 2 years B.2-5 years C. 6-10 years D. Above 10 years
7. Respondent's marital status: A. Married B. Single C. Divorced D. Widowed/widower
8. What is an estimate of gross monthly financial gain of this family?
A. less than 500-birr B.500-1000 birr C. 1001-1500 birr D.1501-2000 birr
E. 2001-2500 birr F. 2501-3500 birr G.3501- 4500 birr H. more than4501
9. Family size of households? A. Less than or equal 2 B.3-5 C.6-8 D. More than 9

II. Form ready for investigating households' solid waste management awareness, and practice together with their attitude regarding municipal solid waste management of the town.

1. How often do you clean your house?
A. Each day B. With 2 days interval C. With 3 days interval D. With one week interval
E. If others please specify it might be_____
2. Do you have any waste storage receptacles in your home? A. Yes B. No
3. If yes question number 2, what is it made of?
A. Sack B. Basket C. Plastic bag ("festal) D. No storage E. Write if any_____
4. Do you practice separating waste materials at home? A. Yes B. No
5. If your answer for question no 5 is 'Yes', for what purpose do you separate those waste storage?
A. To reuse B. To sell/exchange C. To recycle D. To help waste collectors E. Other, specify

6. If your answer for question no 5 is 'No', what do you think the reason behind?
A. I didn't have the understanding about waste separation
B. I didn't think, as it is my responsibility
C. I didn't visualize the use of separation
D. Other, please specify it_____
7. How do evaluate the effort made by the municipality to provide efficient solid waste management service compared with other services of the town?
A. Very strong B. Strong C. Fair D. Weak E. Very weak

8. Do you pay for collection of waste from your home? A. Yes B. No
9. If 'Yes' for question 11, how much do you pay for the waste collectors services, indicate in birr per month? _____
10. Is solid waste disposing container available in your neighborhood? A. Yes B. No
11. If your answer for question no 12, is 'yes,' how far is container from your house?
A. 25-50 meters B. 51-100 meters C. 101-200 meters D. 201-500 meters E. other_____
12. Do you have access to door-to-door solid waste collection service delivered from the municipality solid waste collection vehicle? A. Yes B. No
13. If your answer for question no 14, is 'Yes,' in how many days interval you get this service? A. 1-3 days B. 4-7 days C. 8-15 days D. 16-30 days E. above 30 days F. as available
14. Types of disposal methods practiced in Burayu
A. Burying inside compound D. On nearby open fields and road areas
B. Burning inside compound E. into river courses or canals
C. Spreading inside compound F. Into municipal collection containers
15. Have you ever obtained training, education or information about problems created due to Carelessly thrown solid waste? A. Yes B. No
16. Does solid waste management service in your area is burning issue as it compared with other service like road service, water supply and electricity. A. Yes B. No C. If no why? _____
17. Do you know the rule and regulations of solid waste management of the town?
A. Yes B. No C. If no why? _____
18. Are there sanitation agents that make supervision and control on illegal dumping of solid waste on the streets, open areas, riverside's and other areas?
A. Yes B. No
19. How do see the services related to solid waste management in Burayu town?
A. Excellent B. Very good C. Good D. Fair E. Bad

III. Community as a key stakeholder

20. Do you know that you are among of the key stakeholders in enhancing the success in solid waste management in your community?
A. Yes, I know B. No, I do not know

21. If 'yes' in question no 24, what are your responsibilities?

22. Are those key stakeholders participating fully particularly in mobilization of community to participate in solid waste management? A. Yes B. No

23. If you have any additional comments, suggestions, or would like to elaborate on any of your previous answers _____

THANK YOU FOR YOUR PARTICIPATION!

Appendix 2: Questions for Focus Group Discussion

These questions are only prepared for the Municipality staff and health extension bureau

1. Are there rules and regulations of Solid Waste Management Practices in your town?
2. If exist how do you see its follow up by the responsible bodies in the town?
3. Have you ever penalized the violators of the rule and regulation when solid wastes are disposed illegally?
4. Is the private sector involved in waste management in this town?
6. Mention the types and total number of equipment that your town uses for collection and transportation of solid waste?
7. Is there any formal final disposal site for waste? If yes, where does it locate?
8. Is there the system of integrated waste management (reduce, reuse and recycling) practices in the town? If yes, by whom?
9. Are there any environmental problems in the town? If 'yes' what are the major environmental problems in the town? How their impact manifested in the town?
10. What are the common health problems of the dumping site?

THANK YOU VERY MUCH FOR YOUR TIME!

