

**POLICY RESPONSES TO URBAN ENVIRONMENTAL PROBLEMS: THE
CASE OF SOLID AND LIQUID WASTE MANAGEMENT IN THE MAJOR
URBAN CENTRES OF TIGRAY NATIONAL REGIONAL STATE**

By

GEBRETSADKAN GEBREMICHAEL BERHE

(Student number: 45883688)

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SUPERVISOR: SOLOMON MULUGETA (PhD)

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DECLARATION

Name: **GEBRETSADKAN GEBREMICHAEL BERHE**
Student number: **45883688**
Degree: **DOCTOR OF PHILOSOPHY IN ENVIRONMENTAL MANAGEMENT**

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I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

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Abstract

The highly accelerated rates of growth that the cities and towns of the Tigray National Regional State witnessed in the recent past has been followed by a growing problem of urban and peri-urban environmental degradation in the region. Environmental deterioration owing to poor waste management does not only adversely affect human health and wellbeing but also tends to hold back the rates of growth of the urban and regional economy. The main purpose of this research has, therefore, been to examine the extent to which urban environmental problems in general and shortcomings in waste management issues in particular have achieved commensurate policy responses from regional and local authorities as the threats they posed to good living and working conditions intensified over the decades. In short, the status of environmental considerations at policy level and their implementation strategies and degree of execution at the grassroots level has been thoroughly assessed in this study. To this end, the researcher has primarily defined his research philosophy and approach as pragmatism and mixed methods, respectively. The convergence model of a mixed methods triangulation design has been used. He employed semi-structured questionnaire, in-depth interview and observation as instruments of primary data collection. Household heads, personnel and decision makers were basic sources of data. Multi-stage sampling techniques were used to select sample units that involve both probability and non-probability sampling techniques. The researcher used descriptive statistical techniques and thematic content analysis techniques supported by SPSS and Atlas ti Programs to analyze the primary data. The main findings of the study revealed in many ways that urban liquid waste and solid waste management practices in the Tigray National Regional State is woefully far from adequate. The main indicators of the markedly low level of development of the region's municipal waste management services include lack of appropriate liquid waste collection and treatment systems; limited access to and substandard private and public toilet services; lack of and poor management of liquid waste dumping sites; poor solid waste collection service delivery; very low collection coverage, and poorly managed landfills. The study has also shown that the responses of the region's policy makers to such unquestionably severe problems are not worth mentioning. Nothing shows this better than the fact that the region has no municipal waste management policy. The other major weakness of the policy makers in this regard is their irresponsiveness to the deficient institutional capacities of the sector as a whole. What is more, despite its strategic importance, the 4Rs principle, as waste management approach, has also been overlooked by the local and regional administration. Accordingly, the researcher recommends that the government should work aggressively on implementing the 4Rs approach and strengthen the institutional and financial and material capacity of the relevant public institutions and MSEs involved in waste management activities.

Key terms: *Waste, waste characteristics, waste collection service, spatial disparities, on-site waste handling, waste management approach, policy responses.*

List of Abbreviations and Acronyms

BPR = Business Process Re-engineering

BUDIT = Bureau of Urban Development, Industry and Trade

CH₄ = Methane

CO = Carbon monoxide

CO₂ = Biogenic Carbon dioxide

CSA = Central Statistical Agency

ECSU = Ethiopian Civil Service University

EFY = Ethiopian Fiscal Year

EPRDF = Ethiopian Peoples Revolutionary Democratic Front

FA = Factor Analysis

FDRE = The Federal Democratic Republic of Ethiopia

GDP = Gross Domestic Product

GER = Gross Enrolment Rate

GHG = Green House Gases

GNI = Gross National Product

HDI = Human Development Index

IWMS = Integrated Waste Management System

KMO = Kaiser-Meyer- Olkin

MDG = Millennium Development Goal

MSEs = Micro and Small Enterprises

MSW = Municipal Solid Waste

MSWM = Municipal Solid Waste Management

MUDC-USBB = Ministry of Urban Development and Construction, Urban Sanitation and
Beautification Bureau

MUDHCo = Ministry of Urban Development, Housing and Construction

N₂O = Nitrous oxides

NER = Net Enrolment Rate

NMVOCs = Non- methane Volatile Organic Compounds

PCA = Principal Component Analysis

SBD = Sanitation and Beautification Department

SW = Solid Waste

SWM = Solid Waste Management

TPLF = Tigray People Liberation Front

TS = Transfer Station

VT = Vacuum Truck

Table of Contents

page

Acknowledgements	i
DECLARATION	ii
Abstract.....	iii
List of Abbreviations and Acronyms	iv
Table of Contents	vi
List of Tables.....	ix
List of figures.....	x
List of Boxes.....	xi
Chapter One: Introduction.....	1
1.1. Background of the Study	1
1.2. Statement of the Problem	5
1.3. Research Objectives.....	10
1.3.1. General Objective	10
1.3.2. Specific Objectives.....	11
1.4. Research Questions.....	11
1.5. Research Methodology.....	12
1.5.1 Research Design.....	12
1.5.2 Research Methods	15
1.6. Personal Motivation to Undertake the Study.....	18
1.7. Significance of the Study.....	19
1.8. Scope of the Study	21
1.9. Limitation of the Study	22
1.10. Organization of the Paper	22

Chapter Two: Literature Review	24
2.1. Urbanization and its Environmental Implication.....	24
2.2. Waste Management.....	31
2.2.1. Introduction: Definition and Classification of Waste.....	31
2.2.2. Solid Waste Management.....	34
2.2.3. Liquid Waste Management.....	54
2.3. Urban Environmental Management.....	62
2.4. Environmental Policy	67
2.4.1. What are the Implications for Policy?.....	67
2.4.2. Environmental Policy Instrument	74
2.5. Environmental Governance	77
2.6. Waste Management Approaches.....	80
2.6.1. Community Participation in Waste Management	80
2.6.2. Waste Hierarchy: 4Rs.....	82
2.7. Brief Review of Related Research Works	92
2.8. Conceptual Framework	97
Chapter Three: Research Methodology	103
3.1. Background of the Study Area.....	103
3.1.1. Physical Background	103
3.1. 2. Socio-economic Background.....	105
3.1.3. Waste Management Institutional Framework	113
3.2. Research Philosophy and Methodology (Overview).....	115
3.3. The Researcher’s Philosophical Position and Methodology.....	121
3.4. Research Methods	126
3.4.1. The Nature and Sources of Data	126

3.4.2. Primary Data Collection Instruments and Procedures	127
3.4.3. Sample Design: Sample Size and Sampling Techniques.....	135
3.4.4. Data Analysis	141
3.5. Trustworthiness of the Research	149
3.6. Ethical Consideration	152
Chapter Four: Results and Discussion	155
4.1. Background of the Respondents.....	155
4.2. Waste Collection and Disposal Services	160
4.2.1. Principal Components Determination.....	160
4.2.2. Liquid Waste Management: Component I.....	173
4.2.3. Solid Waste Management: Component II.....	222
4.2.4. Spatial Disparity in Waste Management Service	290
4.3. On-site Waste Handling Practices of Residents.....	295
4.3.1. On-site Solid Waste Handling	296
4.3.2. On-site Liquid Waste Handling.....	303
4.4. Waste Management Policy Document.....	326
4.5. Institutional Framework of the Waste Management Sector	339
4.6. Waste Management Approaches.....	357
Chapter Five: Summary, Conclusion and Recommendations	380
5.1. Summary.....	380
5.2. Conclusion	383
5.3. Recommendations	392
References	397
Annex I: Questionnaire.....	415
Annex II: In-depth Interview Questions.....	438

List of Tables	Page
TABLE 1: TRENDS IN SELECTED ECONOMIC INDICATORS (PERCENTAGE GROWTH RATES).....	109
TABLE 2: GROSS AND NET ENROLMENT RATES IN ALL GRADE LEVELS (GRADE1-8, 9-10, AND 11-12) IN 2000, 2004, AND 2008 E.C.	110
TABLE 3: SELECTION OF KEY INFORMANTS.....	138
TABLE 4: HOUSEHOLD HEADS' SEX DISTRIBUTION.....	156
TABLE 5: EDUCATIONAL STATUS OF HOUSEHOLD'S HEAD	157
TABLE 6: POPULATION 5 YEARS OLD AND OLDER BY SCHOOL ATTENDANCE AND SEX (%), 2007	158
TABLE 7: HOUSEHOLD SIZE AND OCCUPANTS PER HOUSING UNITS.....	159
TABLE 8: SYNTAX OF THE OUTPUTS OF FA/PCA	165
TABLE 9: OUTPUTS OF THE PRINCIPAL COMPONENT ANALYSIS.....	165
TABLE 10: THE EXTENT OF LIQUID WASTE MANAGEMENT PROBLEMS IN THE STUDY AREAS	175
TABLE 11: PEOPLE'S PERCEPTION AS REGARDS THE AVAILABILITY OF SEWER SYSTEMS IN THE STUDY AREAS..	177
TABLE 12: CAUSES OF HIGH LIQUID WASTE MANAGEMENT PROBLEM.....	177
TABLE 13: THE MAIN CAUSES OF LIQUID WASTE MANAGEMENT PROBLEM IN THE STUDY AREAS	179
TABLE 14: THE MAIN CAUSES OF LIQUID WASTE MANAGEMENT PROBLEM AND THEIR STATUS	183
TABLE 15: THE PROBLEM OF SPILLING OVER OF SEPTIC TANKS OR TOILETS	187
TABLE 16: THE TYPES OF PROBLEMS ASSOCIATED WITH SEPTIC SUCTION TRUCKS IN THE STUDY AREAS.....	192
TABLE 17: THE NECESSITY OF THE PUBLIC TOILET SERVICES IN THE STUDY AREAS.....	210
TABLE 18: BASIC FEATURES OF THE PUBLIC TOILETS IN THE STUDY AREAS	212
TABLE 19: ESTIMATION OF SOLID WASTE GENERATION IN THE STUDY AREAS, 2004-2009 FYE	228
TABLE 20: WASTE COLLECTION COVERAGE IN THE STUDY AREAS, 2004-2009 FYE.....	238
TABLE 21: THE BASIC FEATURES OF THE KERBSIDE COLLECTION SERVICES PROVISION IN THE STUDY AREAS .	240
TABLE 22: AVAILABILITY OF COMPLAINT HEARING SYSTEM.....	244
TABLE 23: DISPARITIES AMONG NEIGHBORHOODS IN WASTE COLLECTION AND REGULATING SERVICES IN THE STUDY AREAS.....	293
TABLE 24: ON-SITE SOLID WASTE HANDLING PRACTICES OF RESIDENTS	298
TABLE 25: ASSOCIATION BETWEEN COLLECTION PROGRAM CANCELLATION AND DROPPING OF LITTERS SOMEWHERE ILLEGALLY.....	299
TABLE 26: BASIC PROBLEMS LINKED WITH ON-SITE LIQUID WASTE HANDLING OF RESIDENTS IN THE STUDY AREAS.....	305
TABLE 27: CAUSES FOR OPEN-TOILET PRACTICES BY RESIDENTS IN THE STUDY AREAS	310
TABLE 28: BUDGET ALLOCATED TO WASTE MANAGEMENT SECTOR IN MEKELLE, 2007-2009 EFY (2014/15- 2016/17).....	355

List of figures

Page

FIGURE 1: SIMPLIFIED DIAGRAM SHOWING THE INTERRELATIONSHIPS OF THE FUNCTIONAL ELEMENTS IN A SOLID WASTE MANAGEMENT SYSTEM	42
FIGURE 2: CONCEPTUAL FRAMEWORKS OF THE POLICY RESPONSES (DESIGNED BY THE RESEARCHER).....	99
FIGURE 3: MAP OF ETHIOPIA AND ITS INTERNATIONAL BOUNDARY (UPPER LEFT), NATIONAL REGIONAL STATES OF ETHIOPIA (LOWER LEFT), AND TIGRAY NATIONAL REGIONAL STATE (UPPER RIGHT).....	104
FIGURE 4: THE MAJOR TOWNS OF TIGRAY NATIONAL REGIONAL STATE WITH A POPULATION GREATER THAN 20,000	107
FIGURE 5: SCREE PLOT	168
FIGURE 6: LIQUID WASTE EXPLODING FROM THE SEPTIC TANK IN CONDOMINIUM HOUSES, NEAR REGIONAL ADMINISTRATION OFFICE, MEKELLE CITY	188
FIGURE 7: SPILL OVER OF SEPTIC TANK IN <i>KEBELES</i> 18, MEKELLE CITY	189
FIGURE 8: SEWAGE DRAINING INTO A GRAZING LAND OF A COMMUNITY.....	190
FIGURE 9: SLEDGE DRYING UP TO BE CONVERTED TO FERTILIZER IN THE DRYING BED	203
FIGURE 10: DISCHARGE FLOWING OUT FROM THE DRYING BED TOWARDS THE ROMANAT RIVER CROSSING THE FARMLANDS.....	204
FIGURE 11: COLLECTION TRUCKS UNLOADING WASTES IN MEKELLE LANDFILL.....	236
FIGURE 12: PUBLIC CONTAINERS LEFT UNCOLLECTED FOR INDEFINITE TIME LENGTH, SITED IN MAY DUBBA TRANSFER STATION, MEKELLE CITY	251
FIGURE 13: THE OLD DUMP SITE OF ADIGRAT TOWN LEFT WITH NO PROPER CLOSURE	278
FIGURE 14: AN INTERVIEW WITH THE LANDFILL MANAGER.....	280
FIGURE 15: RAG-PICKERS VISITING THE LANDFILL OF MEKELLE.....	281
FIGURE 16: LOADERS LEVELING THE HEAPS OF WASTE IN THE LANDFILL OF MEKELLE CITY.....	281
FIGURE 17: WASTE HIERARCHY, ADAPTED FROM K. FERRARI, R. GAMBERINI AND B. RIMINI, 2016	374

List of Boxes	Page
Box 1. OUTPUT: LIQUID WASTE COLLECTION SERVICES.....	196
Box 2. OUTPUT: LIQUID WASTE DUMPING	206
Box 3. OUTPUT: PUBLIC TOILETS	216
Box 4. OUTPUT: SOLID WASTE CHARACTERISTICS.....	230
Box 5. OUTPUT: SOLID WASTE COLLECTION SERVICES.....	253
Box 6. OUTPUT: LANDFILL.....	283
Box 7. OUTPUT: ON-SITE WASTE HANDLING.....	312
Box 8. OUTPUT: WASTE POLICY DOCUMENT	333
Box 9. OUTPUT: INSTITUTIONAL CAPACITY.....	341
Box 10. OUTPUT: WASTE MANAGEMENT APPROACH	363

Chapter One: Introduction

1.1. Background of the Study

By definition, urbanization refers to the process by which rural areas become urbanized as a result of economic development and industrialization. Demographically, the term urbanization denotes the redistribution of populations from rural to urban settlements over time. However, it is important to acknowledge that the criteria for defining what is urban may vary from country to country (Cockab, 2011).

In the past half a century, urbanization has been the main demographic feature in the whole world due to a great rural-urban migration. This has created high concentration of people and diverse socio-economic activities in the urban areas that continued to take place until the 21st century (Ichimura, 2003). Today, mainly due to rapid rural-urban migration, world urbanization level and the number and size of world's largest cities have unprecedentedly increased. According to the world urbanization prospects, the size of world urban population has surpassed the world rural population in 2007, which is the first time in the history of humankind. Henceforth, the world population has become predominantly urban, and it is predicted to continue in all regions in the future, wherein, 62 % and 66% of the world's population will live in 2020 and 2050, respectively (Un, 2015). Particularly, in the 21st century, developing countries are experiencing rapid urbanization with a high concentration of people in the urban areas where Africa and Asia are urbanizing faster than the rest. Most of the world's fastest growing medium and small-sized cities of Asia and Africa are the world's fastest growing urban areas (Özden & Enwere, 2012). The magnitude of the urban population growth in the developing countries could mirror the extent how people, industries, commerce, vehicles, energy and water consumption, waste generation, and other environmental problems have been concentrated (Williams, 2000).

It is, therefore, necessary to recognize the fact that urbanization has been and will be an inevitable demographic feature of the world in general and developing countries in particular. Besides, it is well recognized that urbanization could have positive effects on socio-economic condition of the people of the local area, region or country. urbanization is

more often than not accompanied by more benefits like better income, literacy, quality of life, etc. Conversely, the negative effects of urbanization, though usually not adequately and properly understood by the commons and even the decision makers, is extremely high particularly in the developing countries' cities. Despite all these positive impacts, almost all major cities of the developing region are increasingly plagued by environmental problems. Along with benefits, environmental and social ills have come to prevail. The rapid rate of urbanization and development has led to increasing environmental degradation. The environment in most cities in the developing countries is deteriorating rapidly, faster than the ability of the cities to solve them (Ichimura, 2003). Such urban environmental degradation has been one of the greatest challenges of the present century, which is largely attributed to rapid urbanization. Cities are, therefore, both engines of socio-economic growth and causes of intense environmental problems (Bartone, et al, 1994).

Urban environmental problems are apparent in a number of ways particularly in and around the cities in developing countries. A significant number of urban residents suffer to a greater or lesser extent from harsh environmental health challenges linked with inadequate sewerage facilities, and insufficient solid waste disposal. City dwellers are being faced with various problems of urban environment such as such discharge of pollutants and generation of wastes (solid/liquid/gaseous) causing many negative impacts on the lives of the residents and the rural community that reside around the urban areas (Choosuk, 2014).

Enormous amount of waste is generated daily and its management is a huge task. One of the big challenges that today's growing cities are trying to cope with is the delivery of effective and sustainable waste management together with a good sanitation. Hence, improving public sanitation has been one of the major urban environmental challenges that need immediate attention in almost all cities of the developing countries. Failure to collect garbage as well as inadequate waste management and recycling policies and practices mean that cities are being inundated in their own waste. In African cities, waste management has been described as a monster that has aborted most efforts made by city authorities, state and federal governments and professionals alike (Cohen, 2006).

Wastes generated from all sources are significantly damaging water resources used for drinking, irrigation, recreation and so on in both rural and urban settlements (Syed, 2006). Solid wastes inappropriately handled and left anywhere uncollected can have severe health consequences. They block drainage systems and contaminate groundwater at landfill sites. In tandem with rapid urbanization, economic growth, industrialization, and increase in living standard and consumerism, the magnitude of waste generation in urban areas continue to increase worldwide, and have reached unmanageable levels in many localities particularly in developing countries (Ichimura, 2003). Wastes generated from all sources but left uncollected are significantly damaging water resources used for drinking, irrigation, and recreation and so on in both rural and urban settlements (Syed, 2006). It has been evident that parallel to urbanization, rapid population growth, industrialization and consumerism, waste generation has been increasing. This problem has become one of the primary urban environmental issues.

Municipal Solid Waste Management is an issue of great concern to urban governance in most developing and transitional economies. This is because of the effects of solid waste on environmental health of most developing countries especially in Africa (Addaney & Oppong, 2015). The environmental and health implications of waste are mounting in urgency particularly in developing countries (Marshall & Farahbakhsh, 2013). Waste management has been vital in every human society (Shekdar, 2009). Similarly, the volume of liquid waste generated from all streams, and their impacts will continue to increase parallel to population growth, urbanization, economic development, and improvement in living standards and change in life style of the people (Hanjra, et al., 2012).

While attempting to accelerate the pace of their socio-economic development, more likely due to the growth-first view, developing countries have failed to pay adequate attention to their waste management; they have been overlooked. Such failures incur them immeasurable costs in the form of unnecessarily lose of resources and a staggering adverse impact on the environment and on public health and safety. The costs are neither avoided nor minimized by the delayed efforts or decisions delayed till the country gets the capacity to take appropriate measures.

In turn, the dysfunctional urban environments have brought with them high costs that have undermined the benefits of economic growth and development needed to improve the living standards of urban populations (Mpofu, 2013).

Environmental imprints of cities also extend much beyond their urban border; cities have an extraordinary impact on the neighbouring rural, regional and global ecosystems (Poredoš, 2011). Many cities also cause serious environmental degradation to their surroundings and increasingly contribute to global warming (Mpofu, 2013). In other words, the impact of urbanization is not limited to only local environments but could also have large 'ecological footprints' that extend beyond their immediate vicinity. With good planning and governance, however, the increasing concentration of people in urban settlements can facilitate economic and social development, while also offering opportunities to mitigate the adverse impact of consumption and production goods on the environment (UN, 2015).

Therefore, stringent environmental policy and strategy is needed in order to reverse the deteriorating urban environment but it should not be at the expense of the economic development. Today, the major aim and, of course, the claim of most cities in the world is to be sustainable.

In order to ensure sustainability and conservation of natural resources, waste management practices are transitioning towards more sustainable options by reducing untreated waste disposal which involves preventing of production, separating of waste at sources, reusing of waste, recycling/composting of waste and intensive thermal recovering (Chisadza, 2015).

To reverse urban environmental degradation in most developing countries, it is indispensable to recognize and identify the factors that have been responsible for the lack of suitable preventive and curative environmental actions. By and large, urban environmental problems may come about owing to deficient institutions, improper and insufficient policies and improper actions (lack of actions) of the public and private actors.

Waste management specifically needs urgent attention in most cities. Any future development endeavours should include wide-ranging waste management policy frameworks and plans that bear in mind all aspects of waste management including the physical, technical, legal, institutional, financial, environmental, and socio-cultural aspects. In most cities, the importance of institutional strength and sound management practices are highly recognized with the intention of expanded waste collection service coverage for low-income communities, efficient service delivery, and environmentally friendly disposal operations (Bartone, et al., 1994; Ichimura, 2003).