Appendix 3: Interview Questions Prepared for Head of SB Department of Burayu Town

Dear respondent this interview is conducted for an academic purpose for the fulfillment of M.Sc. degree in general Biology. Specifically the objective of the study is to assess municipal solid waste management practices in Burayu town. Therefore, the knowledge you may provide is extremely vital for the research hence you're kindly requested to forward your views and experiences as fastidiously as potential every of your answer has great value for the completeness of the thesis. Furthermore, the information you provide are used for only the academic research. The information that you simply provide me are unbroken confidential.

I agree to participate in this study: Tesfaye Alemu Welfena

1. How do you rate the services related to solid waste management in Burayu town?
2. Which approach is used for solid waste collection in Burayu town?
3. How many micro and small-scale enterprises are there in your town on SWM?
4. How frequently are wastes collected?
5. Which method of solid waste disposal practiced in Burayu town?
6. Do your collection, transportation and disposal services cover all parts of the town? If not covered, Specify the major reasons?
7. What are the problems associated with solid waste management in Burayu town?
8. How do you evaluate your institution status on interaction with other government and non-government organizations regarding MSWM of the town?
9. What is the level of awareness and attitude towards community participation in solid waste management?
10. What do you think should be done to improve the situation of MSWM of the town in general?

Thank you for your cooperation!

Appendix: 4: Interview questions prepared for sanitation and Beautification workers of Burayu town

Dear respondent this interview is conducted for an academic purpose for the fulfillment of M.Sc. degree in general Biology. Specifically the objective of the study is to assess municipal solid waste management practices in Burayu town. Therefore, the knowledge you may provide is extremely vital for the research hence you're kindly requested to forward your views and experiences as fastidiously as potential every of your answer has great value for the completeness of the thesis. Furthermore, the information you provide are used for only the academic research. The information that you simply provide me are unbroken confidential.

I agree to participate in this study: Tesfaye Alemu Welfena

Part one: Background information about the respondents

1. Job title in your department_____

2. Employment condition

A. Permanent B. Contract

3. Educational level: A. No formal education B. Primary school C. Secondary school

D. Diploma E. First-degree

4. Work experience_____

5. Monthly salary_____

6. Family size_____

Part two: Structured questions prepared for investigating MSWM System and capacity together with their attitude regarding households' solid waste management of the town.

1. Do you think the controlling mechanism of municipality is effective? If your answer is 'no', what is the reasons behind?

2. Are you provided with the medical care, safety wares and other materials that are necessary to keep your health?
3. Have you ever been participated in solid waste management trainings or education given at regional/national level?
4. Does your institution give incentives, promotions and salary increment to you?
5. If your answer for question number 3 and 4, is 'yes', how do you evaluate the level of training, education, incentives, promotions and salary increment opportunities offered to MSWM workers?
6. What do you think should be done to improve the situation of MSWM of the town in general?

Thank you very much!

Appendix 5: Household waste generation rate

Lower income Group				
Sample HH	Family size	Qty/HH/Week(kg)	Qty/HH/day(kg)	Generation rates of a group Qty/day/person(kg)
1	8	13.72	1.96	0.245
2	5	6.23	0.89	0.178
3	4	7.98	1.14	0.285
4	6	10.22	1.46	0.243
5	4	9.75	1.39	0.348
6	7	12.35	1.76	0.252
7	5	10.15	1.45	0.290
8	5	7.62	1.09	0.217
9	4	6.5	0.93	0.232
10	5	11.2	1.6	0.320
11	7	10.35	1.47	0.210
12	3	8.47	1.21	0.403
13	8	15.22	2.17	0.271
14	7	11.72	1.67	0.239
15	6	10.32	1.47	0.245
16	4	9.32	1.33	0.332
17	2	6.82	0.97	0.487
18	11	16.1	2.3	0.209
19	7	10.2	1.45	0.208
20	4	7.7	1.1	0.275
21	6	9.3	1.32	0.221
22	5	8.8	1.25	0.251
23	10	18.4	2.62	0.262
24	6	11.2	1.6	0.266
25	2	6.37	0.91	0.455

26	8	8.4	1.2	0.150
27	6	7.2	1.02	0.171
28	3	9.12	1.3	0.434
29	8	14.68	2.09	0.262
30	6	11.33	1.61	0.269
31	2	6.67	0.95	0.476
32	5	10.17	1.45	0.290
33	7	9.12	1.3	0.186
34	8	13.54	1.93	0.241
35	3	7.7	1.1	0.366
36	12	20.21	2.88	0.240
37	4	10.5	1.5	0.375
38	7	8.4	1.2	0.171
39	5	11.2	1.6	0.320
40	5	7.7	1.1	0.220
41	6	8.81	1.25	0.209
42	4	9.8	1.4	0.350
43	8	13.57	1.93	0.242
44	4	8.42	1.2	0.300
45	3	10.21	1.45	0.486
46	5	9.99	1.42	0.285
47	6	12.12	1.73	0.288
48	6	9.17	1.31	0.218
49	7	13.11	1.87	0.267
50	2	8.4	1.2	0.600
51	3	9.42	1.34	0.448
52	7	10.92	1.56	0.222
53	7	11.00	1.57	0.224
54	5	12.52	1.78	0.357
55	8	11.87	1.7	0.211

56	4	8.97	1.28	0.320
57	4	9.4	1.34	0.335
58	7	11.37	1.62	0.232
59	6	10.2	1.45	0.248
60	5	11.44	1.63	0.326
61	5	16.97	2.42	0.484
62	5	9.72	1.38	0.277
63	3	8.4	1.2	0.400
64	4	11.19	1.6	0.399
65	7	6.92	0.98	0.141
66	5	11.18	1.6	0.319
67	5	9.8	1.4	0.280
68	2	7.7	1.1	0.550
69	8	11.22	1.6	0.200
70	7	13.3	1.9	0.271
71	7	9.7	1.38	0.197
72	5	8.8	1.25	0.251
73	3	8.72	1.24	0.415
74	3	7.6	1.08	0.361
75	5	9.2	1.31	0.262
76	5	8.4	1.2	0.240
77	4	7.55	1.07	0.269
78	3	9.9	1.41	0.471
79	4	11.2	1.6	0.400
80	4	8.8	1.17	0.292
81	9	13.6	1.94	0.215
82	6	9.3	1.34	0.221
83	7	10.7	1.52	0.218
84	6	8.42	1.2	0.200
85	5	9.7	1.38	0.277

86	5	11.7	1.67	0.334
87	11	16.8	2.4	0.218
88	8	12.2	1.74	0.217
89	5	9.3	132	0.265
90	5	8.88	1.26	0.253
91	6	10.42	1.48	0.248
92	5	10.37	1.48	0.296
93	5	9.75	1.39	0.278
94	4	8.2	1.17	0.292
95	3	11.7	1.67	0.557
96	2	8.32	1.18	0.594
97	7	13.3	1.9	0.271
98	6	12.6	1.8	0.300
99	7	9.8	1.4	0.200
100	7	11.00	1.57	0.224
101	8	12.8	1.82	0.228
102	6	9.34	1.33	0.222
103	6	8.72	1.24	0.207
104	5	7.5	1.07	0.214
105	4	11.4	1.62	0.407
106	9	16.8	2.4	0.266
107	2	8.7	1.24	0.621
108	6	10.52	1.5	0.250
109	5	7.7	1.1	0.220
110	5	9.8	1.4	0.280
111	7	11.7	1.67	0.238
112	9	15.5	2.21	0.246
113	11	17.92	2.56	0.232
114	5	8.75	1.25	0.250
115	4	10.28	1.46	0.367

116	6	9.75	1.39	0.232
117	7	9.1	1.3	0.185
118	8	12.37	1.76	0.220
119	5	10.5	1.5	0.300
120	7	9.2	1.31	0.187
121	7	13.2	1.88	0.269
122	5	9.8	1.4	0.280
123	6	11.8	1.68	0.280
124	6	14	2.00	0.330
125	7	14	2.00	0.285
126	5	9.7	1.38	0.277
127	9	18.9	2.7	0.300
128	3	8.4	1.2	0.400
129	4	9.3	1.32	0.332
130	5	11.2	1.6	0.320
131	6	9.3	1.32	0.221
132	6	8.8	1.25	0.209
133	7	12.3	1.75	0.251
134	8	10.7	1.52	0.191
135	2	6.6	0.94	0.471
136	3	7.9	1.12	0.376
137	5	9.8	1.4	0.280
138	5	12.3	1.75	0.351
139	6	9.7	1.38	0.230
140	8	13.7	1.95	0.244
141	3	8.9	1.27	0.423
142	2	5.3	0.75	0.378
143	7	12.12	1.74	0.248
144	5	9.5	1.35	0.271
145	5	11.5	1.64	0.328

146	4	7.4	1.05	0.266
147	8	15.7	2.24	0.280
148	3	9.3	1.32	0.442
149	4	8.5	1.21	0.303
150	4	7.7	1.1	0.275
151	6	11.5	1.64	0.273
152	6	13.7	1.9	0.316
153	5	9.7	1.38	0.277
154	2	6.5	0.92	0.464
155	8	11.25	1.6	0.200
Total	860	1623.3	361.93	0.290