1.2. Statement of the Problem

The environmental problems prevailing in the urban and vicinity areas have been one of the greatest challenges of urban areas and the countries in the present century. The environment in most cities in the developing countries is deteriorating rapidly, faster than the ability of the cities to solve them (Ichimura, 2003). Such environmental degradation of the urban areas is mainly attributed to rapid urbanization. The rapid rate of urbanization and development has led to increasing environmental degradation. Africa and Asia are the two huge continents urbanizing faster than the other regions where their urban population are projected to account for 56 and 64 per cent, respectively, by 2050. The medium-sized cities and cities with less than one million inhabitants located in Africa and Asia are the fastest growing urban agglomerations (Un, 2015). The high speed and level of urban transformation and the increased concentration of population, production and consumption has presented alarming urban challenges particularly in the Sub-Saharan African countries (Mpofu, 2013).

Different literature have tried to show the interaction between urbanization and environmental problems (and more specifically, waste management problems) negatively or positively or both ways. For instance, Bartone, et al. (1994) has indicated that cities are both engines of socio-economic growth and causes of intense environmental problems. Urbanization is an irreversible process, and it may be the best solution for the future and the only way to deal with the massive population increase (Cohen, 2006).

The rapid urban growth prevailing in most of the developing countries' cities has seriously outstripped their capacity to provide adequate services to their residents of which waste collection and disposal services are vital. The environment in most cities in the developing countries is particularly deteriorating rapidly, faster than the ability of the cities to solve them (Ichimura, 2003). The scale of the problem of waste is also beyond the assimilative capacity of nature. And it is more likely that these problems grow with city size (Williams, 2000).

Similarly, Ethiopia, as typical Sub-Sahara African country, is characterized by low level of urbanization but high rate of urbanization. Recent studies on urbanization in Ethiopia have remind that higher population growth rate (5.4%) in urban areas would result in a higher level of urbanization within a relatively short period (Tsutsumi & Bendewald, 2010).

The official Statistical Office of the country indicated that the proportion of urban population of the country as a whole has increased significantly. In 2016, nearly 19.8% of the population of Ethiopia was residing in urban areas, which is far below the level of urbanization of the developing countries. In the same year, the urban population of the Tigray National Regional State accounted for over 25.8 % of its total population.

As compared to other regions of the country, with nearly 26% percent of urbanization, Tigray is next highest only to the Harari and Gambela National Regional States in its level of urbanization¹. Mekelle City, the regional capital, inhabited by 340,858 residents in 2016, which accounts for about 25.6 percent of the regional urban population, is one of the largest cities of the country. Adigrat is the second largest town in the region with a population greater than 90, 658 in the same year (Ethiopia, 2008). Totally, both Mekelle and Adigrat, which are the study areas of the researcher, hold over 32 percent of the urban population of the region. Tigray in general has been and still is experiencing a highly accelerated rate of urban growth (4.5% per year since 1994) (Ethiopia, 2008).

¹ *The Harari National Regional State was originally a city just like the special urban administrative regions of Addis Ababa and Dire Adwa; whereas the Gambela National Regional State has very low total population. According to the latest census results, it has only 16.5 percent of the total population of Ethiopia who are living in urban areas at present.*

The accelerated urban growth accompanied by multiplication of a large variety of business establishments, public and private vehicles and construction works, and the significant change in the living condition and life style, mainly of the urban residents, have significantly impacted the quality of the cities and towns of the region by deteriorating the environmental quality as the quantity and composition of waste generated is steadily increasing.

The mounting volume of waste attributed to changes in population and consumption patterns is bringing a very difficult challenge to all. The wastes produced in the urban areas of the region have been changed significantly both quantitatively and qualitatively. The volume of waste produced and the per capita waste generation rate is increasing.

Undoubtedly, the above mentioned developments in Tigray would have not been achieved without jeopardizing the quality of the urban environment of the region. The damage on the urban environment primarily due to accelerated population growth usually comes from diverse sources. For instance, the health threats that come from the discharge of harmful effluents by industrial plants, households and business establishments into storm drainage channels, natural water courses and open spaces would tend to grow with growing urban population. What is more, the heaps of solid wastes left uncollected in open areas and along water courses in residential neighbourhoods as well as working areas have brought a harmful impacts on the urban population of the Tigray. Moreover, the foul smell coming out from the open storm drainages and garbage containers placed in the transfer stations has been creating severe problems on the health and wellbeing of the urban population of Tigray just like those of the rest of the urban centres of Ethiopia. Therefore, urbanization can be seen as a good engine for socio-economic development, innovation, and employment creation, yet a number of challenges could come about associated with it, most of which are directly manifested within the sphere of urban environment (Mpfu, 2013).

Despite the vital roles of cities in socioeconomic development, urban areas are not playing their socioeconomic roles as they are expected (Decker, 2001). This is because the development potential of cities is all too often crippled by environmental deterioration". He

adds, aside from its obvious effects on human health and wellbeing, especially of the poor, environmental degradation directly holds back economic development. Even though the cities and towns of the Tigray National Regional State are currently faced with serious environmental problems, it seems that, like in many other developing countries, urban environment is not given the attention it deserves by the local and regional governments. If the concentration of population, industries, and other environmentally unfriendly establishments is allowed to take place without paying adequate attention to the harmful consequences that such rapid developments could have for human welfare, the researcher argues that the problem will soon reach a level where it would be extremely difficult to reverse by the capacity of either the municipal or regional authorities.

The basic causes of many urban environmental problems are believed to be poor environmental (specifically waste) management and planning and absence of coherent urban policy rather than urbanization itself. This means that environmental problems are not properly and adequately integrated into the socio-economic development plans of the urban areas. The inappropriate outlook, such as the 'growth-first' strategy, adopted by governments of many countries of the developing region is a critical problem (Ichimura, 2003). In other words, environmental problems in general and waste management problems of the urban areas mainly in developing countries like in Ethiopia-Tigray Regional State are not priority issues. Besides, developing countries' strong aspiration to ensure increasing economic development tends to make worse such problems which may exceed the preventive and curative capacity of the government as well as the assimilative capacity of nature (Williams, 2000). Therefore, for urban areas to be successful, they ought to balance their social, economic and environmental needs. By so doing, it would be possible to bring sustainable urban development. Ensuring sustainable urban development should not be a matter of choice but it should be something of necessity if cities are to meet the needs of their citizens (Alliance, 2007).

Despite the scanty literature available on the area, the researcher has tried to review certain research papers and thesis focusing on related topics in Ethiopia. All the papers focus only on solid waste management, and tried to examine the solid waste management practices and causes of the management problems. One of these papers was entitled

'Assessment of Solid Waste Management Practices and the Role of Public Participation in Jigjiga Town, Somali Regional State, Ethiopia' prepared by (Birhanu & Berisa, 2015). The purpose of the study was to analyze the town's current municipal solid waste management problems, opportunities and existing solid waste management practices and role of community participation. The study has discovered that there is low performance of solid waste management unit in Jigjiga town mainly due to problems linked with poor collection system, poor condition of dumping sites, insufficient fund and lack of public awareness.

In the same way, Gedefaw (2015) in his paper 'Assessing the Current Status of Solid Waste Management of Gondar Town, Ethiopia' has tried to assessing the current solid waste management service of Gondar town. Ultimately, the research has revealed that the provision of service has not kept in pace with the town's solid waste generation rate owing to poor institutional structure and capacity of Sanitation and Beautification Unit, limited participation and contribution of stakeholders and poor households' solid waste management practices.

What has been clear from these and other studies conducted in the Ethiopia is that almost all studies revolve around one types of waste that is solid waste, and still these studies cover only limited aspects/issues of the waste management system. Worst of it, liquid waste, that has been causing serious damages on the quality of urban environment, has lacked attention from the academia and the decision and policy makers.

While pursuing his MA program in Addis Ababa University, Department of Geography and Environmental Studies, the researcher himself has done his thesis on the title 'Domestic Solid Waste Management in Mekelle City' in 2002. The basic objective of the study was to examine the overall pattern of solid waste generation, collection and disposal in Mekelle city. The researcher has tried to disclose the basic problems of solid waste management prevailing in the city such as improper organizational structure, inadequacy and inappropriateness of the collection, lack of detailed rules and regulations, ordinance and public education and improper handling of solid wastes at home, etc. As a result, poor performance had been the fundamental feature of the Solid Waste Management Unit.

Now, on the one hand, the purpose of the researcher is to fill in the time gap. A ten years time gap is not unimportant when evaluated in terms of its policy relevance. The relevance of the findings of the MA thesis for current policy recommendation would be highly limited; it needs to be updated. On the other hand, both research projects (the researcher's MA thesis and Doctoral Dissertation) vary in their focus and scope. The purpose of this study is to go beyond the estimation of the extent of the waste collection and disposal service problems at grass root level. The researcher has tried to bring together both liquid and solid wastes which are highly intermingled in different ways. Besides, the most important waste type, that is liquid waste, has been covered in the MA thesis as well as in other research papers. The researcher argues that research papers conducted in the country has remained silent pertaining to liquid waste management to date. And more importantly, the researcher argues that the main focus of this study is different from those conducted to date in that it emphasizes on the extent how waste management receives policy responses in the region.

In short, mainly because of the rapid urbanization, the urban environment is deteriorating. This implies that there is a growing demand for all types of public services particularly for waste management service in the urban centres of the region. This in turn necessitates adequate attention from the decision makers including for appropriate policy measures. Yet, it is not known whether adequate and appropriate policy responses are in place.

The main purpose of this research is, therefore, to examine the extent to which urban environmental considerations in general and urban waste (both solid and liquid) management issues in particular have achieved policy responses which would be reflected in various policy measures. The level of concern and commitment of the authorities is also reflected on how they are executed at grass root level.

1.3. Research Objectives

1.3.1. General Objective

In view of the research problems stated above, the principal objective of this study is to assess the extent to which urban environmental issues have achieved proper policy

responses at the regional and local levels in Tigray National Regional State with specific reference to the case of waste (solid and liquid) management.

1.3.2. Specific Objectives

More specifically, this study attempts to

- a) estimate the scale of the solid and liquid waste management problems of the urban areas of Tigray;
- b) examine the on-site waste management practices and problems of residents in the study area;
- c) evaluate the extent the waste management policy documents in Tigray adequately and properly address (measure up to) the main challenges posed by the urban environment problems of the region;
- d) assess the organizational and operational capacity as well as the political commitment of the institutions that are in charge of providing waste management services and monitoring and regulatory works in the region; and
- e) examine the extent to which the strategic waste management approaches have achieved policy priorities to bring about sustainable solution to waste management problems.

1.4. Research Questions

The key research question: In this study, attempts have been made to answer the following main research question: Have the urban environmental problems of the Tigray National Regional State in general and the solid and liquid waste management problems in particular received proper policy responses?"

Specific Research Questions:

- a) How severe are the problems of waste (solid and liquid waste) management services provision in the urban areas of the region in general and the study areas in particular?

- b) To what extent do the waste generating entities (waste generators') properly and adequately handle their wastes so as to ensure compliance with the waste management requirements of their cities?
- c) Are there appropriate and feasible environmental policies and programs to effectively address the environmental problems (waste management problems) of the urban areas of the region?
- d) How adequate is the organizational and operational capacity as well as the political commitment of the institutions in charge of providing environmental services and monitoring and regulation of environmental quality in the Region.
- e) Which types of waste management approaches have achieved sound responses by the local authorities to bring about sustainable solution to waste management problems in the urban areas of the region?

1.5. Research Methodology

The questions 'what to research', 'why to research', and 'how to research' are fundamental issues which need clear and convincing/logical answers in any scientific research undertakings. These questions refers to the research title (key research question/s), the philosophical position of the researcher, and the methodology (the research approach, strategy and methods) of the research. They way how a particular research addresses these questions in harmony largely determines the quality of the research paper. Whichever the research interest of the researcher, the answers to these questions need to be consistent to each other. Therefore, the research philosophy, the research approach strategy and methods are discussed briefly in sub-topic to come.

1.5.1 Research Design

1.5.1.1 Research Philosophy, Approach and Strategy

The research philosophy is founded on important assumptions about the way in which the world is viewed. Philosophy is concerned with views about how the world works and it, as an academic subject, focuses primarily on reality, knowledge and existence. It is these assumptions that underpin the choice of research approach, methodology and the

methods. Ahead of these procedures, however, the nature of the research problem /research question should be thoroughly examined. Therefore, the research has to strive to establish a meaningful link among the three main aspects of research (research problem, philosophy, and methodology- approach and methods). This implies that research methodology emanates from the researcher's research problem and philosophy (Mason & McBride, 2014).

Accordingly, the researcher has initially identified or formulated the research problem/ research question. Sub-objectives /sub-questions are formulated from the key research objective and research question. The key objective of the researcher is to assess the extent to which urban environmental problem has received policy responses in the region while the key research question reads as 'what is the extent to which waste management has achieved policy responses in the urban areas of the region in general and the two major towns of the region in particular. The 'appropriateness' (of the way the responsible bodies have responded to the problem) and 'adequacy' of the responses have to be examined in terms of the nature and magnitude of the waste management problem of the urban areas. In other words, the responses given to the waste management problems should measure up the types and scale of the problem.

To this effect, the key research question has been split into two key research questions: first, 'what and how severe are the waste management problems of the study area'; and second 'what policy measures have been taken to offset these problems?' The former question is formulated in the assumption that the answer to the second question is measured against the answers to first question because any policy measures taken should measure up the magnitude of the problems. Therefore it would be logical to primarily estimate the scale of the problems before the adequacy or effectiveness of responses is evaluated. Once the research problem or research questions have been defined, the researcher continued to make a choice of the philosophical position of his research work. Based on the idea that instead of approaches and methods being important, the problem is most important, and researchers use all approaches to understand the problem, the researcher has defined the philosophical assumption of his research study. The researcher argued that the better understanding of a complex phenomenon could be

achieved by merging vast numerical data and specific details of qualitative data. To make it more clear words can be used to add meaning to numbers and numbers can be used to add precision to words. In short, quantitative and qualitative inquiry can support and inform each other so that the researcher would be able to understand better the research problem. Likewise, the basic research question or key objective in this research basically requires both quantitative and qualitative data; both are equally necessary to carry out interpretation of results meaningfully thinking that one data type is complementary to the other data type. In this case, most of the qualitative data collected mainly from key informants have been sole sources of data to some of the specific research objectives. This implies that neither only quantitative nor only qualitative approach serves this research work but a mixed one. The choice of a philosophical ground which backs mixed methods research approach is, therefore, straightforward. Mainly because research problem (research question) has been given importance and mixed methods are recognized as suitable approach, the philosophical orientation of this research could neither be pure objectivist nor pure subjectivist, but it is pragmatist. Pragmatism clearly argues that the most important determinant factor of a research philosophy adopted is the research question. Moreover, the theoretical paradigm underpinning the mixed methods research approach is pragmatism.

Mixed methods research design is of different types. The research design procedures for collecting, analysing, interpreting, and reporting data in research studies are triangulation design and exploratory design. The purpose of triangulation design is 'to obtain different but complementary data on the same topic and intention' (Creswell & Clark, 2007:62). But also to answer some of the research objectives (research questions) the data obtained through one approach may not be adequate to serve the purpose; it is not the purpose to generate supplementary data but distinct data. These objectives call for more data to be searched; to explore as rich data as possible to avoid deficiency. Therefore, the mixed methods approach (both quantitative and qualitative approaches) have been used in this research to triangulate data collected from different sources and to explore the nature and types of the problems using very rich data of both quantitative and qualitative nature.

1.5.2 Research Methods

1.5.2.1 The Nature and Sources of Data

The research has used both primary and secondary data sources. Generally, the primary data sources for this research are the key stakeholders of the urban environmental management who are thought to have a role directly or indirectly in protecting or damaging the respective urban centres. These key stakeholders of urban environmental managements are broadly classified as waste generating entities, environmental service providers and beneficiary, policy and decision makers, environmental protection regulators and supervisors, and civil societies including small and micro-enterprises which are directly or indirectly involved in environmental issues. They can basically be classified into two: households and authorities and experts. The last but not the least important primary data source used in this study is the field where the real waste management problem is clearly reflected.

1.5.2.2. Sampling Technique and Sample Size Determination

The households are selected using multistage sampling techniques. The urban areas of the region, being identified as clusters, are selected from the region, using purposive sampling techniques. The purpose was to include the large size urban areas bearing in mind the fact that urban environmental problems are more severe in large urban centres. Hence, primarily (in the first stage Mekelle city and Adigrat town are selected). Next, sub-cluster areas (lower administrative units) are selected. In this case sub-cities and *Kebeles* from Mekelle city and Adigrat town are selected, respectively, using simple random sampling techniques. These include three sub-cities from the total seven sub-cities of Mekelle and three *Kebeles* out of the six *Kebeles* of Adigrat selected using simple random sampling technique. In the third stage, following the identification of localities arbitrarily as inner and outer part of the respective sub-cities (in Mekelle) and *Kebeles* (in Adigrat), households/ housing units are selected using systematic random sampling technique. Similarly, purposive sampling technique was employed to select key informants from the offices which are in charge of providing waste management services in different ways

(collection and disposal services, regulatory and monitoring services) and policy makers or decision makers.

In a sampling design, determination of the sample size is a paramount task. Hence, the sample size of the samples formed for questionnaire, and in-depth interview is fixed. Taking into consideration the pressure which could be exerted by large size sample on time and resources and the limited access to information, fairly small sample size has been fixed. However, mainly due to the huge size of the Because of the frequently re-delimitation of the administrative units of sub-cities, *Kebeles* or *Tabias* and thus lack of reliable data to determine sample frame it has been difficult to access the population number (and household size) of the current sub-cities and *Kebeles* and thus determine the sampleframe of the study area. Therefore, the research has arbitrarily determined the sample size of household heads to the questionnaire survey as 450. This number has been distributed to the two urban centres proportional to their total population. Likewise, five key informants were selected.

1.5.2.3. Data Collection Instruments

The primary data collection instruments employed are mainly of two types. These are those used to collect from the household heads and from environmental/waste management experts, managers and policy makers. The data from household heads were collected using semi-structure questionnaire which is composed of both open- and close-ended questions. Similarly, in-depth interview was employed to collect data from the environmental experts and managers involved in waste management services and regulatory and monitoring activities. Moreover, data from decision makers in the Bureau of Urban Development, Industry and Trade Bureau, Department of Sanitation and Beautification Department of the Region were involved as key informants in the in-depth interview.

1.5.2.4 Data Analysis

Corresponding to the types of data collected, appropriate data analysis techniques are employed. It is to be remembered that both quantitative and qualitative data have been

used in this research which clearly implies that making use of quantitative and qualitative methods of data analysis is obligatory.

Quantitative Data Analysis

To make quantitative data analysis, the data collected through questionnaire were so large to manage. The researcher was somehow ambitious to have as many data as possible and strived to include more question items (and thus more variables) in the questionnaire, particularly questions pertaining to waste collection and disposal services. Indeed, this helped out the researcher to access huge data at hand but was not simple to manage. Owing primarily to this challenge, the researcher has made use of analytical technique called Principal Component Analysis (PCA) technique mainly for the purpose of diminishing the size of data for analysis but being aware of the need to retaining the original information as much as possible.

Following the identification of the principal components, descriptive and inferential analysis technique was used for the quantitative data collected through semi-structured questionnaire; these include rates, percentiles and tables, and the Spearman correlation coefficient. In the case of the correlation model, the research has tried to identify the relationship between the occurrences of 'cancellation of collection program' and 'inconvenient collection schedule' and occurrences of 'dropping of waste in illegal areas' by the community. The assumption is that both cases are directly related in that the dropping of waste in illegal areas is more frequent when the act of cancellation of collection program and inconvenient collection schedule are in place.

Qualitative Data Analysis

Most part of the qualitative data generated from in-depth interview of the key informants are used as sole data sources to the objectives indicated in 5.4, 5.5, and 5.6 Sub-chapters. On the other hand, the remaining part of the qualitative data is employed to triangulate the data obtained through questionnaire from residents.

There are wide ranges of qualitative data analysis techniques, among which thematic content analysis is the most common type and it meets the demand of this research

project. The qualitative data analysis has been supported by software program called Atlas ti version 7. Based on the procedures indicated in the manual published by Elizabeth Archer (Archer, et al., 2017), the researcher has primarily prepared the data in a way that fits the program. Following the creation of the New Hermeneutic unit, the researcher assigned five primary documents and continued working on selecting quotations, coding and creating families or themes. Finally, he came up with 108 quotations, 21 codes, and 10 families or themes and produced reports or outputs to each theme. The outputs or reports of the analysis produced by the software are presented in one to ten boxes.

1.6. Personal Motivation to Undertake the Study

The main reason that motivated the researcher to undertake the study was the widely observed environmental problems in the urban areas of Tigray. The wastes that are left uncollected in residential areas, shopping areas, open market areas, and particularly in drainage ditches, unoccupied spaces and streets are visible in almost all urban areas of the region. Moreover, use of open areas, drains and even roadsides as toilets are common practices in the urban areas of the region. The storm water canals built particularly in the big cities are emitting foul odours and are disturbing movements and activities. Overflowing of liquid waste from big institutions like Mekelle University campuses, individual residential and business houses and garages are also usual phenomenon particularly in the big cities like Mekelle. The destination of all these wastes has been the streams that are found within and nearby the urban areas. Undoubtedly, all these environmental problems do readily cause different types of pollutions.