Middle income Group				
Sample HH	Family size	Qty/HH/Week(kg)	Qty/HH/day(kg)	Generation rate of group Qty/day/person(kg)
1	7	13.7	1.957	0.279
2	4	11.8	1.685	0.421
3	5	10.5	1.500	0.300
4	6	12.72	1.817	0.302
5	6	14.4	2.057	0.342
6	8	18.2	2.600	0.325
7	4	9.33	1.332	0.333
8	6	11.9	1.700	0.283
9	6	13.72	1.960	0.326
10	2	6.9	0.985	0.492
11	9	17.4	2.485	0.276
12	5	12.2	1.742	0.348
13	5	10.8	1.542	0.308
14	7	13.3	1.900	0.271

15	8	16.2	2.314	0.289
16	3	7.2	1.028	0.342
17	4	9.8	1.400	0.350
18	6	14.9	2.128	0.354
19	6	13.2	1.885	0.314
20	7	15.7	2.242	0.320
21	10	19.4	2.771	0.277
22	4	10.2	1.457	0.364
23	3	8.4	1.200	0.400
24	5	11.2	1.600	0.320
25	5	9.3	1.328	0.265
26	6	14.3	2.042	0.340
27	3	7.2	1.028	0.342
28	8	13.6	1.942	0.242
29	7	16.4	2.342	0.334
30	7	13.3	1.900	0.271
31	6	12.2	1.742	0.290
32	4	9.3	1.328	0.332
33	5	8.6	1.228	0.245
34	5	9.2	1.314	0.262
35	7	14.3	2.042	0.285
36	5	11.6	1.657	0.331
37	5	13.2	1.885	0.377
38	11	19.8	2.828	0.257
39	7	15.3	2.185	0.312
40	8	13.67	1.952	0.244
41	8	16.2	2.314	0.289
42	6	11.7	1.671	0.278
43	5	12.35	1.764	0.352
44	6	9.67	1.381	0.230

45	6	13.8	1.971	0.328
46	4	10.7	1.528	0.382
47	3	8.8	1.257	0.419
48	5	9.3	1.328	0.265
49	6	14.2	2.028	0.338
50	5	10.3	1.471	0.294
51	5	11.7	1.671	0.334
52	3	9.8	1.400	0.446
53	9	15.5	2.214	0.246
54	12	17.6	2.514	0.209
55	8	14.32	2.045	0.255
56	8	16.6	2.371	0.296
57	6	10.8	1.542	0.257
58	4	9.4	1.342	0.335
59	5	10.12	1.445	0.289
60	5	9.9	1.414	0.282
61	4	8.4	1.200	0.300
62	6	13.6	1.942	0.323
63	7	15.2	2.171	0.310
64	7	14.4	2.057	0.293
65	6	10.8	1.542	0.257
66	2	6.5	0.928	0.464
67	2	6.8	0.971	0.485
68	6	13.33	1.904	0.317
69	5	12.8	1.828	0.365
70	5	14.6	2.085	0.417
71	7	17.2	2.457	0.351
72	8	19.6	2.800	0.350
73	4	10.3	1.471	0.367
74	3	9.3	1.328	0.442

75	4	8.4	1.200	0.300
76	4	6.5	0.928	0.232
77	6	11.4	1.628	0.271
78	5	8.6	1.228	0.245
79	7	15.3	2.185	0.312
80	7	11.2	1.600	0.228
81	8	17.6	2.514	0.314
82	8	12.8	1.828	0.228
83	4	9.7	1.385	0.346
84	4	13.2	1.885	0.471
85	3	8.8	1.257	0.419
86	10	13.9	1.985	0.198
87	5	10.28	1.468	0.293
88	6	14.2	2.028	0.338
89	6	13.8	1.971	0.328
90	7	16.2	2.314	0.330
91	4	8.7	1.242	0.310
92	4	10.5	1.500	0.375
93	4	9.6	1.371	0.342
94	3	8.5	1.214	0.404
95	7	18.4	2.628	0.375
96	6	15.3	2.185	0.364
97	8	17.3	2.471	0.308
98	5	14.8	2.114	0.422
99	5	11.52	1.645	0.329
100	7	11.5	1.642	0.234
101	4	13.6	1.942	0.485
102	5	10.92	1.560	0.312
103	5	14.8	2.114	0.422
104	8	19.7	2.814	0.351

105	6	16.1	2.300	0.383
106	2	6.82	0.974	0.487
107	7	12.95	1.850	0.264
108	6	13.7	1.957	0.326
109	8	16.9	2.414	0.301
110	4	9.48	1.354	0.338
111	4	11.6	1.657	0.414
112	3	8.75	1.250	0.416
113	6	10.92	1.560	0.260
114	6	13.2	1.885	0.314
115	11	18.6	2.657	0.241
116	5	10.17	1.452	0.290
117	4	9.15	1.307	0.326
118	3	8.6	1.228	0.409
119	8	19.2	2.742	0.342
120	7	12.95	1.850	0.264
121	7	17.5	2.500	0.357
122	5	9.5	1.357	0.271
123	5	10.38	1.482	0.296
124	6	13.8	1.971	0.328
125	7	15.4	2.200	0.314
126	6	13.8	1.971	0.328
127	4	9.9	1.414	0.353
128	6	10.65	1.521	0.253
129	5	13.6	1.942	0.388
130	5	16.32	2.331	0.466
131	6	14.8	2.114	0.352
132	9	18.9	2.700	0.300
Total	756	1660.59	237.17	0.326

Higher income Group				
Sample HH	Family size	Qty/HH/week(kg)	Qty/HH/day(kg)	Generation rate of group Qty/day/person (kg)
1	6	15.8	2.257	0.376
2	8	19.4	2.771	0.346
3	8	13.4	1.914	0.239
4	9	20.5	2.928	0.325
5	7	14.3	2.042	0.291
6	5	15.2	2.171	0.434
7	6	12.92	1.845	0.307
8	12	17.95	2.564	0.216
9	8	16.5	2.357	0.294
10	7	13.4	1.914	0.273
11	7	10.85	1.55	0.221
12	2	12.3	1.757	0.878
13	6	14.2	2.028	0.338
14	6	11.3	1.614	0.269
15	4	10.4	1.485	0.371
16	5	9.8	1.400	0.280
17	5	12.85	1.835	0.367
18	2	9.7	1.385	0.692
19	11	17.5	2.500	0.227
20	7	13.27	1.895	0.270
21	6	14.44	2.062	0.343
22	7	16.8	2.400	0.342
23	8	15.75	2.250	0.281
24	8	19.3	2.757	0.344
25	6	12.8	1.828	0.304
26	5	10.34	1.477	0.295
27	12	18.6	2.657	0.162

28	9	15.72	2.245	0.249
29	8	13.7	1.957	0.244
30	6	10.62	1.517	0.252
31	2	10.2	1.457	0.728
32	5	13.33	1.904	0.380
33	4	10.2	1.457	0.364
34	4	9.84	1.405	0.351
35	8	17.78	2.540	0.317
36	7	13.6	1.942	0.277
37	7	14.3	2.042	0.291
38	5	11.95	1.707	0.341
39	8	20.8	2.971	0.371
40	8	18.62	2.660	0.332
41	10	21.6	3.085	0.308
42	11	17.95	2.546	0.233
43	7	12.8	1.828	0.261
44	2	10.63	1.518	0.759
45	8	13.99	1.998	0.249
46	6	14.75	2.107	0.351
47	6	10.18	1.454	0.242
48	7	12.88	1.840	0.262
49	10	20.77	2.967	0.296
50	9	16.08	2.297	0.255
51	4	12.32	1.760	0.440
52	6	10.66	1.522	0.253
53	4	11.6	1.657	0.414
54	6	14.32	2.045	0.340
55	7	17.62	2.517	0.359
56	7	14.75	2.107	0.301
57	9	19.87	2.838	0.315

58	8	13.7	1.957	0.244
59	8	15.5	2.214	0.276
60	7	12.85	1.835	0.262
61	6	9.97	1.424	0.273
62	7	12.99	1.855	0.265
63	9	16.6	2.371	0.263
64	4	13.25	1.892	0.473
65	5	11.28	1.685	0.337
66	5	15.6	2.228	0.445
67	8	19.7	2.814	0.351
68	7	14.85	2.121	0.303
69	6	13.08	1.868	0.311
70	7	10.8	1.542	0.220
71	8	8.9	1.271	0.158
72	8	14.6	2.085	0.260
73	9	20.09	2.870	0.318
74	7	17.5	2.500	0.357
75	6	13.65	1.950	0.325
76	7	10.85	1.550	0.221
77	7	11.55	1.650	0.235
78	11	21.75	3.107	0.282
79	8	20.65	2.950	0.368
80	6	11.5	1.642	0.273
81	8	16.88	2.411	0.301
82	7	17.22	2.460	0.351
83	6	14.3	2.042	0.340
Total	568	1202.61	171.845	0.333

Source: Sample from Burayu Household

Appendix 6: Photo from field survey