Secondly, the researcher's interest in this study is rooted in the fact that, being one of the regions of the Country with the rapid rate and highest level of urbanization, it would be more likely that the very complex environmental problems to prevail in the Region. Comparatively, Tigray Regional State has the highest level of urbanization of the major Regional States of the Country. The region's level of urbanization (19.5%) is marked which is higher than the country's average (16.5%) and its urban growth rate is 4.5% per annum, which is obviously higher than the national urban growth rate which is 4.3% per

annum (Ethiopia, 2008). Provided the high growth rate, it is unquestionable to face huge population concentration in the urban areas of the region shortly in the time to come.

Nonetheless, the capacity of the local and national governments has usually been weakened by the rapid urbanization, and as a result, they could not provide even the most basic services to urban residents including the waste collection and disposal services (Achankeng, 2003). Generally, the municipal service delivery capacities of most developing countries have woefully failed to keep pace with their accelerated urban growth rates.

One of the major consequences of the aforementioned shortfalls in the municipal service delivery capacities of most local governments in the developing world has been rapid deterioration of urban environmental conditions in such countries. These fast worsening urban environmental problems have actually become serious threats not only to specific localities but also to the whole world. Most local and global environmental problems are created in the urban areas mainly owing to the consumption patterns prevailing in these urban areas. The cities are centres for most of the sources of the world's environmental problems (Fernandes, 1998; Fernandes & Varley, 1998). Besides, the environment is one of the three pillars of sustainable development. This implies that all the efforts made in the cities and the region to ensure sustainable urban development would not be successful without proper management of the environment. Therefore, environmental problems are not only sources of varied health complications but they are also obstructing the efforts to create sustainable cities (Suresh, 2003).

Since these problems are common in most of the urban areas of the region, the current researcher has come to the understanding that the urban environmental management policy and practices in Tigray Region have critical shortcomings that need to be systematically researched in order to address the problem and improve the quality of life in the Region in general and the urban centres in particular.

1.7. Significance of the Study

The researcher believes that the result of this study will be of paramount importance primarily to bring the issue of urban environmental problems to the attention of the policy and decision makers so that they would rethink the relevance and workability of the existing, if any, policies, programs and regulations that govern environmental management systems in urban areas. Moreover, this research would be helpful to generate concern from and responsiveness of the main stakeholders in urban environmental management and thus they would play proactive role in the urban environmental management endeavours. Ultimately, it is hoped that, other things remaining normal, the study could be helpful in realizing the efforts to create cleaner, healthier, more attractive and sustainable cities that could attract more investment from time to time, so that its citizens may enjoy increased access to jobs and to higher standards of life.

The very idea of urban development planning and management is usually narrowly and riskily conceived. Urban environmental problem is overlooked though (sustainable) development is made up of three pillars: social, economy and environment,. Particularly the development first syndrome has been serious obstacle to fully address environmental problems. Therefore, it would not be possible to ensure sustainable urban development unless urban environmental problems are thoroughly and, at least, equally with the social and economic aspects is addressed. Therefore, the outputs of the research not only will receive attention from the sustainable urban development planning and management sector but also will provide inputs in their overall endeavours to ensure sustainable urban development. Moreover, unlike to many of the research works undertaken locally and regionally, this research project has tried to address one the serious environmental issues comprehensively.in such a way that it could influence the planning and management system of the urban managers and policy makers.

It is also hoped that the outcomes of this research can help to enhance our knowledge about the basic challenges of urban environmental management in similar towns of the region and the country- Ethiopia. More specifically, though it is focussing on the nature and effectiveness of the policy responses to urban environmental management problems in the Tigray region, the study could shed light on the research undertakings on similar issues in the country as a whole.

1.8. Scope of the Study

Environmental issues are very broad and complex. The study of these diversified issues requires the involvement of scholars with similarly diverse disciplinary backgrounds. This is so not only because the constituents of the environment are diverse but also because the proper exploration of each environmental issue in adequate depth and breadth calls for the expertise of well-trained and reasonably specialized researchers. Accordingly, it would not be advisable and feasible to address all environmental aspects of the urban areas within a single research topic. Cognizant of the breadth and complexity of urban environmental aspects, the researcher has tried to delimit the scope of his study from the viewpoints of the subject matters of the discipline of Geography and Environmental Studies and time.

Waste management, which is one major aspects of urban environmental management, is the focus of the study. Waste refers to solid, liquid and gaseous substances. However, the focus of the researcher is specifically on solid and liquid wastes. The nature and magnitude of waste management problems and the responses they received from policy and decision makers are the main concern of this study.

The methodology of the study has been delimited to mixed methods triangulation design. To achieve the main objectives of the study, the researcher has mainly relied on the analysis of socio-economic and environmental data of the 10 years that lasted from 2007 to 2017. Moreover, data collected from sample household heads (respondents) and key informants (participants) using questionnaire and interview, respectively, and from field observation. Data are analyzed basically using descriptive methods and thematic content analysis method. The findings, therefore, primarily revealed the problems prevailed during the time range methioned above. Geographically the study has been broadly delimited to the settlements with a population greater than 2000, i.e urban areas of the region. Even though, the study focused on the two largest urban areas of the region, its findings markedly reflect urban environmental management issues that prevailed in the region as a whole during the period under question.

1.9. Limitation of the Study

It is not unusual to face certain challenges during research works. So, like in many other studies, the researcher has encountered various types of challenges which do have varied ranges of consequences. One of these challenges is lack or shortage of access to data. Mainly due to the weak database and filing system, most of the data found in the relevant offices and institutions are disorganized, unreliable or nonexistent. To overcome such problems, the researcher has been forced to knock at the doors of a large number of offices and thus unnecessarily much time has been wasted in collecting secondary data from documents, reports and booklets. Moreover, the researcher has not been able to access population data and waste collection data at lower administration levels (sub-cities and below) in Mekelle for the years prior to 2014 and 2015, respectively. Similarly, data pertaining to population and waste collection (particularly for the days mainly before 2016), and the budgets (requested, permitted and executed during the entire study period) have been lacking in the respective offices in Adigrat. Had these data been available, the researcher could have made a trend analysis and assess the relationship (calculate the correlation coefficients) among these variables. Besides, repeatedly redefining of the territory and spatial coverage of the administrative units particularly in the urban areas has made many of the data lost their relevance to limited relevance of the data to the different administrative units (sub-cities, *Kebeles* or *Tabias* and zones) because the data particularly socio-economic data do not match with the active administrative unit.

The last but not the least challenge was that, for no reason the persons in the relevant offices are tending to hesitate and show reluctance to offer information when requested. Though the researcher has tried to patiently persuade them, reluctance was so strong challenge and it took the researcher more time and efforts. In general, despite all these challenges and certain limitations, the researcher vows that they have not brought noticeable effects on the quality of the thesis.

1.10. Organization of the Paper

This study has six chapters. The first chapter consists of the introductory sections of the work and as such focuses on the presentation of preliminary but essential information

about the research. The contents included in this chapter are the background of the study, the statement of the problem, the main and specific objectives as well as research questions of the study and other relevant sections. The second chapter presents a review of the relevant theoretical and empirical literature. It consists of three main parts, namely the theoretical framework, review of, as much as possible, more recent empirical studies (related research works) on related issues, and conceptual frameworks.

The third chapter of this research report deals with the Research Methodology. This section mainly consists of background of the study area, research philosophy, approach, design and methods and procedures (data sources, data collection instruments, sampling techniques and data analysis and interpretation). The next chapter, i.e., Chapter Four, is the Results and Discussions part of the thesis. In this chapter, all data collected through different instruments from different sources are analysed and discussed (interpreted). Primarily, as it is common in all research undertakings, the Socio-economic Background of the Research Participants such as the household heads have been described as the first sub-chapter in this chapter. Following this sub-chapter, five other key topics are treated as sub-chapters. These include Waste Collection and Disposal, On-site Waste Handling Practices, Waste Management Policy Documents, and Waste Management Approaches. Under each of these sub-chapters in turn several critical issues are discussed. Moreover, initially, the Principal Component Analysis technique has been employed in this chapter to reduce the number of factors (variables) pertaining to waste collection and disposal services into manageable size. Following this Analysis, three main components such as Waste Water Collection Services, Solid Waste Collection and Disposal Services and Disparities in Waste Collection Services which have been considered as main topics were extracted. With in Under the On-site Waste Handling Practices section (sub-chapter), two main topics have been differentiated as On-site Liquid Waste Handling and On-site Solid Waste Handling.

The last but not the least is Chapter Five that comprises the Summary, Conclusion and Recommendations. Here, the main issues of the thesis, including the basic findings, are briefly summarized. Based on the key research findings the researcher has proposed his basic, brief and feasible recommendations.

Chapter Two: Literature Review

In this chapter the researcher has tried to review the more relevant literature which helped basically to form the theoretical framework of this study. The review generally focuses on three broad areas such as the link between the urbanization and urban environmental problems, urban environmental management and policy issues, waste management opportunities and challenges particularly in developing countries. Within each of these three broad areas varied issues organized as contents and sub-contents have also been discussed.

2.1. Urbanization and its Environmental Implication

Based on ones purpose, urbanization might be defined within different scopes. The most common definition of urbanization may focus on demographic features observed in a particularly area; more specifically, the population change in urban areas (urban population change) is considered as vital element of urbanization. For instance, urbanization could be viewed as a process whereby large number of persons are gathering and settling in an area and ultimately forming social institutions like businesses and governments to support them. However, urbanization is a wider concept which goes beyond the mere change in human population size. Urbanization should mean not only the process of changing in the number of people in a particular area or the re-distribution of human population within an area but it also refers to the process of an overall transformation of the social, economic and political life of the society. Hence, urbanization can comprehensively be defined as

a process of becoming urban, moving to cities, changing from agriculture to other pursuits that are common to cities and corresponding changes of behaviour patterns. Urbanization is not only an evolutionary process of redistributing human population within a given society but also a way of transforming many patterns of social, economic and political life towards satisfying the development needs of man (Özden & Enwere, 2012:4-8).

Moreover, besides the socio-economic and political changes, urbanization process is associated with distinct environmental changes.

In the second half of the 20th century, the world has experienced a dramatic change in human population and particularly in urban population. Urbanization has been a dominant feature during the last half century when significant number of rural population has shifted to urban areas. The share of the world urban population has been lifted from less than 30% in 1950 to nearly 47% in 2000. And the process of concentration of population and activities in urban areas will continue well into the 21st century. The urban population will increase from 3.3 billion in 2007 to 5 billion in 2030 whereas the rural population will decline from 3.3 billion in 2003 to 3.2 in 2030 (Cohen, 2006; Ichimura, 2003).

As a result of the rapid urbanization, increasingly large number of people will be residing in urban areas thereby raising both the sizes as well as the number of cities around the world. The level of world urbanization today and the number and size of the world's largest cities are unprecedented (Cohen, 2006; Mpofu, 2013).

Indeed, developing countries are less urbanized. Nevertheless, urban population of developing countries have been estimated to grow on average at a rate of 2.4% per year between the years 2000 and 2030. With this, the proportion of population living in urban areas will rise to 56% in the year 2030. This implies that there will be more people added each year increasingly due to the reason that the rate is applied to an ever-rising base population. On account of this high rate of growth, the developing countries' urban population is expected to double in 29 years. In contrast, the rural population of the developing regions is likely to increase very slowly; during the same year, it is estimated to grow at 0.02 % per year..

Almost all continents have gone through urban transition before Africa, and it is now Africa that is facing all challenges that the rest of the continents have faced during their transition. Today, Africa is facing both the challenges of high population growth and rapid urbanization. Especially, the Sub-Sahara African countries' urban growth rates are and will continue to be much higher for a number of decades than the world average. The urban population of Africa is projected to increase by 0.9 million by 2050. The urban growth particularly in terms of population is mainly attributed to the net migration to the urban

areas, grabbing of nearby rural settlements, and natural population growth in the urban areas (McGranahan, et al., 2009).

From the above discussion, it has been evident that the size of population residing in urban areas has been rising since the 2nd half of the 20th century. It has also been argued that every person added to urban population in the developing countries is more likely to create a challenge to the urban areas in all aspects and for all actors. Thus, the number of persons added to the urban population in developing countries create additional burden on administration, planning and service delivery and ultimately on the urban residents in general. Urbanization has diverse impact, which could be positive and negative impacts on the environment and human beings (Choosuk, 2014; Li & Ma, 2014).

Generally, urban population growth is clearly associated with several socio-economic and environmental phenomena: high concentration of people, industries, commerce, vehicles, energy consumption, water use, waste generation and other environmental stresses. As urban population grows, the degree of concentration of these socio-economic elements and environmental damages increases and very large and a number of small- and medium sized cities are created (Bartone, et al., 1994; Williams, 2000). The effect of urbanization is observed heavily at local level, but it is also strongly felt at national level. The link between human development and urbanization at national level could be strongly positive. Cities could also play key role in transforming society through extraordinary growth in the productivity of labour and they are promising to liberate masses from poverty, hunger, disease and premature death, and yet, they pose serious challenges on the environment in and outside of the cities (Ichimura, 2003:3).

It is hardly denied that cities could offer important opportunities but it should also be noted that it is only possible if these urban areas are managed well. Mainly because huge population is concentrated in a very limited space, which might be designated as urban settlement, urbanization contributes to minimize the effects of man on the local ecosystem. One of the most important effects of population concentration in a tiny fraction of area on per capita cost of providing infrastructure and other basic services is minimal. It is only less than 3% of the earth surface that is occupied by cities but the concentration of the

population, industry, different activities and energy use in these tiny spaces is disproportionately higher than the remaining surface of the earth. The higher density of urban populations offers significant cost advantages for governments in the delivery of essential goods and services and for the private sector in the production and consumption of such items (Cohen, 2006; Choosuk, 2014).

However, regardless of its many socio-economic advantages, the rapid growth of urban population (urbanization) creates negative economic, social, and environmental consequences. Some of them include increasing rates of unemployment, lack of urban services, overburdening of existing infrastructure and lack of access to land, finance and adequate shelter. Increasing violent crime and sexually transmitted diseases, and environmental degradation are the most significant problems. It is also argued that, even if the national output is rising, the quality of life may decline for most of the population as usually it is the case. This impedes the benefit of the national economic growth. Bearing in mind these negative effects, one could easily imagine how urbanization could be a challenge to the efforts made to ensure sustainable development (Poredoš, 2011). The negative effect of urbanization on the (urban) environment, which is more relevant to this sub-topic and the research question, is particularly severe

On the one hand, it is well recognized that cities are both engines of growth and sources of intense environmental problems; on the other hand, as cities grow productive activities tend to concentrate in urban centres. Nevertheless, managing cities becomes increasingly very complex when they are growing larger and larger. The developing countries are facing enormous challenges caused by the speed and level of urban transformation they are experiencing. The speed and scale of increase in the world's largest cities and metropolitan areas can create enormous stresses particularly on the immediate and surrounding environment, natural resources, health conditions, social cohesion, and on individual rights, and these in turn create huge challenges on the effort to ensure and maintain sustainable development (Cohen, 2006).

The environmental footprint of cities is not limited only to their administrative boundary, but cities have also extraordinary impact on areas beyond their boundaries on the

neighbouring rural, regional and global ecosystems. Some of the environmental problems that accompany rapid urbanization include unsuitable water supply, fast growing problems of waste water and solid waste management, inadequate energy supply, loss of green and natural areas, accelerated expansion of the built up areas of cities, soil and air pollution, traffic congestion and, noise pollution (Poredoš, 2011).

The broad categories of urban environmental problems of developing countries are those arising from inadequate waste disposal (including pollution), congestion of urban systems, and degradation of natural support systems. These environmental impacts have major impacts on health and safety, productivity, amenity value and ecological value (Shin et al., 1997).

Currently, many studies have well recognized the impacts of the prevailing rapid urbanization on the environment, health and overall development. The rapid urbanization going on throughout developing countries has seriously outstripped the capacity of most cities to provide adequate basic services for their citizens (Cohen, 2006; Mpofu, 2013). Due to the environmental degradation which is mainly brought about by the rapid urbanization, the development potential of cities has all often been crippled. In addition to its effects on human health and well-being (especially on the poor), environmental degradation, directly holds back economic development. It also recommends that to ensure the sustainability of development achievements, cities should look for better ways of reconciling the needs and pressures of urban growth and development with the constraints and opportunities of the urban environment (Decker, 2001). In other words, a city cannot be successful and operate efficiently in isolation from its environment; it must, balance the social, economic and environmental needs (Alliance, 2007).

The efforts made to prevent and control wastes and emissions in urban areas is hindered or obstructed by the level of growth of the urban areas and rapid accumulation of the wastes' emissions in these areas. 'Level' here refers to the per unit area product of population density times per capita waste generation or resource use. Economic development has the role of aggravating the problems for the reason that the per capita

waste produced tends to increase gradually as the per capita income increases (Decker, 2001).

Above all, it is necessary to recognize that urbanization is an inevitable process while environmental degradation attributed by urbanization is not an inevitable issue. Hence, cities should not be discouraged by the cities (unfortunately most do) which are still suffering from severe environmental and economic damage; they should know there are also promising signs of being successful. Environmental problems in urban areas vary from city to city and region to region. The pattern of environmental pressure also differs from city to city. Poor cities have different agendas from rich cities. The environment problem (mainly related with industrial production, residence and basic infrastructure in cities) of developed countries, for instance, have been reduced; while their problems related with consumption and thus more waste production, and traffic congestion have increased (Poredoš, 2011). On the other hand, the human health, environment, and urban productivity of the developing countries' cities are being threatened by their rapid urbanization. Health impacts of urban pollution are the critical and most immediate problems of the developing countries' cities. The health problems associated with urban pollution are mainly attributed to several issues such as inadequate water, sanitation, drainage and solid waste services, poor urban and industrial waste management, and air pollution, especially from particulates. For that reason, the issue of protecting and improving the urban environment is fast becoming a necessity rather than a luxury especially in many developing countries' cities (Decker, 2001).

Different literature sources indicate a number of factors that complicate urban environmental problems. These include city's size, population growth, local geography, climate, rapid economic growth, weak organization which is responsible to handle the problem, etc (Choosuk, 2014). Mainly for the reason that environmental problems of urban areas are attributed to different factors, it is must to come across marked disparities among cities and within cities in the types of environmental problems. The major disparities in the types and strengths of environmental problems among and within cities are largely attributed to variation in the extent (coverage) and quality of environmental services they received. It is well noted that, as compared to big cities, the people residing

in small cities of the developing countries are widely underserved by most of the basic services (Cohen, 2006). This could be attributed partly to the weak and insufficient capacity of local administration in many aspects like institutional capacity, financial capacity, expertise capacity, etc. and partly because small cities grow faster than the larger ones (Poredoš, 2011).

As a continent packed by predominantly developing countries, Africa shares most of the basic features of urbanization and associated environmental implications to a considerable extent. Urbanization is a recent phenomenon in Africa but it is among the highest concern of the region, especially in the Sub-Saharan Africa. Despite the fact that cities have been the centres of economic growth, innovation and employment, the Sub-Saharan African cities are characterized by a number of emerging environmental challenges (Mpfu, 2013).

'Brown agenda' issues are the more severe environmental problems of the Sub-Saharan urban areas which demand serious attention for action to minimize their threats to the health and well-being of human being. This could be realized by improving the quality of the people's living environment such as better provision of water and sanitation. Most of these urban environmental problems occur at various levels namely at household, neighbourhood, community and city levels. Yet, it is the green agenda which focuses more on reducing the indirect threats to human well-being that receives more attention in the environmental policies. As indicated in the policy, the green agenda has thought to be implemented by protecting resource degradation and the deterioration of life-support systems (McGranahan, et al., 2009).

Notwithstanding the enormous positive impacts, virtually all major cities of the Sub-Saharan Africa region are increasingly overwhelmed by environmental problems. As revealed by the study of Ichimura (2003:3-4), the key problems of Sub-Saharan Africa which are directly or indirectly linked to the environment and rapid urbanization could be summarized as follows:

- As a direct result of urbanization, great threat to health and safety in cities comes from water and air pollution;

- The productivity of many cities is adversely affected by traffic congestion and water pollution;
- Uncollected and improperly handled solid waste can have serious health consequences, such as blocking drainage systems and contaminating groundwater at landfill sites;
- Urbanization does not have only local environmental impacts but also large so-called 'ecological footprints' beyond their immediate vicinity;
- Waste generation in urban areas continues to increase in tandem with concentration of populations and increase in living standards, and has reached unmanageable levels in many localities.

The researcher, therefore, strongly believed that the speed and sheer scale of the urban transformation and the increased concentration of population, production and consumption in urban areas has presented formidable urban environmental challenges. The dysfunctional urban environments reciprocally have brought with them high costs that have undermined the benefits of economic growth and development needed to improve the living standards of urban populations. As cities grow, therefore, managing them in general and their environment in particular has become increasingly complex and difficult in Sub-Saharan African countries like Ethiopia, Tigray National Regional State (Mpofo, 2013).

2.2. Waste Management

2.2.1. Introduction: Definition and Classification of Waste

Above all, it is necessary to have a clear understanding of the essence of 'waste' and its basic characteristics as a prologue to unpack the research problem. The definition of 'waste' is controversial. What waste is meant to the researcher might be different from what it is to others. Basically, those who generate waste and those who create value from waste vary in their understanding about waste. That's why researchers have usually come across two ways of definitions such as from the perspective of the waste generators and from the users. The difficulty related with the definition of waste has widely been recognized in several literatures. The literal meaning of 'waste' as indicated in Cambridge

Advanced Learner's Dictionary is 'unwanted matter', unnecessary substance which completely contradicts the initiatives to make use of wastes as resources. Waste is usually defined from the viewpoints of the generator.

As to Bortoleto (2014), *'waste can be loosely defined as any material that is considered to be of no further use to the owner and is, hence, discarded'*. However, it is possible to recycle or reuse most of the discarded wastes, in conformity to one of the basic principles of waste management philosophy. It is apparent that what may be of no further use to one and regarded as waste to be dumped could be of use to somebody else and this has made possible activities like rag picking trade, sorting of refuse at landfills for recovery and resale. Still now, very basic historical practices of waste management have been in use, but also they have been conducted on a highly organized commercial basis.

Waste is the direct product of all activities of human being and it is a universal phenomena. Wastes are generally classified into solid, liquid and gaseous.

Generally, the term 'waste' refers mainly to solid and liquid or liquid waste matter which has no longer any economic value as it has been used in this study. The word 'waste' and the act of 'wasting' are human inventions for short-term convenience. Otherwise, waste does not exist in nature. It is in terms of collection and disposal that they are liquid and solid wastes (Suryawanshi, et al. 2013).

Nelson,et al., (2009) as cited in Lindell (2012:14), defined solid waste as *'solid materials as well as some liquids in containers, which are discarded or rejected as being spent, useless, worthless, or in excess'*.

As indicated above and in some other definitions, concepts like *'lack of use or value'* or *'useless, worthless'* have been widely used while defining 'waste'. For instance, according to White, et al. (2012:12), as cited in Lindell (2012:14), *"waste implies lack of use or value, or useless remains. Waste is a by-product of human activity. Physically, it contains the same materials as are found in useful products; it only differs from useful production by its lack of value"*

The definition cited above is given from the perspective of the generator, not based on the nature and absolute status or fate of the material designated as waste. This is because waste which is considered as useless by someone (the generator) could be useful for others who are willing and capable to use it again as it is or in different way. The concepts used in the definition like 'lack of use' or 'lack of value' are generally generator-oriented. However, this perspective is not necessarily reflected in legislation. In the European Union waste framework legislation, as indicated in Lindell (2012:14), waste has been defined as:

Any substance or object which the holder discards or intends or is required to discard"; Or "any substance or thing that the holder discards or disposes of, or intends or is required to discard or dispose of, irrespective of its value to any person, and any substance or thing deemed by regulations to be waste.

The EU has defined waste with caution by explicitly referring to the perspective from which it is defined. It is in light of the generator or the holder that waste is defined. Solid waste is a material, in a non-liquid state which has no value to the producer. Commonly, the term solid waste does not include materials human and animal excreta though they often end up in solid waste stream. Many synonyms terms to solid waste are usually used interchangeably in different literature like 'garbage', 'trash', 'refuse', and 'rubbish' (Zurbrugg, 2003).

On the other hand, liquid waste is defined in different literature in different ways; some defined it broadly while others defined it briefly. When defined briefly, liquid waste is the water carrying wastes from home, businesses and industries and institutions that are mixture of water and dissolved or suspended solids. Liquid waste management may also be defined more broadly as institutional, financial, technical, legislative, participatory, and managerial aspects related to the problem of liquid waste. But it could also be defined based on its sources and destination. For instance, liquid waste is defined as water produced by households, industries, commercial centres (after use), and from storm-water run-offs (with variable materials mixed), that is ultimately discharged as waste or as of non-use into surface water bodies or infiltrate back into the ground (Un-habitat, 2010).

Liquid wastes are commonly discharged into sewers or rivers, which in many countries are subject to legislation governing treatment before discharge. Bortoleto (2014) illustrated that such types of legislation has either missed or has not been adequately implemented in many parts of the developing countries' urban areas; liquid wastes from different streams are directly channelled to water bodies or are made to infiltrate into the ground. The liquid waste which is indiscriminately disposed of into water bodies and other surface is posing a major pollution threat to surface water as well as to groundwater.

Liquid waste may refer to one or a combination of two or more of the following types

- domestic effluent consisting of black water (excreta, urine and faecal sludge) and grey water (kitchen and bathing liquid waste);
- water from commercial establishments and institutions, including hospitals;
- industrial effluent, storm water and other urban run-off;
- agricultural, horticultural and aquaculture effluent, either dissolved or as suspended matter" (Corcoran, 2010).

2.2.2. Solid Waste Management

Introduction

Urban solid waste is brought from a wide-range of streams; some of them include households, offices, shops, markets, restaurants, public institutions, industrial establishments, water works and sewage facilities, construction and demolishing sites, and agricultural activities. Solid wastes particularly in urban areas are mainly from four sources such as domestic households, commercial enterprises, industrial establishments, and institutional activities. However, because of their unique nature, two more types of sources can be distinguished. These are health care which mainly comes from health institutions and are hazardous and street wastes generated from all other sources but found on streets mixed together. Street wastes specifically contain a mixture of wastes collected from many sources including human faecal matter and animal manure. This is mainly because streets are used as dumping grounds for most of the generators and sanitation facilities are missing. Moreover, where a large animal population wanders the streets, it becomes common to find animal wastes on the streets. The huge amount of

construction and demolition debris is also dumped in the streets which add further to the solid wastes (Utz, 2008).

Wastes can also be classified based on their nature as biodegradable and non-degradable, putrescible and non-putrescible or organic and inorganic. But more widely and functionally, urban wastes could be classified according to their source into different waste streams such as municipal, industrial, hazardous, construction and agricultural waste. The municipal or domestic solid waste mainly refers to relatively wider waste streams: wastes from domestic households, commercial establishments, institutions, and street and public places. In most cases, the management of these types of wastes is the responsibility of the local government and the municipality. However, the local government or municipal government should take into account the management aspects of the industrial wastes partly because they usually end up in the municipal solid waste stream in the city or in the disposal site.

2.2.2.1. The Need for Solid Waste Management

Solid waste management is a discipline that deals with control of solid waste generation, storage, collection, transfer and transport, processing and disposal in a way that it accords with the best principle of public health, economics, engineering, conservation, aesthetics and other environmental considerations. Solid waste management should also be responsible to public attitudes (Sridhar & Hammed, 2014). In other words, solid waste management refers to all activities undertaken to minimize health, environmental, economic and aesthetic impacts of solid waste.

The very need for (solid) waste management is to reduce or eliminate adverse impacts of unmanaged (solid) waste on the environment and human health and support economic development and improved quality of life. To effectively manage municipal wastes, waste management system needs to involve monitoring, collection, transport, processing, recycling and disposal (Organisation, 2007; Syed, 2006).

An increasing amount of waste, both solid and liquid, is being generated in the developing countries' urban areas which are attributed to the rapid population growth, urbanization

and industrial growth. Moreover, rapid growth in the income of the population and a change in the lifestyle of the urban residents have brought about a change in the volume and composition of the waste generated, which in turn have created severe waste management problems in the urban areas. As a result, it becomes of necessity to establish an effective a collection, transportation and disposal system. Besides to the huge amount of waste generated, the occurrence of new types of waste like paper, plastic and metallic items in abundance has elevated the difficulty in disposal and thus it amplified the pressure on the municipalities to collect and dispose wastes properly and safely (Narayana, 2009).

Unlike the municipal waste, the collection and disposing (proper handling) of industrial waste is primarily the duties and responsibilities of the generators, that is the industries themselves. Indeed, municipalities or local governments do have one core responsibility with respect to industrial (and hazardous) wastes, that is regulating and monitoring of the industries' waste handling system based on the predefined requirements. Otherwise, industrial waste management is principally the duty and responsibility of the industry owners, whereas, the collection and disposal of municipal solid waste such as waste generated from households, institutions, commercial enterprises, and from streets and sometimes construction and demolishing activities is the duty and responsibility of municipalities (SHAFQAT, et al., 2014).

Generally, the rapid increase in volume and composition of solid and hazardous waste that occurs owing to continuous urban, economic and industrial growth has been a growing problem for local governments as well as national government to ensure effective and sustainable management of waste. It was estimated that in 2006, about 2.02 billion tones of municipal wastes was generated globally. This indicates that the total municipal waste generated in the world has grown by 7% annually since 2003. It was also projected that global municipal waste generation rate rose by 37.3% between 2007 and 2011 which is almost equal to 8% increase per year (Group & Management, 2009).

It would not be unusual for almost all human activities to create waste, but it is the way that waste is handled, stored, collected, and disposed off that can pose risks to the

environment and to public health. Safe and appropriate solid waste management are of greatest importance in urban centres where intense human activities are concentrated with the intention of maintaining healthy living conditions for the population (Zurbrugg, 2003).

The problems and issues of (municipal) wastes have been and will continue to be an immediate concern of local governments or municipalities of the urban areas, especially of the rapidly growing urban areas of the developing countries. Most governments well recognizes the need for proper management of the solid wastes generated within the urban areas. Unless effective and efficient solid waste management program has been set up, the waste generated from various human activities particularly both domestic and industrial can result in health hazards and environmental degradation. Nevertheless, the rapid increase in the quantity of waste generated and the changing nature and complexity of the waste composition caused mainly by rapid population growth surpasses the capacity of most local governments or municipal authorities to provide even the most basic services (Utz, 2008).

Put differently, the issue of solid waste management has become increasingly a global concern owing to the continuing growth of urban population and change in consumption pattern of the urban society. Consequently, the health and environmental implications of the solid waste management are escalating in urgency, especially in the developing countries. Surprisingly, it has been estimated that about one-to two-thirds of the solid wastes generated in the cities is not properly collected, and these uncollected wastes dumped indiscriminately in streets, open lands, and in drains are causing flooding, breeding of insects, rodents and various other vectors that spread diseases. Even the wastes that are collected are not properly dumped; they are usually either dumped in uncontrolled dumpsite or burned contributing to pollution of water resources and the air (Utz, 2008).

When one thinks about waste management, it is important to primarily recognize two basic facts: first, virtually all human activities produce waste; second, it is almost unfeasible to totally avoid the production of waste. Hence, it is vital to install appropriate and safe solid waste management (SWM) system. SWM is an important environmental health service,

and is an integral part of basic urban services. It is well known that there was an attempt to safely dispose of solid wastes since the primitive human society. And disposal was not problem in the early days because there was no problem of space for disposal (shortage of land) and settlements were very sparse. The problem of disposal has become very intense as towns and cities grow indefinitely accompanied by large number of people that gather in relatively a tiny area in quest of livelihoods. Then, on the one hand, the man-land ratio (density of population) increased resulting in an increase in waste generated per unit area; on the other hand, available land for disposal of waste decreases in proportion. For that reason, SWM emerged as an essential, specialized sector for keeping cities healthy and liveable (Ahmed & Ali, 2004; Zurbrugg, 2003).

The reasons and methods for managing solid waste have been evolved gradually depending on the socio-economic and environmental (physical) context of the urban areas in particular and the countries in general. For example, the reasons or drivers for solid waste management in developing countries and developed countries are not typically the same. In other words, the drivers, which emanate from the specific problems, for the solid waste management in developing countries are different from that of developed countries. Furthermore, what has been a key concern long time before in the developing countries will not be necessarily remain the same to that of today and tomorrow. In recognition of the time gap between developed and developing countries, Edwards (2010) and Marshall and Farahbakhsh (2013) have pointed out that despite the fact that globalization has increased, poor waste management practices and associated public health implication have been one of the severe problems in developing countries even after one and half centuries of the European Sanitation Revolution. This has been a case for various reasons which are mostly distinct from that of developed countries.

This implies that since socio-economic and environmental context is different, it will be unwise to replicate directly the industrialized countries' solid waste management practices and equipment. Waste management solutions in one region might not be appropriate elsewhere. Some waste management techniques might be more appropriate in developed or middle-income countries than in developing countries. In developing countries, for instance, composting organic waste and biogas capture may be more useful to deal with

wastes for they are high in organic matter, but recovery or incineration could be more appropriate waste management system in developed than in developing countries for the former have wastes of more calorific nature.

Rules and regulations that prohibit unregulated disposal systems and obligate the closure of inappropriate disposal sites are in place; yet, the enforcements tend to be weak. Instead, the economic value of waste has been the main driver for solid waste management in many of the developing countries today, where informal recycling gives livelihood in parts of the world (Konteh, 2009; Marshall & Farahbakhsh, 2013).

The benefits of solid waste management practices for public health and environmental quality are direct and substantial. Poor management of solid waste may bring about serious health problems and environmental degradation. Because of their organic and biodegradable nature (decay soon after its generation), wastes in developing countries' cities need frequent collection and disposal onto final site. Nevertheless, due to the ineffective and inefficient collection system, these components of solid waste generated in the cities of the developing countries are creating adverse impacts on human health and environmental quality of the urban areas. The adverse impacts of the organic, biodegradable materials on human health occur mainly because they attracts rodents and vector insects for which it provides food and shelter, whereas the impact on environmental quality comes in the form of foul odours and unsightliness. These impacts are not limited to only disposal sites but also they pervade the surrounding area and anywhere that wastes are generated, spread, or accumulated in the city. The adverse effects mainly of the organic, biodegradable wastes will continue until they are fully decomposed unless they are properly managed (Utz, 2008).

The overall objective of solid waste management is, therefore, to properly address the problems associated with health, environment, aesthetic, land use, resource, and economy produced due to improper waste collection and disposal of waste. Nevertheless, the waste produced by the flourishing cities in the developing countries is overwhelming the capacity of the local authorities and national governments alike (Edwards, 2010; Marshall & Farahbakhsh, 2013).

2.2.2.2. Functional Elements of Waste Management System

Today, the problems of solid waste management are very complex partly because of the huge magnitude and diverse nature of the waste produced. As they are accompanied by the development of sprawling urban areas, the funding limitations for public services in many large cities, the impact of technology, and the emerging limitations in both energy and raw materials, the problems of solid waste management has been intensified. Therefore, to manage solid wastes in an efficiently and orderly manner, it would be necessary to identify and clearly understand the fundamental functional elements / activities and relationships involved (Syed, 2006).

Solid waste management involves various activities ranging from generation point to disposal which include generation, reduction, reusing, recycling, handling, collecting, transferring, transporting, transforming (e.g. recovery and treatment), and disposal. A sound waste management program that goes with the local condition can be developed by cautiously bringing together some of the necessary activities into integrated solid waste management. Besides, legislative efforts and effective implementation are vital for the safe management and disposal of solid waste (Organisation, 2007).

The functional waste management elements are described in different sources in different level of detail and sequences of activities. In one of these sources, the functional elements in low or middle income countries are described as follows:

- Waste generation and storage
- Segregation, reuse, and recycling at the household level
- Primary waste collection and transport to a transfer station or community bin
- Street sweeping and cleansing of public places
- Management of the transfer station or community bin
- Secondary collection and transport to the waste disposal site
- Waste disposal in landfills
- Collection, transport, and treatment of recyclables at all points on the solid waste pathway (collection, storage, transport, and disposal) (Organisation, 2007).

The importance of context such as the institutional, socio-cultural and economic condition is highly recognized wherein the functional elements are founded on such local context. It is also accepted that the local context could be affected by the national politics, policies and legislations. To ensure sustainable and integrated solid waste management, in addition to the physical handling of waste such as storage, collection, transportation, treatment, disposing and so on, it is very important to consider the following key activities:

- develop and put into effect policy, standards and regulations
- appraising the data pertaining to waste production and characterization mainly for planning purposes.
- training and developing the capacity of the workers and planners.
- running public information and awareness and education programs.
- choosing and executing appropriate instruments, financial and cost recovery systems
- integrating formal and informal elements of the private sector as well as the community-based and non-governmental organizations.

Syed (2006:25) has clearly defined the functional elements into six main activities which encompass the right from the point of generation to the final disposal. As Syed tried to explain it diagrammatically with respect to their flow of occurrence and linkage, the main six functional elements include waste generation, storage, collection, transfer and transport, processing and recovery and disposal. By considering each functional element separately, it is possible, firstly, to identify the basic elements and relationships involved in each element, and, secondly, to establish numerical relationships which would be helpful to make engineering comparisons, analyses and evaluations. It is noted that the functional elements may not have fixed sequential arrangement. Moreover, the researcher believes that certain functional elements or activities like reusing, processing or recovery and treatment of recyclables could be consider as a cross-cut activities. This is because, particularly in developing countries, they can occur at any phase/stage of the functional elements. For example, collection of reusable or recyclable wastes could take place at sources (waste generation phase), primary storage, transfer stations or at the disposal sites.

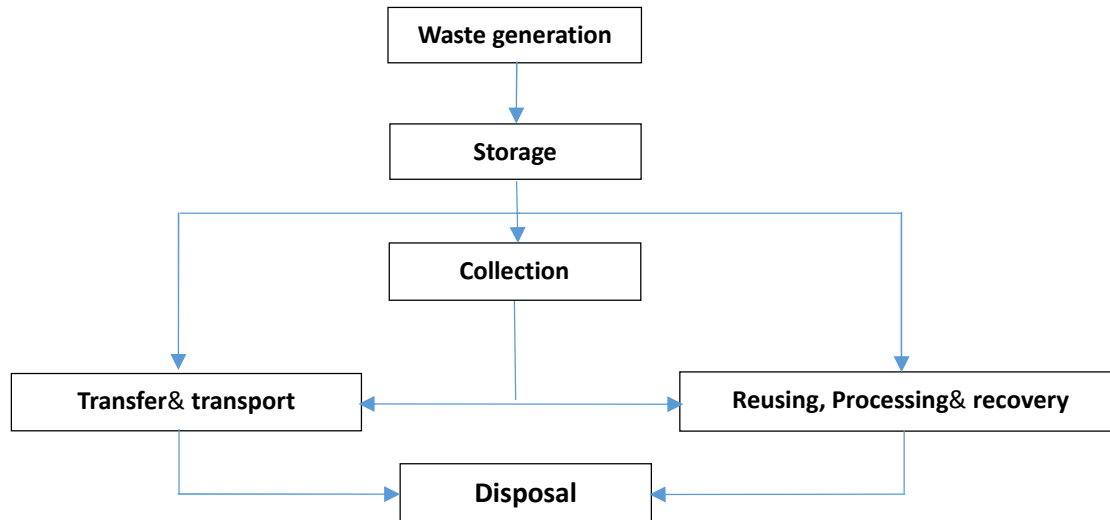


Figure 1: Simplified diagram showing the interrelationships of the functional elements in a solid waste management system

Source: adapted from Syed (2006)

2.2.2.3. Solid Waste Characteristics

Waste characterization is the initial phase of waste management and it is particularly very important for it determines the nature, magnitude (as measured in volume or weight), and composition of waste. This phase must be considered thoroughly in the design of solid waste management system because the activities in the subsequent functional elements of solid waste management system totally depend on the characteristics of solid waste. For instance, the types and sizes of storages, the need for transfer stations, the types and quantities of collection and transportation facilities, the design and size of landfill facility, and the need for and practicing of 4Rs (reducing, reusing, recycling and recovery) largely depends on the magnitude, nature and composition of waste (Syed, 2006).

Taking into account the significant increase in the quantity of waste generated and high variability in the composition of the wastes generated accompanied by very important sanitary, environmental, economic and social impacts linked with solid waste management, it would be worthwhile to bring the idea of proper management of waste to the attention of the community in general as the first priority issue.

Overall, from the discussion above, it has been possible to identify the two most important aspects of solid waste characteristics that play vital role in the solid waste management endeavours; these are waste generation and composition. Therefore, proper and adequate knowledge about waste generation and composition is a necessary precondition for all waste management activities including policy making, decision making and planning purposes.

Waste Generation

It is a usual phenomenon to generate waste material either as a by-product of human activities for which the generator could not find any use and/or as a product, which has finished its useful life (though not necessarily coincides with its life span). However, notwithstanding this phenomenon has been going on since long time ago, it has not been a problem until recent times mainly because it was not beyond the assimilative capacity of nature; nature has its own waste treatment methods like dispersion, dilution and degradation, which took care of these problems for long time.

Solid waste generation may be expressed either as rate (solid waste generation rate) and total amount (total quantity of waste generated). The generation rate allows comparison of different countries when investigating why solid waste is generated. However to describe the actual situation, the total amount of solid waste is more relevant since the population of the inhabitants is included. The total amount of waste generated can be used to estimate impacts of the waste management (whether or not it focused on strategic aspects of waste management) as well as to evaluate different treatment options.

Solid waste generation is the reflection of diverse factors including the lives of the people and the socio-economic activities in the country altogether. The role of income level of the people to determine the rate of generation of waste is highly emphasized by many researchers (Memon, 2010; Utz, 2008). But there are some more factors which are almost equally important to affect the amount and rate of waste generated in a particular area such as degree of industrialization, level of urbanization, public habit (lifestyle), consumerism, local climate, etc. (Lindell, 2013; Utz, 2008).

According to some studies, there is a linear relationship between the waste generation rate (when expressed as kg per person per day) and the four main factors. These factors include living standards, income level, degree of urbanization, and industrialization expressed as HDI (human development index), GNI/capita (per capita Gross National income), % of population (percentage of urban population), and % of GNI from industry (percentage of gross national income obtained from industry), respectively. The waste generation rate is directly related to these four factors; waste generation increases as the living standards and income levels of the people increases. Likewise, as the urbanization increases and industrialization grows the rate of waste generation increases. Despite the fact that it has been a serious challenge to make analysis and comparison among different countries partly due to lack of proper waste data and disparity in the definition of 'waste', it is widely believed that generation rate of the developed, industrialized countries is greater than the developing countries. Generally, highest generation rate has been recorded for the more developed countries like Europe, North America, Australia and New Zealand; whereas most of the African countries and certain Southeast Asian countries are characterized by lowest generation rate of waste. Besides, many literature sources have indicated that waste generation in urban areas has continued and will continue increasing throughout the world for various reasons like increase in the concentration of population and increase in living standard of the society, and waste generation has reached to unmanageable size in many urban areas (Ahmed & Ali, 2004; Ichimura, 2003; van Dijk, 2012).

The overall reports of waste generation rate show significant variation between countries. For various reasons, low-income communities generate lower waste volumes. They (lower income countries) buy little and are less wasteful in consumption and this is a straightforward and simple reason for why lower income countries generate lower volume of waste than higher income countries. As a result, low income community living in urban areas particularly in developing countries spend most of their meagre, disposable income for purchase of food items and most part of it is consumed, which means is that they have little to be disposed (van Dijk, 2012).

On the contrary, the higher income communities of the urban areas, particularly in the developed countries, generate higher volume of waste partly due to; 1) since they have higher disposable income they purchase and consume more goods that have high waste portions; 2) the higher income communities generally have a more wasteful consumption practices. Moreover, the high-income groups do purchase a variety of goods wherein some of them have wastes in the form of non-consumable like packaging, containers, etc. In general, the lower waste generation level, whether measured in terms of rate or total volume of waste, of low income countries in Africa and Asia than higher income countries is attributed to their lower national GDP per capita (van Dijk, 2012).

In general, the process of rapid population growth and urbanization and economic growth promoted by globalization has been accompanied by a greater volume of waste. Besides, this situation has created serious strain on the capacity of municipality in many aspects (Van Beukering, et al., 1999).

The most appropriate option is to avoid waste generation; however, for various reasons it becomes unrealistic to totally avoid generation of waste, but it is feasible to minimize the wastes to be generated and hence arrive at the final disposal sites. Hence, it would be necessary to assess options to handle the waste that has already been generated. To this effect, different hierarchies, policies, and handling strategies have been established, giving priority to reduction in the amount of waste generated. Likewise, the waste management hierarchy, along with the waste generation reduction, should ensure material recovery (as the most preferable option to handle the waste generated), treatment and disposing in controlled sanitary landfills as alternatives with final disposal (van Dijk, 2012).

However, today, as remarked by Syed (2006), the situation is not as simple as it was long time before mainly because of the significant change in waste produced both quantitatively and qualitatively. Wastes are produced and disposed of faster than nature's ability to degrade and absorb them. Worst of it, the composition of the waste has increasingly been dominated by modern waste materials like plastics and detergent materials which are not biodegradable. All these changes in the characteristics of waste are causing and will

continue to cause serious problems for public health and environmental quality, and the ecosystem in particular (Syed, 2006).

Composition of solid waste

Urban areas in developing countries have to deal not only with increasing quantities of waste (residential wastes, commercial waste, industrial wastes, and institutional wastes) but also with the continually changing composition of waste. The same as generation rates, the composition of wastes vary considerably in place and time owing to the differences in cultural traditions such as food habits and more particularly differing socio-economic characteristics.

A monster of solid waste which is composed of domestic garbage, organic litter, plant leaves, branches, logs, spoiled agric produce, crop residues, bad food materials, pieces of paper, polythene bags, rags, vehicle scraps, used tires, dusts, mire, plastics, glass, blood, bones, animal skins, hides, leather, urinary and fecal materials, etc is generated in the urban areas of developing countries. If they are not properly disposed, which is a general truth, these wide-ranging types of wastes will causes serious threat to air, water, land and soil, vegetable, wildlife and man. Sickness and disease epidemics often occur due to the poorly managed and improperly disposed of sewage, garbage wastes and unwanted substances (Awomeso, et al., 2010).

Many aspects of the waste management system are determined by the nature and composition of wastes. Lindell (2012:22) has showed the effects, spatial patterns and opportunities of composition of waste on the overall waste management systems. The composition of waste, for instance, determines possibilities for waste treatment, the waste management practices, and the effects of improperly managed waste. For instance, high organic content of the waste coupled with tropical climatic condition can become a major health hazard if they are not timely collected and properly disposed. On the other hand, it could be an opportunity for it has high recycling potential particularly composting and biogas production. He also recognized that there is a distinct difference between developed and developing countries in the composition of their waste. One of their distinct

differences is in the proportion of the organic content of their waste. Usually, developing countries (such as Africa, Latin America and South East Asia) have larger proportion of organic wastes which is estimated to be nearly three times greater in proportion than that of developed countries.

Despite the fact that data is unavailable or unreliable, the organic materials of the developing countries' waste account for 50% and above of the total waste composition; whereas, for developed countries they are less than 50%. Another differences among developed and developing countries is that the calorific value of the urban solid waste of the developing countries is lesser than that of developed countries (Cotton, et al., 1999; Lindell, 2013). The calorific value of the waste of developing countries' cities (which is estimated to be less than 1500kcal/kg) is insufficient to self-sustain incineration waste and, thus it cannot burn unless fuel is added on it (Cotton, et al., 1999; Lindell, 2013).

This clearly implies that composition has an implication on the disposal options where incineration of domestic waste is not normally a suitable option in the developing countries. Whereas, composting of solid wastes of urban areas is not an appropriate option in the developed countries (Cotton, et al., 1999; Lindell, 2013). The composition of the waste will also change from organic waste to non-organic and hazardous or clinical waste. Solid waste generation is much lower than developed countries; yet, it creates more environmental problems in this region as many cities are not able to manage it due to institutional, regulatory, financial, technical, and public participation shortcomings (Memon, 2002).

In addition to the rapid rural-urban shift and natural population growth, the gradual progress of the developing countries towards industrialization, which has been evident since the last few decades, has been increasingly creating additional burden on their waste collection and disposal methods and added treats to the environment. As a result, the quota of developing countries of pollution hazards released to and on the environment has raised and intensified significantly. Nevertheless, the prevailing serious deficiency in information and resources such as technology, finance, human power, expertise and

facility and capacity has hampered the developing countries' efforts to mitigate the environmental pollution generated from their domestic and industrial wastes.

2.2.2.4. Waste Collection, Transportation and Disposal

The huge quantities of waste generated due to rapid population growth, urbanization and industrial growth have led to severe waste management problem particularly in urban areas of the developing countries. This has made the proper and systematic collection, transportation and disposal of the wastes very essential (Narayana, 2009).

Effective removal (which mainly represents collection and disposal) and treatment of the wastes is an important urban environmental service. In addition to electricity, gas and clean water, waste collection specifically is an essential utility function as well as part of the infrastructure and service. The impacts of poor urban waste collection and disposal are directly reflected on the health, length of life of human being and the urban environment. Therefore, ensuring adequate and effective waste collection and disposal has to be the primary concern of the city authorities as their essential task. To effectively collect waste, city authorities need understanding of their citizens and their city, and making a focused and sustained effort to mobilize the human and financial resources.

Many authors argue that the first step in the way to modernization is to ensure properly handled waste collection activities. Doing this efficiently, fairly and effectively means is that cities should be kept clean, cost effectiveness of services should be improved, and effective channels of communication between users and providers should be created. Unless they are properly collected and disposed, solid wastes end up somewhere. The somewhere may refer to open spaces, alongside roads or pathways, in river courses, public parks, etc. Uncollected waste has economic, social and technical costs for a city. A dirty and unhealthy city will make it difficult to attract businesses (Un-habitat, 2010).

Municipal or local authorities should be responsible for the provision of solid waste collection service to their citizens mainly because the occurrence of health problems is largely linked with poor sanitation and properly uncollected wastes. For instance, incidences of infectious diseases are directly and indirectly associated with poorly

managed (uncollected and improperly disposed) solid wastes. The main waste streams for which municipality is responsible for their collection are municipal solid wastes such as residential houses, commercial houses, institutions, light industries as well as rubbishes swept from streets. Residential wastes usually account for about 50% to 80% of the total quantities of wastes generated by the aforementioned sources (Technology & Economics, 2005).

Waste also causes health problems when it is burned in a barrel or in a heap and when children play on it and with it. Wastes dropped somewhere clogs drains and causing flooding and subsequent spread of waterborne diseases. When blocked storm drains and pools of stagnant water are created, it becomes a fertile ground for breeding and feeding of mosquitoes, flies, and rodents. These altogether causes diarrhoea, malaria, parasitic infections and injuries. For instance, the floods in West Africa are mainly caused by the small plastic bags (Technology & Economics, 2005; Un-habitat, 2010).

Solid waste collection and transportation services are usually featured by severe challenges related with equity. The problem of equity related with this important service is reflected in many ways. Primarily the poor waste management usually and more strongly affects the poor people than the richer neighbours in many ways. Moreover, the types and quality of collection services provided at the centre and outer part of the city varies significantly. It is apparent that city centres usually receive a better door to door collection and more frequent services (several times per a week) than the outer part. The outer part of the city including the peri-urban and the slum areas usually receives container services, which are rarely emptied to dump sites. Since they are emptied so seldom, the areas where the containers are sited are converted to informal dumpsites attracting insects, rats, dogs and grazing animals, and, always, more waste.

However, there is one vivid fact that, according to Un-habitat (2010), providing good collection service to both the poor and the rich is not only an issue of equity, but also problems related with it like infectious diseases will not affect exclusively the poor neighbourhoods but the whole city. Furthermore, it pointed out that 'one thing is certain: even though the poor suffer more from inadequate waste collection services, the rich

cannot afford to ignore the poor in their city – infectious diseases have no respect for wealth’(Un-habitat, 2010).

Waste collection may be classified into two phases: primary waste collection and secondary waste collection. This method of classification presumes the existence of short-haul transfer, which may be referred to as transfer station, collection points or storage points in between the primary and secondary collection. Primary waste collection refers to the removal of waste from houses to some kind of waste collection points in the neighbourhood; whereas secondary waste collection denotes collection and transportation of waste from those collection points to the disposal sites or a processing facility. Secondary collection and transportation is usually carried out by the municipal department or a large private company that the city has contracted.

Because of different reasons, collection methods used in different cities may vary. Moreover, collection methods may be classified in different ways. The collection methods include house to house collection, community bins, kerbside collection, and self-delivered, contracted or delegated service. The house to house collection refers to collection of waste directly from individual houses where the user pays a fee to get the service. When waste generators bring their waste to a communal collection point in neighbourhood, he classified the method as community bins. The bins are then picked up by the municipality according to their schedule. The kerbside collection basically refers to method where the people living in the neighbourhood place their waste in a container directly outside their houses and then the municipality collects based on the schedule it set in advance. Whereas in the rest two collection systems (self-delivered and contracted or delegated), the waste generators take the responsibility of collecting and transporting their waste to collection points or disposal sites. This means is that no communal collection service is provided to waste generators. The only difference between self-delivered and contracted or delegated collection systems is that in the case of the latter, the waste generators give contract to private entrepreneur to collect their waste and the entrepreneurs receive service fee directly from the waste generators or through the municipality who collect fees from the inhabitants. He noted that within a city border, there could be more than one methods of collection implemented at different neighbourhoods. In developing countries,

the prerequisite for waste collection can vastly differ even within the city border (Lindell, 2013).

Another classification system has also been used by other scholars. Essentially, there are four basic collection systems, depending on the level of efforts required on the part of the generator. The types of collection systems are: communal, block, kerbside, and door-to-door. Communal storage and collection may require delivery of the wastes by the generator over some distance. In block collection, the generator delivers the wastes to the vehicle at the time of collection. In kerbside collection, the generator sets out the full container and later retrieves it. In door-to-door collection, the collector enters the premises, and the generator basically is not involved in the collection process. When evaluated from the viewpoint of cost, convenience, effectiveness or other factors, each of these collection systems do have their own advantages and disadvantages.

The status of solid waste management system could be determined in various ways. Among which, the collection coverage and disposal systems are the most important indicators of solid waste management status of a particular city. They largely determine the extent to which solid wastes are managed. Moreover, the standard of the operating systems of solid waste management in general and waste collection and disposal system in particular could reflect the position of the waste management system. Wilson, et al (2006) argued that solid waste management systems are poorly managed and the operating system is substandard when waste collection service is unreliable and waste collection coverage is very low. Waste collection service also not only competes but also conflicts in many ways with other urban services.

Developing countries in general are characterized by insufficient collection, uncontrolled street collection points. Improper disposal of waste in open dumps allows refuse to be readily available for informal waste recycling through scavenging/waste picking (Wilson, et al., 2006). Moreover, developing countries' cities employ very rudimentary organizational and planning systems of solid waste collection services. They provide waste collection services which is not supported by knowledge about the quantity and types of solid waste

they are collecting. The amount of solid wastes recovered and recycled are also unknown (Buenrostro & Bocco, 2003).

More specifically, despite the fact that waste collection service occupies the pivotal position in waste management system, poor performance has been recorded in most of the developing countries. Some of the major problems associated with this poor collection service in developing countries include low waste collection service coverage, application of inappropriate technology, tendencies to acquire imported equipment, inadequate resource mobilization, and inappropriate methods of finance. The low coverage of collection service implies mainly two situations that, on the one hand, the size of urban community or neighbourhood which receives collection service is minimal; on the other hand, the magnitude of waste collected properly as compared to the total waste generated is very low. As it is indicated in many sources, the urban poor or marginal neighbourhoods receive minimal services, and if any, the level (the quality and coverage) of services provided in these areas will be much lower than the services available in the middle and high income areas (SHAFQAT, et al., 2014).

In developing countries, where vehicle costs and fuel costs are generally high, it would be possible to ensure optimum system of cost efficiency and high vehicle productivity by using labour intensive methods because labour is relatively cheap. Generally, developing countries should consider the specification of equipment because those equipments that requires continuous and precise maintenance procedures and imported spare parts results in extremely high expenses and long periods of downtime.

There are several reasons for the poor levels of collection service existed in the low-income communities. Some of them are mentioned below.

- The presence of many open communal waste containers sites and illegal dump sites that create favourable condition for the breeding of flies and rodents.
- Improper collection method that causes physical damage and health problem in the workers who have direct contact with wastes that sometimes contain faecal matters.
- Not only collection vehicles are too old and too few, but also there is poor maintenance and absence of vehicle replacement policy.

- There is heavy dependence on imported vehicles and equipment, which are not suitable with physical and socio-economic condition of their urban areas (SHAFQAT, et al., 2014).

It is suggested that developing countries require proper and efficient waste management mechanism, which requires them to introduce and use appropriate technologies and efficient facilities suitable for all waste-polluted environments (Awomeso, et al., 2010). Norbu, et al. (2010:111) have argued that (municipal) solid waste management problems are man-made and come about to a great degree due to the greedy behaviours and ignorance of the waste generators as well as the practitioners (particularly the collection and disposal service providers).

The paramount importance of information on waste composition and quantity as a base to understand the potential for waste recovery, collection, transportation and disposal and successful management has also been well acknowledged. However, despite the significant concern to improve the existing poor waste management system as a whole, the data available on waste composition and quantity which is a prerequisite for overall waste management planning is very limited. The problems regarding the data are not only linked to unavailability of data in all aspects but also the quality of data we have is questionable.

To design and plan sustainable waste management, it is essential to have reliable data about the waste characteristics (generation rate and composition, if possible, by types of waste stream) together with the socio-economic factors that determine their characteristics. Nevertheless, bearing in mind the commitment they have and the time and financial resources they allot to establish database by conducting studies, many municipalities are not capable of making reasonable decision about the best SWM systems and approaches (Buenrostro & Bocco, 2003).

Shortly, the most typical characteristics of solid waste management of the developing countries could be summarized into four as 1) inadequate service coverage and operational inefficiencies of services, 2) limited utilization of sustainable and integrated

approaches like recycling activities, 3) inadequate and inappropriate waste dumps or landfills and 4) inappropriate management of hazardous and health care wastes (Zurbrugg, 2003).

2.2.3. Liquid Waste Management

Municipal liquid waste refers to the mixture of all types of liquid waste from all sources, which might be distinguished as domestic, commercial and industrial liquid waste or effluents and urban runoff and infiltration. Environmental conditions arising from inadequate or non-existing liquid waste management pose substantial threats to human health, well-being and economic activity. The consumption of contaminated water and food as a result of untreated liquid waste has been one of the greatest challenges to the public health and environmental problems and this problem has hindered the development and poverty reduction efforts particularly in the urban poor.

Liquid waste can be contaminated by numerous different components like pathogens organisms, organic compounds, synthetic chemicals, nutrients, organic matter, toxic compounds and heavy metals. They may occur either in solution or as particulates and carried along with water from different sources and affect the quality of water. These components, in general, have the characteristics of being bio-cumulative, persistence and synergetic and affect the health and function of the ecosystem (such as food production, human health and wellbeing and the human security). Literature and practical evidences demonstrate that improperly or poorly treated or totally untreated liquid waste released to the environment has serious consequences on health and environment, and socio-economic and financial resources (Water, 2015). According to certain studies, about 80 percent of the sewage produced in the world, mainly in the developing countries, do not go through preliminary treatments at least to remove high-level contaminants coming through sanitary system before they flow to surface or water bodies. This condition intensifies both the environmental and public health impacts of effluents (Eko Victor, 2013).

The problem related with liquid waste management is particularly high in the developing countries. The proportion of population with no infrastructure and the quantity of untreated liquid waste flowing directly to water bodies is significantly high. It is estimated that 80-90

percent of the unmanaged liquid waste generated in developing countries is discharged directly in surface bodies and has been the main sources of pollution and a hazard for the health of human beings, animals and the environment. Unless urgent response for action to manage liquid waste better is given, it would be more likely the situation to get worse (Corcoran, 2010).

Hence, tackling the challenges of liquid waste should not be considered as luxuriant act, but a prudent, practical and transformative act, in order to boost public health, secure the sustainability of natural resources and trigger employment in better, more intelligent water management. Liquid waste should not only be considered as a threat, but also as opportunities for, among others, socioeconomic wellbeing and ecological health (Corcoran, 2010).

Today, the pressure exerted by unmanaged liquid waste has been beyond the capacity of nature to assimilate itself and has threatened the basis of various activities. The volume of liquid waste generated from the domestic, industrial and commercial sources has increased owing to the population growth, urbanization and improved living standard and economic development. In the last three decades alone, the world population has doubled to six billion people, the world economy has been more than doubled and the level of urbanization has increased, especially in developing countries (Kamyotra & Bhardwaj, 2011). These changes have been accompanied by an increased discharge of municipal liquid waste. The continued growth of population and economy will further result in more increase in (municipal) liquid waste discharge and hence more damage of the environment in the years ahead except appropriate and adequate action is taken to control pollution. Especially, developing countries are more vulnerable to the problem (Kamyotra & Bhardwaj, 2011).

Huge volume of the liquid waste is produced mainly from households where its quantity and quality (which mainly depends on its composition) is largely determined by the availability and consumption of water supply, number and standard of living of population, and climatic condition. Domestic liquid waste can have high concentration of pathogens associated with human excreta especially in countries where diarrheal diseases and

intestinal parasites are common (Water, 2015). Moreover, the composition of the liquid waste and hence its quality is also mainly affected by the constituents of the industrial discharges like heavy metals and other toxic compounds (Eko Victor, 2013; Schomaker, 2004).

The main goals of municipal waste (solid as well as liquid) management are highly regulated within the municipal infrastructure. The assumption is that by so doing it would be possible to achieve a wide range of goals such as to protect human and environmental health; promote waste minimization and recycling activities; control and restrict improper waste management activities; and to minimize the impacts of unmanaged waste on the residents, water bodies and the ground and soils. Hence, any activity related with waste management including transport, recycling, treatment, disposal and utilization of liquid waste, and energy use should be controlled by regulations, restrictions and guidelines at all administration levels such as national, regional and local.

The problem of waste in general and liquid waste in particular is not only related with pollution of water but also its contribution to Green House Gases (GHG) emission is significant. In developing countries, due to rapid population growth and urbanization without concurrent development of liquid waste infrastructure, Methane (CH₄) and Nitrous oxide (N₂O) emissions from liquid waste are generally higher than in developed countries. It is recognized that the Green House Gas (GHG) emission from liquid waste alone in the developing countries is substantially high especially from septic tanks, latrines and uncontrolled discharges (Bogner, et al., 2007).

Many sources indicated that in almost all parts of the world, there is huge need for water and it will continue to be scarcer especially in the developing countries. In the coming 30 years, it is estimated that over half of the world population will face water shortage. This implies that there is huge unfulfilled demand for domestic water. To meet these demands, it is hoped that sustainable liquid waste treatment could be secondary water resources. That is why a need is widely arising (particularly in the seriously water deficient developing countries) to generate water from all available resources including liquid waste by recycling, reusing, recharging, and storing. Moreover, liquid waste could also be sources

of nutrients for agriculture and the environment if safely recycled as it is in Mexico, Zimbabwe, China, and Sweden (Kamyotra & Bhardwaj, 2011; Mara, 2013). As a result, it has been strongly argued that future demands for water cannot be met unless liquid waste management is revolutionized (Corcoran, 2010).

2.2.3.1. Liquid Waste Treatment

Why and how to treat liquid waste?

The overarching aim of liquid waste treatment is, therefore, not limited to only reducing the pollutants before disposing into the environment, but also to increase water supply and then minimize the problem of water shortage to all purposes like domestic, agricultural, industrial and constructional purposes. There are a wide range of liquid waste management systems including treatment system, but the types of management and treatment systems to be used should be context-specific such as physical (like location, climate, topography, etc), socio-economic and culture of the society, purpose and use of the treated waste and residues or sludge. Thus, the choice of liquid waste management system in general and treatment systems in particular should primarily be locally appropriate and feasible (Water, 2015).

According to certain literature sources, developing countries have implemented a wide range of legislations and policies. Since a wide range of waste management legislation and policies have been implemented with evolving structure and enforcement, the regulatory frameworks in developing countries is expected to become more stringent in parallel with development trends. Nevertheless, when the liquid waste management practices of the developing countries prevailing so far, is examined, it seems that currently they are repeating the same history of the developed countries in that they are giving priority to the ineffective and unfeasible collection and disposal systems (Bogner, et al., 2007).

The Millennium Development Goal (MDG) was expecting the developing countries to reduce the number of people without access to safe sanitation by 50% in 2015 by encouraging them to focus more on on-site waste management rather than centralized

liquid waste management system which requires very expensive transport of sewerage and treatment plants (Bogner, et al., 2007).

Currently, no doubt that effective liquid waste treatment is mandatory for the sake of environmental and human health. Therefore, the governments and regulatory agencies including local authorities like city or town councils, or specific liquid waste treatment authorities, or more generally the water and sewerage authorities need to understand that domestic and other liquid waste types require treatment before being discharged or, preferably, re-used in agriculture and/or aquaculture (Mara, 2013).

Because of the significant increase in the volume of urban liquid waste and the release of untreated liquid waste in developing countries, it is highly recommended to employ treatment systems of primary, secondary and advanced types. However, the sustainability of some of the treatment systems is questionable. Only a tiny fraction of the liquid waste produced in the developing countries' cities is treated. This is attributed to numerous factors, among which, financial constraints (which resulted in non-existent) and impractical or unfeasible liquid waste treatment systems/ technologies take the lion's share. Also ignorance of low-cost liquid waste treatment process and the economic benefit of reusing treated liquid waste are part of the main reasons which inhibit developing countries to establish liquid waste treatment.

As it has been practiced in many tropical countries, it would be more preferable to focus on cheap, sustainable, and small-scale and low-cost sewerage treatment technologies rather than on conventional capital intensive, large-scale and high cost conventional treatments. What is essential above all for designing and selection of liquid waste treatment technologies is that, as a preliminary condition, the nature of the liquid waste in terms of types, sources and compositions should be differentiated.

An 'on-site liquid waste management' system is a system that provides the treatment and return to the environment of domestic liquid waste residuals within the boundaries of its property of origin. Domestic liquid waste is the liquid waste or sewage discharged from residential households or human wastes of a similar character discharged from other facilities. Domestic liquid waste includes liquid waste discharged from toilets, bathrooms,

sinks, showers, baths, laundries and kitchens, dishwashers, sinks and garbage grinders. The types of facilities that typically generate such liquid waste include dwellings and other residential institutions such as hotels, rest homes and equivalent accommodation units, as well as facilities servicing schools, cafes, restaurants, offices, commercial premises, and other public facilities. Such a treatment system includes a primary treatment stage (such as a septic tank). Primary treatment involves separation of bulk solids, grease and grit from the main liquid stream (Council, 2004).

Septic tanks are the primary treatment units; they are watertight chambers sited below ground level that receive excreta and flush water ('black water') from flush toilets and also household silages or 'grey water'. The solids settle out and undergo partial anaerobic degradation in the tank, while the effluent stays in the tank for a short period before, according to conventional design, overflowing into a soak pit or drain field (Fewtrell & Bartram, 2001).

Septic tank is an underground tank where all the water-borne waste from a house is deposited and decomposed by bacteria. Solids and dead bacteria settle to the bottom as sludge while the liquid portion flows into the ground through a 'soak away' comprising either a network of underground pipes or a stone filled pit that allows the effluent to percolate into the soil. The sludge needs to be removed periodically in order for the tank to function properly (Torondel, 2010).

Liquid waste discharge from on-site liquid waste systems typically contains high concentrations of pathogens such as bacteria and viruses, elevated nutrients and to a lesser extent toxic substances. These contaminants can present health risks to people and give rise to negative environmental effects. To avoid such effects, it is essential that every on-site liquid waste system is correctly installed and maintained. Even a well designed, appropriately installed and maintained system, may bring some changes on the receiving environment over a long period of time. Therefore, the design and installation should be considered in view of the site characteristics (Association, 2013; MacDonald, et al., 2014).

Obviously, a wide range of measures have been identified that could potentially improve water quality but it is so vital to conduct a feasibility assessment that focused on the application, effectiveness, efficiency, cost and ease of adaptation of the different on-site liquid waste treatment options. Torondel (2010) argued that for a large percentage of the world's population, the only real sanitation option available is 'on-site sanitation'; an approach where liquid waste collection from sources, transportation to a suitable location, storage and treatment and reusing and /or returning to the environment is smoothly undertaken within the boundaries of the household.

2.2.3.2. Public Toilets

Public toilet is one of the most important public service which plays a crucial role in maintaining the health and cleanliness of the public and the environment. Moreover, public toilets as an essential infrastructure are necessary to improve the social wellbeing and practical operation of a functioning city (Oyinloye and Oluwadare, 2015:9). The term public toilet is also known by different and more euphemistic terms as 'public convenience' (Oyinloye and Oluwadare 2015), and 'public restroom' (Anthony & Dufresne, 2007).

Public toilets pose a myriad of health and safety issues for women, men, adults, children, the elderly, persons with disabilities, and caregivers (Anthony & Dufresne, 2007). While illuminating the importance of the public toilets, Oyinloye and Oluwadare (2015:9) have said that public toilets are so important components of liquid waste management system and vital to create sustainable, accessible and inclusive cities. The presence of sufficient and appropriately located public toilet facilities at the right time during both day and night time could prevent street fouling which could impair the quality of places and of life for local people.

Public toilets are usually designed and located bearing in mind the transient population and the places where a variety of activities are concentrated and people gathers for some purposes like markets, shopping areas, transport terminals, religious institutions and cultural and recreational centres, etc. Public toilets are needed not only for habitual and persistent occasions but also in places where irregular special occasions and events are undertaken. The design and location of the public toilets are important factors which

should be considered thoroughly because public toilets that badly designed, maintained and poorly located could not readily attract for beneficiaries and they might be hidden places convenient for illegal acts like vandalism, anti-social behaviour, and social disorder (Oyinloye and Oluwadare, 2015).

Safety also plays a crucial role in public toilet services provision. The design criteria should also include safety criteria to ensure safe environment within and around the public toilets. The safety criteria includes, among other, single cubicle unisex toilets, self-contained cubicles with hand washing facilities, cubicles accessible directly from public space (no common foyer or hand washing area), clear sightlines to toilet entry, toilets visible from public space (not shielded from public view), cubicles on single frontage if there is more than one cubicle, and adequate lighting in and around the toilet cubicles.

The design of public toilets refers to a wide range of aspects but it is very difficult to consider them exhaustively. Besides to the design elements described above, a public toilet may be identified as well-designed if it has the following basic features: clean and dry, well ventilated, easy to maintain, carefully planned layout, and friendly to persons with disabilities and special needs (Association, 2013).

Put it differently, since illegal acts like vandalism is more likely to occur when the toilets are located in remote sites, located in places hidden from public view or have a low average usage, the sitting of toilets in places of maximum visibility while maintaining privacy is therefore of primary importance to protect them from any types of illegal acts. Sometimes, while efforts are made to consider aesthetic issues and privacy, location of toilets are compromised but it should not to be; public toilets should not be placed in sites shielded from view by any erected structure or vegetation or other things, and it must have adequate lighting (Association, 2013).

The researcher, therefore, emphasizes that it is not only lack of public toilets which should be considered but also the design and location of these public toilets (which usually is overlooked) should equally be considered while thinking effective waste management in urban areas.

As it is indicated in different literature, because of varied reasons, public toilets are not contributing to the sanitation condition of the urban areas in the developing countries rather they have been major causes of environmental and human being health problems. The services they provide are very limited and of poor quality not only because their prevalence rate is very low but because their quality and standard is very low. For instance, the public toilets in Nairobi, Kenya are suffering from insecurity, inadequate lighting, poor accessibility, lack of privacy, and dirty and unhygienic environment (Note, 2004).

2.3. Urban Environmental Management

As a complex living entity, the environment could be recognized as an ecosystem and as such it encompasses all structures and infrastructures built in a defined area that is commonly called as urban area together with the natural resources and all conditions that make up or cause urban areas to exist including all the human beings who reside and work in them. The urban environment comprises very diverse components, among which, the human beings who reside and their activities and their goods and belongings, built up structures, and the naturally occurring resources are the most common. All these and other components of the urban environment are highly interconnected with each other and could be affected directly by the growth of the urban area. Consequently, the complex nature and interconnectedness of the constituents of the urban environment have made the problem of the urban area very complicated and so difficult to solve and bring out solutions. For the reason that it is very complex in nature and its constituents have many-sided connections among each other, urban environment has exerted pressure on local urban administrators and make them to consider many factors while they are searching solutions to urban environmental problems (Shin, et al., 1997).

Virtually all literature sources have documented that rapid urbanization is increasingly threatening the urban environment. Thus, protecting and improving the urban environment is not a matter of choice for extra comfort but a necessity for survival. The rapid urbanization which is particularly prevailing in the developing countries could be a threat to health, the environment and urban productivity unless it is given attention to the best

possible level. It is recognized that cities are the engines of economic growth; however, it is as well noted accepted that the environmental implication of such growth needs to be well assessed and managed (Williams, 2000).

Efficient and productive cities are essential for national economic growth. But the development potential of cities is all often crippled by environmental deterioration. Besides its vivid effects on human health and wellbeing of the society, particularly of the poor, environmental problems could hold back the economic development of a particular country or region or city (Decker, 2001). To be efficient and successful, therefore, a city should not operate in isolation from the environment; rather it should be able to balance the social, economic and environmental needs (Alliance, 2007). It is unquestionable that cities, if well managed, could give vital opportunities for economic and social development of the cities as well as the country in large (Cohen, 2006). Therefore, cities, to be a real home of human being in the future, they should be socially equitable, economically successful and environmentally sustainable. Ensuring sustainable urban development is, therefore, an issue of necessity but not a choice of cities so that they could be successful to meet the needs of their residents (Alliance, 2007). Hence, as experiences have shown in both the developed and developing countries urban environmental management strategy and action plan formulation has been an effective approach for tackling the environmental issues of urban areas (Bartone, et al., 1994; Williams, 2000).

Theoretical and empirical sources have widely witnessed the paramount importance of (urban) environmental management system or approach formulation to deal effectively with the diverse environment-linked problems. Indeed, literature sources indicated that because of various reasons it has been very difficult to provide a concise definition of environmental management and to delimit its scope. In recognition to the problem related with the definition and scope of environmental management, Barrow (2006:6) has said that 'there can be no concise universal definition of environmental management given its very broad scope and the diversity of specialization involved'. He has tried to show the difficulties in defining the concept by illustrating definitions provided by different scholars in his book entitled 'Environmental Management for Sustainable Development'. It is apparent that significant differences are observed in the definitions and scopes of the concept

among the different scholars as cited in the book. Most of them seem purpose-specific definitions or operational definitions.

As Alexander (2007:1) stated, 'environmental management is a mixture of science, policy, and socioeconomic applications'. The centre of attention of environmental management is the solution to the practical problems that humans face while they are living with nature, exploiting resources, and generating wastes. The concept environmental management, Barrow (2006:5) said, is 'the process concerned with human-environment interactions, and inquires to identify what are the environmentally desirable, and the physical, economic, social and technological constraints and most feasible options to achieving those environmentally desirable'.

However, whichever way we defined it; it is so apparent that environmental management is a response to the increasing seriousness of the human impact on natural ecosystem. Indeed, the impacts could be reciprocal: human impacts on environment or environmental impacts on human health and wellbeing. The response to human impacts on environment may be undertaken at different administration, sectoral or institutional level but in different mechanisms. Environmental management as a response to environmental impacts of human activity may focus on reducing pressures, improving conditions, or taking defensive action against impacts. Nevertheless, it is commonly illustrated that institutions in many of the developing countries face serious limitations including political and technical matters. On the one hand, whereas local governments of cities are bearing most of the responsibilities for infrastructure, provision of varieties of services including waste collection and disposal, controlling and monitoring of pollution, etc, national and regional governments continue to control the power, financial resources, and level of representation needed for effective governments. Put it differently, the local governments and institutions have very little power and control over resources allocated to the city wherein central governments are strong and control resources (Linares, 2003).

As explained above, the environmental problems of urban areas are complex and interrelated. Local initiatives to resolve one problem may bring new problems elsewhere. Accordingly, we rarely found a singly simple workable solution to environmental problems.

Attempts to address one problem may bring alternatives and challenges on others (Barrow, 2006; Linares, 2003).

Environmental problem, which basically refers to the physical environment, has usually significant harmful effects on human health caused by man-made activities on the human health, either now or in the future (Mpofu, 2013). Environmental management is devoted to understanding the interactions of human and environment, and science and common sense is applied to solve such problems (Barrow, 2006). Urban environmental problems are conventionally categorized technically into air, water, sanitation, solid waste, etc independent to the social, economic, and institutional factors which play critical role in addressing these problems.

The nature and severity of environmental problems in a particular urban area will depend on various factors, which include the unique natural features of urban areas, population size and rate of growth, the level of income and economic development, the diversity and spatial dimensions of problems, and the roles of local actors (Williams, 2000). Williams also acknowledges the role of the linkage among poverty and economic development and the environment, and he recommended that their linkage should not be under estimated. Therefore, the environmental management system we introduce to a particular urban area shall be contextualized. This is mainly because the different factors do have different magnitude of spatial concentration and hence create spatially varied challenges. It is more likely that the spatial variation in the concentration of people, industry, commerce, vehicles, energy consumption, water use, waste generation, etc among urban centres and within urban centres is more likely to bring spatial variation in the nature, type and magnitude of urban environmental problems they face. Similarly, the effect of the income and economic development level of a city on the nature and magnitude of environmental problem of urban areas is straightforward and very high because they are usually linked with the scale of production and consumption and thus waste generation level (including pollution) of the urban areas (Williams, 2000).

The rate and scale of urban growth accompanied by high concentration of urban waste and emissions has paralyzed the pollution prevention and control efforts of the local

governments. Economic development, if outpaced the waste management efforts and capacity, exacerbates the environmental problem because the quantity of urban waste generated per capita tends to increase steadily with increased per capita income. Then ultimately the scale of the problem of urban areas exceeds the capacity of the local government or municipality to collect, treat, and dispose of municipal sewage and solid waste. Moreover, the high waste production coupled with limited capacity to properly and fully manage will surpass the capacity of nature to assimilate all of these wastes.

Environmental problems affect the different social groups and areas within the urban area in different ways and degrees. Usually, it is the low income groups and their neighbourhoods which are hardest hit (most affected) by environmental problems. This is mainly because the low income groups are the least able to afford, among others, the environmental services. In turn, the major impacts of these environmental problems are identified as those involving health and safety, productivity, amenity values, and ecological value (Fernandes, 1998; Fernandes and Varley, 1998).

Overall, a successful urban environmental management may, as described by Ichimura (2003), include increase in resource efficiency, reduction in waste generation, improving urban infrastructure for water supply, the management and conservation of water resources in urban areas. To correct the urban environmental degradation of the developing countries, it is suggested that clear understanding and specification of the factors that constrain to taking appropriate and preventive and curative measures should be given priority. The environmental problems that appear in different urban areas may have different causes which might be specific to their socio-economic and environmental condition. Based on the context of the particular urban area, varied types of causes could be identified. But the most common types of causes of urban environmental problems which prevail in most urban areas of the developing countries could be described as institutional deficiency, inappropriate policy and inaction by public and private actors, absence of full participation, inadequate governance, inadequate regulatory and economic policies and insufficient knowledge and information (Bartone, et al., 1994).

Accordingly, once they have unpacked the most important factors of urban environmental problems, Bartone, et al. (1994) and Williams (2000) have proposed six policy messages to protect and properly manage the urban environment. These are described as mobilizing public support and participation, improving policy interventions-making strategic choices, building institutional capacity, strengthening service delivery, closing the knowledge gap, and planning strategically.

Similarly, the study conducted by Ichimura (2003:6) has come with some findings pertaining to the factors or causes of urban environmental problems particularly in developing countries which are not, of course, entirely different from others but which more of generalized concepts. He argues that it is not the urbanization itself which caused many of the environmental problems of the developing countries rather it is poor management, poor planning, and absence of coherent urban policies. He added, it is the strong conviction of the researcher, that the 'growth-first' strategy adopted by many of the developing countries' governments has worsened many of the problems of urbanization. Following his findings, detailed actions needed to ensure successful urban environmental management recommended. The respective sectoral offices need to increase resource efficiency, reduce in waste generation, improve urban infrastructure for water supply, and improve the management and conservation of water resources. This could be made possible by improving waste water treatment through legislation, setting up of recycling schemes, developing more effective waste collection systems through public-private partnership and strict legislation for treatment of hazardous waste, and adoption of energy technologies by industry and households and restoration of brown fields (Ichimura, 2003).

2.4. Environmental Policy

2.4.1. What are the Implications for Policy?

For various reasons, since the last few decades urban waste management problems have been among the most debated policy issues throughout the world. The policy implication of waste management can be examined from two perspectives: first, the adverse consequences of poor waste management on public health and environmental quality; second, the complex task of managing waste that involves/requires changes in

consumption and waste production pattern, appropriate technology, organizational capacity, and cooperation among a wide range of stakeholders.

Besides, there is an increasing need to develop waste management plans at national and municipal /local government level. But while determining the actual needs of the communities and prioritizing the limited municipal resources fairly, it is essential to go through a democratic, public process of formulating solid waste management goals (Marshall & Farahbakhsh, 2013). Since the characteristics (nature) of the wastes generated and factors that challenges waste management vary markedly among different countries' urban areas, there will not be a single best solution for all waste management problems of countries and cities. Hence, waste management solutions in one region might not be appropriate elsewhere. For example, some waste management equipment and techniques might be more appropriate in developed or middle-income countries, while in developing countries, composting organic waste and biogas capture may be more useful to deal with waste high in organic matter. To this effect, it would be helpful to use waste hierarchy so that the most resource-efficient, long-term approach to waste management could be identified. Moreover, guidelines that indicate the way how national waste strategies could be generated will exist.

Hence, waste management is essential not only to avoid or minimize the detrimental impacts of waste on public health and environmental quality, but also it presents a good opportunity to recover resources and realize the environmental, economic and social benefits (Theuri et al., 2013). Waste management also helps to pave the way to sustainable development. In view of these benefits achieved from waste management, all government bodies responsible for policy making, decision making, and planning should be well informed while they are developing integrated waste management strategies adapted to the needs of a particular society or residents (Guerrero, Maas, & Hogland, 2013). This is because if informed decisions about waste management are made and applied based on context (the prevailing situation), waste management could also provide economic value. Nevertheless, despite the multi-dimensional benefits described above, it is argued that solid waste management, especially in developing countries, is not always among the high priorities for the national as well as the local policy makers, decision

makers and planners. It is only those issues that have more social and political urgency that take precedence leaving tiny fraction of the budget for waste management issues. Literature sources clearly show that in many cities around the world, effective, functioning policy measures have been scanty and the resources invested in waste management has been inadequate. To solve these problems, it is suggested that the contribution of national governments has been well recognized partly by making waste management a national priority and partly by ensuring the availability of skills, knowledge and capacity of the local governments to implement the waste management programs effectively, particularly helping them to turn waste to 'gold' (Konteh, 2009).

Sustainable and effective waste management needs to consider the specific objectives and to implement appropriate measures pertaining to political, institutional, social, financial, economic and technical aspects of solid waste management rather than sticking only on the purely technical aspects of the waste management. To make it clearer, the main concerns of each of these aspects have been described as follows:

Political aspects deal with the formulation of goals and priorities, determination of roles and jurisdiction, and the legal and regulatory framework.

Institutional aspects concern the distribution of functions and responsibilities and correspond to organizational structures, procedures, methods, institutional capacities and private sector involvement.

Financial aspects of MSWM concern budgeting and cost accounting, capital investment, cost recovery and cost reduction.

Economic aspects of MSWM are concerned with the impact of services on economic activities, cost-effectiveness of MSWM systems, macro-economic dimensions of resource use and conservation, and income generation.

Technical aspects of MSWM are concerned with the planning and implementation and maintenance of collection and transfer systems, waste recovery, final disposal and hazardous waste management (Schübeler, Christen, & Wehrle, 1996).

Mainly due to the rapid growth in population, urbanization, industrialization, consumerism and resultant urban environmental degradation more and more people than before are obliged to breathe for air, drink contaminated water and eat hazardous food. Moreover, the beauty and abundance of nature are disappearing in many parts of the world mainly due to the human-induced environmental change. As a consequence, it has brought the need for protection and preservation of the environment and the urgency of developing sound environmental policies and programmes to forefront. Development would, otherwise, be unsustainable and even tend to decline (Singh & Shishodia, 2007).

Based on the lesson taken from world experience, it could be advised that an effective approach to deal with (tackling) urban environmental issues is to formulate an urban environmental management program complete with policies, strategies and action plan in accordance to the principles of participation, building commitment, and choosing effective policy interventions. Government's intervention specifically to manage and protect the environment could be realized in different ways. Among which policy intervention plays the crucial role. Environmental policy is one of the major interventions basically designed to improve the environmental quality of a particular area.

So what is policy? Policy, as defined by Singh and Shishodia (2007:351), is "a definite course of action selected by government, an institution, a group or an individual, from among alternatives and in light of given conditions to guide and usually to determine present and future courses of action".

Policies could be developed for different sectors, purposes, goals and objectives at different administration levels. There could be economic, social, or environmental policy of a country, a region or even a city level, an individual project or institution, etc. Policy intervention intended to ensure proper management and protection of environment could be legalized in different mechanisms. In addition to the policy documents adopted, organizational structure, institutional arrangement and capacity, budgeting, strategic waste management approaches employed, etc are among the most important intervention measures to be considered by governments (Singh & Shishodia, 2007).

Basically, government intervention in environmental issues becomes necessary when market failures are perceived to take place. Market failure simply means when market forces fail to realize the socially optimal use and protection of the environment. Market failure in protecting the environment is mainly attributed to the existence of externalities.

Market failure is largely caused when economic activities are creating an effect on the environment but they are not taken into account by their committers or creators. Moreover, market failures could be the result of lack of or improperly defined property rights and/or ignorance about the impacts of economic activities on environment. They further explained that ignorance implies producers and consumers are not well informed about the environmental implication of their activities or they do not know how best to minimize the environmental impacts of their activities. As a result, the environmental impacts of their decisions are likely to be aggravated (Singh & Shishodia, 2007:169).

Another cause of market failure is the public goods character of certain, for that matter the key, environmental goods and services and the ethical issues associated with the environment (where some individuals are willing to run-down environmental assets for personal benefit without concern for the public's benefit and damage, or for the quality of the environmental assets. Hence, partly taking into account the market failure and the unethical behaviour of the individuals, it becomes imperative for the government to intervene and manage the environmental assets wisely in the interest of the public (Singh & Shishodia, 2007).

Both in-existent or inadequate environmental policy, among others, has seriously constrained the urban environmental management of developing countries. At the outset, in-existence of environmental policy document which clearly and explicitly focuses on (urban) environmental issues has been a crucial problem of urban areas in the developing countries and has resulted in a severe environmental degradation. Fortunately, the cities of most of the developing countries are believed to have urban environmental policy but because of various reasons most of them fail to ensure successful urban environmental management.

The problem of urban environmental management may generally be linked with the nature and characteristics of the policy mix. The definition of policy mix indicated in different sources varies in accordance to the scope and constituents supposed to be (Rogge & Reichardt, 2013).

The problems pertaining to public environmental policy may generally be related either to quality of the policy document (such as policy process, and setting priority, goals, strategies and programmes) and/or to implementation (linked with institutional commitment and arrangement, capacity, management system, etc). In general, the quality of the environmental policy depends largely on the process of formulation, promulgation and application of the course of actions, specifically when we consider the public environmental policy for which the actions are taken by the government in pursuit of certain objectives of improving the quality of environment and its conservation (Singh & Shishodia, 2007).

Sustained participation of appropriate stakeholders in policy process is required to improve the quality of the environmental policy and the effectiveness of environmental management decisions making. There are wide areas where the participation of the stakeholders is needed. Of which the participation of stakeholders in policy formulation, planning, designing alternatives and implementation of policies and plans is very crucial.

Properly selected and designed intervention types are prerequisites for successful urban environmental management because for the success or failure of most of the subsequent actions essentially depend on policy interventions. Hence, to this effect, particularly developing countries are advised to be careful and to give much weight to selecting problem areas, their scale, and available capacity. Moreover, it is essential to understand and specify the factors that continually constrain the action to prevent and cure the environment appropriately. Making strategic choices including the tools like economic and regulatory instruments, property rights, etc are very essential in improving policy interventions. Developing countries' urban problems are numerous and it would be beyond the capacity of the local governments to give immediate solutions altogether. Hence, given

the broad range of political problems and their causes it is highly recommended that developing countries need to set priorities. Priority setting involves primarily valuing the impacts and internalizing the problems of urban environmental issues and then arranging conditions to ensure informed participatory process is in place so that stakeholders could agree on the key issues and best options. Obviously, the very challenge in policy priority setting is to value the effects of and rank the urban environmental problems in terms of health effects, productivity, amenity, ecological values, and other key indicators.

Based on a thorough analysis the most pressing environmental problems and their fundamental causes should be identified. The information attained from such study will be used to devise appropriate policy responses and/or to study the policy implications of the problems. Finally, bearing in mind the defined environmental priorities, which are mainly defined in terms of the severity of the problems, their economic and health costs, and on the availability of the instruments to carry out the reform, selection of environmental policies would be undertaken. Recognizing the severe budget constraints and competing demands for scarce resources prevailing in most of the urban areas of developing countries, it has been recommended that they should look for cost-effective solutions so as to achieve the highest success in environmental management (Bartone, et al., 1994; Leitmann, 1996).

As one integral part of sustainable development policy, the goals of environmental policy are defined with the assumption to improve the overall quality of life of citizens in accordance to the principles of sustainability such as restoration, protection, conservation, improvement and judicious utilization and management of the environment. It is well known that an environmental policy should clearly specify the overarching organizational structure and management system (which include implementation and monitoring functions). The management systems could be as explained, centralized public management or collective management- but neither of them could be single best system of management that could work successfully in all situations and at all times (Singh & Shishodia, 2007).

Cities should adopt appropriate policy options to work towards long term goals and provide an enabling framework to promote ISWM. An environmental policy should also be comprehensive enough to include directions provided for effective implementation and regular monitoring of various project activities. The lack of an adequate policy and regulatory framework complicates matters further (Modak, et al., 2011). Some countries have no or poor regulations and enforcements which could be attributed mainly to inadequate technical capacities, inadequate monitoring and inadequately trained staff in enforcement institutions. Besides, the low or nonexistent participation of impacted (particularly negatively) communities in activities like monitoring of compliance and absence of institutionalized public-private partnership (PPP) has partly been the consequences of deficient policy and regulatory frameworks.

Because of the urgent socio-economic and political problems (other than environmental problems) they face, many of developing countries have been slow or reluctant to adopt stringent environmental policy and regulatory frameworks and to enact and enforce them. Lack of enforcement in developing countries is not only because they are short of capacity but they are reluctant. In other words, lack of capacity and will are the two main causes of absence of enforcement in developing countries, but they are comfortable to sacrifice more of their environmental protection in pursuit of their socio-economic development goals (Louka, 2006).

2.4.2. Environmental Policy Instrument

One of the main challenges to ensure sustainability transition is to improving our understanding about the politics and policy transition. It is well recognized that our ambitions and efforts to ensure sustainability transition has been faced by many failures like market system and institutional failure. And it has been evident as well that these failures require multi-faceted policy intervention (Rogge & Reichardt, 2013). Though in many cases policy mix may be equated specifically with policy instrument mix, policy mix mainly refers to a combination of several policy instruments and environmental policy processes. Environmental policies typically combine the identification of a goal (general and/or specific) with some means to achieve that goal. In practice, these two components

are often linked within the political process. The second component, the 'means' implies to the 'instruments' of environmental policy.

Given the goals of an environmental policy and the choice of a particular management system to pursue the goals, the next logical question relates to what instruments should be used to achieve the given goals within the framework of the chosen management system. The choice of instruments should be consistent with the goals or objectives of the environment policy on one hand, and with the technical, physical, economic, political, institutional, socio-cultural and managerial conditions under which the policy is to be promulgated, on the other (Singh & Shishodia, 2007).

More generally, instruments for environmental policy can be seen as the means for executing the policy. Huppes (2001:8) has defined instruments applied to environmental policy as structured activities aimed at changing other activities in society towards environmental goals. Environmental policy instruments may also plainly be defined as something which the environmental manager can use to produce a desired effect on the environment.

Different instruments could be designed for various purposes mainly for social, environmental or economic reasons. All instruments which are thought to achieve environmental objectives as their key purpose are collectively referred as environmental policy instruments. A wide range of environmental policy instruments are indicated in different literatures and are classified in different way.

For instance, Calel (2009:1-2) has mentioned two main forms of state intervention such as 'command and control' and 'economic instruments'. He explained that 'command and control is the traditional form of state intervention used by the government to mandate certain actions, and penalize non-compliance. He also noted that it is most familiar types of instrument. Nevertheless, economic instrument is realized by simply making adjustment of prices for the natural resources. Consistent with the principle that 'demand falls if the price rises', it is imaginable that consumption will fall to the desired level if the price is high enough.

As indicated in varied literature, it has been evident that the choice of instruments has been and still is as one point of argument among academicians and policy makers. The arguments mostly revolve around the relative effectiveness of the diverse types of instruments. The debate and argument for comparing the two major categories such as the traditional command and control and economic instrument has covered vast literature. The arguments presented in most of the literature highlights the strengths and benefits accrue by using economic instruments against the traditional command and control.

Despite a range of benefits and constraints described for economic instrument and command and control respectively, Calel (2009:4) noted that economic instruments and command and control are not mutually exclusive, and are often used side by side in practice. He defined instrument as something which the environment manager can use to produce a desired effect. An instrument, therefore, is the means by which the objective is pursued. The significance of environmental policy makers and managers' knowledge about what instruments can be used to improve the quality of the environment is highly acknowledged by different scholars in order to make environmental management so effective and successful.

Still others use different terms and classification systems. Stavins (2003:1), for instance, has implicitly recognized two broad classifications of instruments (means to an end of environmental policy): The economic incentives or market-based instruments and conventional approach-command-and-control instruments. He defined market-based instruments as 'regulations that encourage behavioural change through market signals rather than through explicit directives regarding pollution control levels or methods. On the other hand, the command-and-control is a conventional approach to regulating the environment through fixed standards and regulations' (Stavins, 2003). By way of contrast, he argued that command and control regulations allow relatively little flexibility in the means of achieving goals.

Besides, command-and-control regulations could discourage the development of technologies and as a result it demands to raise control to greater levels. Command-and-

control approach gives little or no room for business establishments due to little or no financial incentives, and both technology-based and performance-based standards discourage adoption of new technologies. Even if they adopt new technologies, business establishments may not get financial benefits from their investment; of course, they may be 'rewarded' by being held to higher standard of performance (Stavins, 2003).

Finally, policy instruments constitute the concrete tools to achieve overarching objectives. More precisely, they can be seen as tools or techniques of governance that address policy problems. They are realized with the active involvement of the public sector or, more specifically, are introduced by a governing body in order to achieve policy objectives thereby translating plans of action (Rogge & Reichardt, 2013).

The efforts of the developing countries to implement environmental policies have been challenged by a multitude factors. Most of the challenges are strongly linked with capacity deficiency to implement. These deficiencies are remarkably related to lack of capacities to build and maintain strong environmental institutions, set up effective environment monitoring and implementation schemes, create a strong scientific knowledge base for environmental policy, and fully integrate environmental concerns into Poverty Reduction Strategies and other (Rogge & Reichardt, 2013).

2.5. Environmental Governance

Developing countries are continuing to be challenged, on the one hand, by increasing concentration of human beings, and their activities including industries, on the other hand, by inadequate infrastructure, inappropriate pricing of resources and services and inadequate institutional mechanisms to ensure environmental protection. These challenges in turn have further aggravated the problem of environmental degradation in urban areas. Therefore, the key to successful urban environmental management is to improve urban governance or ensure good governance.

Governance refers to the relationship between government and other key actors of environmental management in general and specifically the private sector and the civil

society, which makes it different from traditional government system between the ruler and ruled, the governor/government and the governed (Ducci, 2000).

The issue of governance covers wide range of governmental issues, particularly institutional issues and administration systems such as stakeholder's participation, public-private partnership, transparency and accountability, capacity building, etc. Efforts to improve urban governance essentially involve activities promoting participatory processes; developing effective partnerships with and among all actors of civil society, particularly the private and community sectors; securing greater effective empowerment of local government, including greater autonomy in finance and legislation; and reform of unresponsive organizations and bureaucratic structures (Ichimura, 2003).

Many sources indicate that most of the problems in developing countries occur mainly because the governments are incapable of administering adequately and lack capacity to provide basic environmental services. Inadequate infrastructure, inappropriate pricing of resources and services and inadequate institutional mechanisms to ensure environmental protection aggravated the problem of environmental degradation in urban areas. Therefore, the key to successful urban environmental management is to improve urban governance or ensure good governance.

As one of the constituents of good governance, it has been widely accepted and strongly recommended that participatory approach shall be strengthened for it has unique place in the efforts to improving urban environmental degradation. Sustained participation of actors, as a typical feature of good governance is therefore key mechanism to ensure sustainable urban environmental management. Thus, strengthening participatory approach, as key element of good governance in environmental policy formulation, priority setting, planning, decision making activities, implementation and monitoring and evaluation would be the best strategy recommended, particularly for developing countries (Choosuk, 2014). By and large, improving governance does mean so many things; as described by Bartone, et al. (1994:46), it covers building local capacity, deciding capacity-building devices, plainly defining institutional arrangements, and improving urban services.

Moreover, governance could also be examined in terms of the role of leadership and political will of the public authorities in environmental management endeavours at the local level since it determines the performance and achievements of municipal governments. Local governments can make their cities more competitive, more efficient and more attractive to investors and workers by promoting the sustainable development of the urban environment provided that they are able to install effective governance in place (Alliance, 2007).

Choosuk (2014:6) noted that effective urban environmental management is attributed to various factors including strong institutional capacity, adequate funding, effective organizations, clear lines of authority, and qualified staffs. Yet (local) governments of developing countries own weak institutions, scarce resources and inadequate technical capacity, the involvement of various actors in development activities would be very essential. Therefore, developing institutional capacity of the local government is a necessity and not a matter of choice so that they could properly and adequately manage problems on environmental issues.

The need for the active involvement of stakeholders is largely to support the local government which in many cases is deficient to provide environmental services as to standard. The deficiency of the local government, which mainly supposed to refer to the municipal government, may be generalized as administrative or institutional, and financial. Many sources have tried to magnify the significance of administrative and financial capacity of municipal governments as factors which determine the effectiveness of environmental management as well as its economic and social performances (Utz, 2008).

By recognizing the importance of synergy among the three key actors-the state, the civil society and the private sector, Ducci (2000:14) has pointed out that one could speak about realistic and positive urban management capable enough to maintaining and strengthening local values provided that they are able to manage to coordinate.

2.6. Waste Management Approaches

Because of the increasing growth in the number of population, urbanization and industrialization, huge volume of wastes are being generated. Moreover, together with these conditions, the changes in the lifestyle of the people have caused an increase in the variety of constituents (composition) and complexity of the wastes generated. Hence, it is obvious that it would be hard to properly handle the wastes by simply focusing on the traditional waste management system. In other words, the new changes in the nature, composition and magnitude of waste generated shall initiate the need for new approaches, which are more effective and efficient. A wide range of approaches have been recommended in different literature sources, of which some tending to technological options while others focus on their socio-economic importance. Some of the most widely promoted waste management approaches include waste management hierarchy which gives more emphasis to 4Rs (reduce, reuse, recycle, and recovery), public participation, partnership, decentralization (which altogether are results of good governance).

The literature review helped to reveal the different measures for improving solid waste management and to evaluate the differences among developing countries to determine if there is possibility to adopt the same measures everywhere. To improve and ensure sustainable waste management system, different approaches are proposed in different literature such as integrated waste management, integration and partnership of the public, private and informal sectors or private-public participation (ppp), decentralization, etc (Lindell, 2013). But in this study, the researcher would like to consider only few of them.

2.6.1. Community Participation in Waste Management

The challenges of the waste management are continuing to grow with the growing urbanization. Though it is rapid in the developing countries, urbanization has been a worldwide phenomenon. Together with the growing urban population, solid waste production is increasing. As a result, the waste management is predicted, on the one hand, to increase in scope and complexity in the future and, on the other hand, to consume a significant proportion of the city's budget. Hence, it is recommended that waste management sector should receive serious attention from the responsible bodies with the

intention to ensure balance between quality of service and cost effectiveness. This challenge is particularly significant for developing countries, where resources are limited but urbanization is occurring rapidly. One of the means to overcome this imbalance is the active involvement of private sectors in waste management endeavour. Existing practices showed that both private and public sectors are actively involved in waste management in developing countries. There is an emerging trend wherein the public sector is encouraging the private sector to be involved in waste management operational duties. It is not only to fill the gap in capacity deficiency of the local government (or municipality), but the creation of formal link between the private and the public sectors might also be very useful to improve the efficiency of the entire sector and create new opportunities for employment (Ahmed & Ali, 2004).

In recent years, it has been recognized that stakeholder participation is a very important strategy or approach to bring efficiency and effectiveness in environmental management and thereby to ensure better urban environmental management. Altogether, it is admitted that a wide range of efforts from institutions, organizations, and individuals is necessary. It is noted that isolated actions cannot be suffice. Lack of synergy of action between key actors (particularly between the public and private actors) has been the major contributing factor to the existing backlog not only in environmental management but also in the overall development of urban areas (Williams, 2000). Though, as compared to developed countries, solid waste generation in the developing countries is much lower, many cities are not able to manage properly their waste mainly attributed to institutional, regulatory, financial, technical, and public participation deficiency (Memon, 2002).

The *World Bank Participation Sourcebook* has defined stakeholders as those affected by the outcome—negatively or positively—or those who can affect the outcome of a proposed intervention. It further argued that urban environmental management cannot be initiated or sustained without constituencies that demand a better quality of life (Schaefer, 1996).

No doubt, collaboration among stakeholders is the way to greater synergy. It involves more than information exchange, or even collective decision-making. The philosophy of participation is based on the principle of mutual trust and understanding and partnerships

at least with the basic stakeholders. The participation of the community and its partnerships together with its stakeholders is a vital constituent of all environmental programmes and projects that determines the strengths and legitimacy of any decision-making process and creates conducive environment for the community to have a say over issues that directly or indirectly affect their lives (Onduru, et al., 2009; Williams, 2000).

2.6.2. Waste Hierarchy: 4Rs

Waste management has become a growing global concern as the generation of solid waste in urban areas continues to grow mainly due to continuing population increase, urbanization, consumption pattern change and, consumerism and industrialization. As a result, the health and environmental implications associated with waste collection and disposal is growing in urgency. Moreover, when the community progress and prosper, the proportion of 'special' wastes generated like hazardous wastes increases and requires special attention for collection and disposal. These problems, together with the growth of solid waste markets, increase in resource scarcity and the availability of new technologies have brought good opportunities for converting wastes into resource (Theuri, et al., 2013).

Apart from the conventional waste management, a new waste management hierarchy has been accepted. It was recognized that the Ontario's Pollution Probe in the early 1970s was the earliest use of the waste management hierarchy. The waste management hierarchy started as 'three Rs (reduce, reuse, and recycle) but latter a fourth R (recovery) was added. The financial, environmental, social and management implications of the waste hierarchy are very significant. It is also important to minimize the GHG (Green House Gases) emissions (Theuri, et al., 2013).

The waste management hierarchy may be arranged in terms of order of importance as reducing, reusing, recycling, recovering, treatment and disposal. The four Rs (4Rs) are meant to be the most significant constituents of the hierarchy in order of importance in waste management. The waste hierarchy has taken many forms in the past but waste minimization strategies have been the basis for the real concept.

The overall objective of the waste hierarchy is to realize maximum practical benefits from products and to generate and dispose minimum amount of waste. They have defined the 4Rs as the idea of reducing the impacts of waste in terms of magnitude and types of the effects owing to reduction in quantity, reusing and recycling of the wastes (Chowdhury, et al., 2005).

The environmental benefits which could be achieved from the use of waste hierarchy in general and the 4Rs in particular are so many. Some of these benefits include reducing or preventing greenhouse gas emissions, reducing the release of pollutants, conserving resources, save energy and reducing the demand for waste treatment technology and land filling space. In view of these basic benefits, it is advisable to adopt and incorporate these methods into the waste management plan.

Indeed, the prevention or avoidance of waste generation is the best solution for waste management problems. In other words, preventing waste as an element in the waste hierarchy through efficient use of resources and raw materials is the best option. However, it might be unrealistic to totally avoid waste given the existing technology and experience of production and consumption of products. However, if well implemented, the other options could be of paramount importance to manage effectively urban solid wastes. These include reducing, reusing, and recycling of waste. Today, a fourth 'R' (recovery) has been introduced for environmental and economic benefits. Upon the completion of the '4Rs' processes, the maximum benefit is minimization of waste volume, decline in the reliance on landfills, decrease in the environmental costs associated with management, and improvement in serious public health concerns.

The first R (reduce) involves prevention and reduction of waste. To reduce waste means to minimize amount of waste generated. Waste reduction initiatives which generally include prevention, minimization and reuse needs to reduce the quantity of waste at generation point and or consumption point. Waste reduction could be effected by redesigning products or changing patterns of production and consumption. In terms of the reduction of greenhouse gas emission, there are two most important benefits of waste reduction: to avoid emissions associated with material and product manufacturing and to

eliminate the emissions associated with the removed waste management activities (Peprah, et al., 2015).

Waste reduction would be possible to realize waste reduction through different ways. Some of them are through legislation, product design, and local programmes to keep recyclables and compostable from waste. Legislation is particularly important in order to enforce manufacturers to maintain particular standards either in designing products or limiting particular production activities. Besides, when intensified by public awareness and education similar goals could be achieved through sorting waste at source. Methods of waste reduction may, for instance, include focusing on production of goods that needs less packaging, convincing the public to use their own reusable bags for packaging and to choose reusable products like close napkins and container (plastic or glass). It is also advisable to practicing backyard composting, and sharing and donating any unwanted items rather than disposal them (Peprah, et al., 2015; Sharma, et al., 2014).

Waste reduction at source as a first tier of solid waste management refers to all the activities that decrease the amount (in terms of weight or volume) or toxicity of waste entering the solid waste stream. Moreover, source reduction includes those activities that increase product durability, reusability, and reparability. Waste reduction and reuse of products are usually considered as methods of waste prevention and are the most preferred phases of waste hierarchy for they prevent the production of waste production at the source of waste generation point and minimize the demand for large scale treatment and disposal facilities (Sharma, et al., 2014).

The second R (reuse) involves secondary and subsequent uses of waste materials either in part or whole. Trade in second-hand goods like cloths, electronics, automobiles, furniture and other merchandise, is typical example of reuse of waste. The process of reusing starts through sorting mainly conducted at the source rather than at the disposal site and involves detail process of checking, cleaning, refurbishing, repairing whole items or spare parts (Peprah, et al., 2015). It is believed that reusing of discarded materials without reprocessing or remanufacturing helps to achieve greater savings in resource consumption and is preferred method more than recycling.

The third R refers to recycling. Recycling may be simply defined as the removal of items from the waste stream to be used as raw materials in the manufacturing of new products. Based on this definition, three phases could be identified in the process of recycling. In the first phase, wastes are sorted, second phase recyclable wastes are collected and in the third phase, collected materials are used to create new materials. In the third phase, these raw materials are used in the production of new products.

Recycling is undertaken on the waste materials which cannot be reused directly but which could be converted to new products or on the raw materials which could be converted through the process of transformation as well as composting. Composting refers to the biological and chemical degradation of organic waste in large centralized, small enterprise, backyard or household bases (Peprah, et al., 2015).

Recycling of materials like paper, glass and plastics and composting and digestion of bio-waste become the most preferable activities following reusing in the waste management hierarchy. Normally, waste minimization should be the first priority of the internationally accepted waste management hierarchy and it is highly recommended that the implementation of 4Rs should begin from our homes.

The fourth 'R' refers to recovery. It is introduced lately to the waste hierarchy and it is meant to adopt a waste object to new use by extracting energy or utility from it. Among the most popular options, conversion of waste to energy (waste-to-energy) is typical case of waste recovery methods. Waste-to-energy involves burning of wastes for fuel to produce heat or power for domestic or industrial use. Because of its effect on cost and pollution, it would not be advisable to use incineration alone (without energy recovery). Both reuse and recycling gives good opportunities to retain some of the values from the waste. However, when compared with recycling, reuse is simpler process involving reutilization of materials in their end-use form and does not need reprocessing. Whereas recycling involves processing and conversion of waste through remanufacturing to recover an original raw matter (van Beukering, et al., 1999).

It should be noted that treatment and disposal options are chosen as a last resort to the previously mentioned management strategies reducing, reusing and recycling of waste. Employing waste treatment techniques has multipurpose, among which transforming the waste into a more manageable form, reducing the volume of waste and reducing the toxicity of the waste are the basic ones. By doing these, it would be possible to dispose the waste more easily. A wide range of waste treatment methods which may be selected based on the composition, quantity, and form of the waste item are available. These include subjecting the waste to extremely high temperatures, dumping waste on land or land filling and use of biological processes to treat the waste.

Generally, the main objectives of the waste management hierarchy as indicated by Kgosiesele and Zhaohui (2010:40) are

- Minimize and reduce waste in industry, commerce and private households.
- Maximize environmentally sound waste reuse/recycling
- Promote environmentally sound waste collection, treatment and disposal.

Towards sustainable waste management, 4Rs can play a vital role to protect environment from greenhouse gas emission and convert waste into invaluable resources. The 4Rs approach for sustainable solid waste management is relatively new to many of the developing countries (Chowdhury, et al., 2005).

Altogether the '4Rs' are aimed at achieving sustainable solid waste management, and also relates to other global environmental challenges, particularly climate change mitigation. More specifically, the emission of greenhouse gases that could create sustainable development co-benefits and reduction in the emissions of methane (CH₄), biogenic carbon dioxide (CO₂), non-methane volatile organic compounds (NMVOCs), nitrous oxide (N₂O), nitrogen oxide (NO₂) and carbon monoxide (CO) from landfills are part of the fundamental objectives of 4Rs approach (Peprah, et al., 2015).

In developing countries, urban areas solid waste management system is often poorly run and operated to at a low standard. They are unreliable, provide inadequate coverage and conflict with other urban services. The waste collection coverage in developing countries'

have been estimated as only 50% to 80% of the waste generated and most of the disposal method available is open dumping. As a result, the insufficient collection, uncontrolled street collection points and improper disposal in open dumps creates an opportunities for the existence of informal waste recyclers for the waste left uncollected through scavenging or waste pickers (Wilson, et al., 2006).

Alongside the formal public sector, in almost all urban areas of developing countries, the informal private sectors are significantly involved in reusing, recycling and recovery of resources. The private sector may refer to all the people not engaged by the public sector whose livelihood solely or partially depends on solid waste. Most, but not all, of the private operators in waste management are informal workers. The informal sector is used to refer to the economic activities characterized by non-permanence and casualness, outside the scope of existing company law or government regulations carried on at a small-scale by less capitalized establishments mostly relying on household labour. Informal sector activities come in to existence and operation in consequence of the market forces or other socio-economic factors but they are not regulated or controlled by the government agencies (Ahmed & Ali, 2004).

As compared to the formal entities, the size of the inform sector involved in waste management activities in low-income countries is significantly attributed to wide spread poverty, unemployment or underemployment conditions. These include community-based organizations and small business enterprises like micro and small enterprises (MSEs). Totally, the private sector operators in waste management may be grouped in the following ways: waste pickers, itinerant (stationary) waste buyers, small-scale recycling industry, large-scale recycling industry, CBOs, NGOs, and Micro-enterprises (Ahmed & Ali, 2004; Van Beukering, et al., 1999).

It is widely believed that the involvement of the informal sector into the waste management system, particularly in reusing, recovery and recycling of waste, can bring significant benefits to the formal management sector as well as to those who are running the informal activities. One of the benefits of the informal waste recycling system which has been increasingly evident in many of the developing countries' urban areas is to reduce the cost

of formal waste management system. This is because it reduces the quantity of waste to be collected and disposed by the formal waste management system. Consequently, less quantity of waste and thus less money and time spent for collection and transportation will result in significant reduction in cost of formal waste management system. Moreover, it has been one of the employment opportunities and as a consequence, a means of livelihood to many of the destitute communities particularly in developing countries. Moreover, the waste materials which could be recycled could be used as resources to produce many more materials. Major industries of many developing countries have strong dependency on secondary raw material either on local or imported secondary raw materials extracted from discarded materials. It is also believed that thousands of people in developing country's cities rely on recycled waste items for their livelihood (Wilson, et al., 2006).

Nevertheless, the contribution of informal recycling of waste to create cleaner environment should also not be overlooked. It should also be accepted that there are a number of points of conflict between formal municipal solid waste management services and the informal waste operators. The formal waste management sector and the respective local administrators have often negative attitude towards informal waste management sector and consider it as backward, unhygienic and generally incompatible with a modern waste management system. This has to be corrected and the multi-benefits of involving informal sectors in waste management endeavour should be well recognized and efforts have to be made to integrate them with the formal waste management systems. Unfortunately, the attempt to integrate the informal recycling with the formal waste management system might continue to face many challenges (Wilson, et al., 2006).

As it has been widely discussed above, the multidimensional challenges and benefits and opportunities of urban liquid waste has been widely recognized and documented in different literature. Obviously, inadequately handled liquid waste has serious consequences for human health, the environment and economic development. It contaminates the water supply by increasing the risk of infectious diseases and deteriorating groundwater and other local ecosystems, for instance after flooding (Corcoran, 2010)

The inefficient and inappropriate or even failing liquid waste management are attributed to several reasons such as low prestige and recognition, weak policies and institutional frameworks, lack of adequate funding and political will, inappropriate technologies, low public awareness and neglect of consumer preferences. Moreover, lack of awareness and high mitigation costs are two major constraints of liquid waste management. However, once they are connected to sewer line, residents may get relaxed assuming that their problems have been solved. However, since the liquid waste is carried away untreated down streams, it often creates problem in many ways to residents living downstream. It is widely understood that polluters are naturally reluctant to take responsibility and remedy mainly because it requires them considerable efforts and incurs them huge costs in monetary aspect. However, they strongly argued that even though the cost of halting pollution from liquid waste may seem prohibitive, and the constraints on initiating action may be numerous, allowing pollution to cause further damage will eventually cost more (Kalbermatten, et al., 1999).

Liquid waste management is part of the public services and public services have not been able to cope pace with urbanization. Public service (more specifically sanitation measures), and sewage and solid waste collection and disposal coverage account for only fractions of the total urban population. Moreover, inequity and disparity in public services among inhabitants, depending on their economic strata, is typical features of urban areas depending on the socioeconomic status of the residents (Kalbermatten, et al., 1999; Kamyotra and Bhardwaj, 2011).

Environmental damage resulting from improper or lack of liquid waste management system poses considerable threats to human health and well-being and economic growth. Water (2015) has pointed out that nowadays, the world needs to make a paradigm shift in the world politics to prevent further damage to sensitive ecosystems and the aquatic life. Paradigm shift is also needed to recognize liquid waste as a resource to be used as sources of water and nutrients for agriculture and its effective management would be essential to secure future water supply.

Corcoran (2010) argued that as the environmental and health problems of liquid waste are so severe, and problems related with liquid waste vary depending on the social, economic, cultural and physical characteristics of the area, it would be so difficult to find single solution to solve liquid waste problems. The liquid waste management problems may vary significantly from city to city and country to country in terms of their magnitude, scope, state of urgency and solutions. For this reason, it is pointed out that there will not be a single formula or method, approach, or strategy to tackle municipal waste management problems.

There are mainly two systems of liquid waste management: centralized and decentralized systems. The centralized liquid waste management system refers to a large-scale system where liquid waste is gathered from many uses or sources for treatment at one or few selected sites, whereas the decentralized system is typically on-site system where liquid waste from individual users (sources) or small clusters of users at neighbourhood or small community levels is treated. Liquid waste management in urban areas of the developed countries has mainly based on centralized system. For instance, in these countries, industrial effluents are usually treated on-site, even though some are sent to centralized municipal system following their on-site pre-treatment (Group & Management, 2009).

Whether to choose the centralized system or the decentralized system depends upon several factors. Both options should be fully considered instead of focusing on only the past situation where sewerage system was usually considered to be the only 'proper' form of urban liquid waste management system. There is mentality that on-site systems are often seen as temporary solution and mainly used for illegal or informal settlements. Accordingly, it is shown in on local building regulation and/or technical standards though usually they are not able to specify appropriate on site systems, but they simply are based on the assumption that new housing will be provided with network sewerage (Water, 2015).

However, the main issue is not which approach to use or is appropriate; but whatever approach is chosen, there should be an emphasis on continued management aspects because no one of these systems could fulfil the quality of being 'fit and forget'. Massoud,

Tarhini et al. (2009) emphasized on the need for appropriate, well-trained staff and capacity like in financial and technical aspects for liquid waste management regardless of the types of the management system. In many cases, the homeowners or local communities are given the responsibility of the operation and maintenance of many on-site systems and this has led to failure due to lack of or improper maintenance. This shows that an enforced regulatory framework is necessary to improve the effectiveness of the decentralized approach. The regulatory framework may include incentives and sanctions and the establishment of management program accompanied by regular inspection and maintenance of the system (Massoud, et al., 2009).

Despite the fact that there is a clear need for effective and appropriate liquid waste management and reuse system, there have been various issues which complicate implementation of strategies. Some of these issues include governance, financial aspects, and barriers to innovation and data needs and thus they should be addressed properly. The need particularly for strong and effective governance is well emphasized in many literatures but it is also well argued that governance without regulations backed by monitoring, controlling and enforcement will bring no or little inspiration to do so. The Group and Management (2009) noted that the lack of good governance, including ineffective policies, enforcement, and institutions, corruption, and the lack of appropriate infrastructure, along with a shortage of new investments in building human capacity, all contribute to ongoing water quality problems. Weak institutions, inadequate water quality policies and regulations, and limited enforcement capacity underlie many water quality problems worldwide. This may recognize numerous issues including the problems caused by lack of human and institutional capacities. Hence, it is strongly argued that countries will not be able to implement policies meaningfully unless they do have the necessary human, technical, financial and institutional capacities because they will lack the capacities to measure and monitor water quality (which is liquid waste effect) parameters and identify violations and thus will be unable to enforce compliance (Group & Management, 2009). Moreover, to ensure sustainable liquid waste system, the need for policies has been further highlighted so as to support more effective water and liquid waste pricing systems

by allowing adequate cost recovery, ensuring adequate investment and supporting long term operation and maintenance (Water, 2015).

2.7. Brief Review of Related Research Works

As it is a specific research topic, and of course a key aspect of the urban environmental management, the current researcher has tried to overview some research works conducted mainly in African countries. Despite their extensive prevalence and potentially threatening conditions, the urban environmental problems of the developing countries and particularly of African countries have achieved insufficient attention from the academic and research community. Literature and research papers pertaining to urban environment readily available for consultation are limited in kind and number. Nevertheless, studies conducted mainly by Henry, et al. (2006) and Ogwueleka (2009) in Kenya and Nigeria, respectively, have greatly served the researcher as a springboard to his research work.

Henry, et al., (2006) have conducted a research on '*Municipal Solid Waste Management Challenges in Developing Countries – Kenya case Study*'. Many of the socio-economic backgrounds of their study area described are more or less similar to my cases. In their studies, they tried to examine the status of the municipal solid waste management (MSWM) as carried out by the local authorities; solid and liquid waste management is the responsibility of the local authorities of the respective urban areas and the authorities use centralized system. The study was a sample survey conducted on five major urban areas including Addis Ababa, the capital city of the country. Their study also tried to describe the activities deemed to be carried out by MSWM sector as collection, transfer, resource recovery, recycling and treatment.

They used both secondary and primary data; the primary data are collected using interview, and an on-site observation (particularly the dump sites). The research participants are the department heads of the relevant offices, local residents and scavengers. They claimed that all the questions were designed in such a way that they could generate information pertaining to the status and problems of municipal solid waste

(MSW) collection and disposal, the environmental fate of uncollected SW and the ways to alleviate MSWM problems (Henry, et al., 2006).

Then they came up with certain basic findings and put them as follows:

1. With respect to status of MSW collection and disposal, the growth in MSW generation has been rapid, while the capacity to collect and safely dispose the material has been generally on a declining trend. The capacity of the local authorities to provide services in most developing countries has often been overstretched owing to the rapid urban population growth. As a result, local authorities tend to focus on central business district and the more affluent communities for services.
2. Open dumping are the predominant disposal systems and local authorities do give little or no consideration of environmental impacts of the dump sites. Convenience is the primary priority criteria in selecting disposal sites. Besides, no consistent inspection and monitoring of the dump sites are undertaken and wastes are indiscriminately dumped.
3. Local authorities are overstaffed with poorly trained (and adds the problems of financial constraints) and limited capacity to implement legislation covering waste management (Henry, et al., 2006).

Another research paper whose findings has considerably contributed towards the shaping up of this study's framework, is the one conducted in Nigeria by Ogwueleka (2009). The main objective of the study was to explore the current practices and problems of solid waste management in Nigeria. The study was carried out in nine city municipalities, which were selected based on the existing situation with different waste management problems, size, and challenges. The researcher used both primary and secondary data. He collected the primary data from the employees of the public environmental agencies and the residents, scavengers, and private contractors through interview. He made it clear that he has visited 20 dump sites. As far as secondary data is concerned, documents, records and academic literature were used.

Finally, he came up with much interesting findings, and concluded that solid waste management is characterized by inefficient collection methods and coverage and improper disposal. In short, the solid waste management in the urban areas of Nigeria is poor. The research has also revealed that the private participation in waste management has not been successful in Nigeria because the waste collection companies are unprofitable, inefficient and dishonest and while they are profit driven, they are not monitored or regulated by the government (Ogwueleka, 2009).

Moreover, the researcher has disclosed some of the major causes of the poor waste management in the study areas. He generally indicated that the poor waste management is attributed to lack of institutional arrangement, insufficient financial resources, absence of bylaws and standards, inflexible work schedules, insufficient information on quantity and composition of waste, and inappropriate technology (Ogwueleka, 2009).

This study has recognized that the research findings of Henry, et al., (2006) and Ogwueleka (2009) have altogether revealed some basic challenges of the urban areas of their respective study areas. More specifically, findings of both researches show that waste management in the urban areas of Nigeria and Kenya is poor. There is inefficient and insufficient collection system, and improper disposal. Moreover, both research undertakings have revealed certain solid waste management constraints that faced the local authorities in the respective countries. Yet, the studies have overlooked one very crucial aspect of waste management that is policy considerations; that is, the question what types of responses have waste management problems achieved from the policy makers has not been addressed. In fact, many of the issues raised as problems could be directly or indirectly connected with policy issues. Nevertheless, all the issues raised by these researchers in connection with waste management have not been deeply and thoroughly examined in relation to policy frameworks; it is not clear whether waste policies are in place, deficient, or are not properly and adequately implemented, or totally missing.

Therefore, this research work, unlike the two, has emphasized on assessing policy gaps in depth from the perspective of formulation and implementation. It is also noted that cities of the world show great diversity of characteristics and so the nature and magnitude of their

environmental problems is more likely to vary. Hence, to provide site specific solutions to waste management, it would be worthwhile to conduct a study on this particular urban area. In other words, this study has been undertaken in urban areas that have different context.

More importantly, both research projects and many other research works have focussed only on one aspects of the waste management of urban areas that is on domestic solid waste management. The management of other waste types such as liquid wastes of developing countries' cities and towns are not properly and adequately addressed in the literature part as well as the analysis and discussion part of the research project.

Moreover, the municipal waste managers are often thought of to handle and have practically engaged themselves exclusively in handling a particular type of waste, which is municipal waste, to which they are accountable to manage. Even though they are required to provide waste management services to only household, commercial, and institutional areas, the municipal waste managers should also be able to assure the proper management of other waste streams. It should be noted that the problems of cleanliness of the cities and towns are not attributed to only poor management of domestic solid wastes. Moreover, owing to their nature and occurrences, it would be impractical to design and run liquid and solid waste management programs separately. In other words, solid and liquid waste management activities are not exclusive to each other.

The researcher has tried to explore research papers in similar fields conducted in Ethiopia in general and Tigray Regional State in particular. But he is only able to access few related research papers of which two are articles and one an MA thesis. All the studies are dealt mainly with solid waste management problems and conducted in Bahir Dar, Gondar and Mekelle by Koyachew Enkuahone (2016), Mohammed Gedefaw (2015) and G/tsadkan G/Michael (2002), respectively. All the studies have tried mainly to reveal the nature and magnitude of the problems of solid waste management of the urban centre in question. The findings of each of the study have directly or indirectly shown that there is poor solid waste management in each of study areas. For instance, Koyachew (2016) in his article entitled 'the problem of solid waste management and people awareness on appropriate

solid waste disposal in Bahir Dar City: Amhara Region, Ethiopia' has tried to show that institutional, economic and social factors are hindrances to the solid waste management services in the city. More specifically, the study revealed that lack of well-organized and accountable SWM structure, lack of adequate budget, and bad attitude towards to the job and the workers are the main problems of the SWM in Bahir Dar.

Similarly, the study conducted by Mohammed (2015) on the title 'Assessing the current status of SWM of Gondar Town, Ethiopia' has come out with findings more or less similar to that of Bahir Dar's. The key objective of his study was to assessing current SWM service in Gondar Town. The study has disclosed that there is low status and spatial coverage of SWM service in Gondar and this has been intensified by poor institutional structure and capacity of the Sanitation and Beautification Department, limited participation and contribution of stakeholders and poor households' SWM practices or poor on-site handling system.

Mekelle, Bahir Dar and Gondar Cities are among the largest cities in the country ranked at second position next to Addis Ababa (the capital city of the country). Bearing in mind the size and growth of the cities, the researcher, however, argued that the waste management problems of both cities are not adequately addressed in the studies. Both studies focus only on solid waste management problems, unlike to this study which does include liquid waste, and have tried to address only few issues to reveal the nature and magnitude of the problem. Moreover, it seems that it was not their intent to explore the responses of the policy and decision makers. They could not give answer to the question 'What efforts have been made by the responsible bodies in response to the quantitatively and qualitatively changing waste created in the cities?'

The researcher of this project has also worked his MA thesis on the topic 'Domestic Solid Waste management in Mekelle City, Tigray Region' in 2002 in Addis Ababa University. The key purpose of the study was to examine the overall pattern of solid waste generation, collection and disposed in Mekelle city by analyzing primary as well as secondary data. Finally, the researcher has found that the per capita waste generation rate varies in accordance to the household's income level, where the lower, the middle and the higher

income groups generate 0.277 kg, 0.301 kg and 0.412 kg per capita per day, respectively. Moreover, the study revealed that there was low waste collection and disposal coverage (less than 40%) attributed to improper organizational structure, shortage and dissatisfaction of the workers, inadequacy and inappropriateness of the collection and transportation facilities (both the containers and vehicles), unfair distribution and sitting (placement) of the containers, inadequate financial resources and lack of detailed rules and regulations pertaining to waste management.

There could be the same issues considered in both studies (in the MA dissertation and now in the PhD thesis). However, the researcher believes that this current PhD study is different from the MA thesis previously conducted in Mekelle city. At the outset, there is significant time gap (more than 10 years) between these two research projects. In view of the socio-economic, demographic and environmental changes recorded in the city in particular and the region in general, it would be less likely that the findings illustrated in the MA dissertation to be useful to solve the current problems of Mekelle. The reason is that the type and scale of the problems have undertaken significant changes in association to the socio-economic and environmental changes of the urban areas and the region as a whole including the waste characteristics.

Moreover, compared to the previous MA study, this study is wider in scope (it includes liquid wastes management and spatially covers more than one urban centre of the region) and gives more attention to the extent how waste management receives policy responses in the region to which the literature has been virtually silent.

2.8. Conceptual Framework

A logical procedure for an assessment of urban environmental management may cover an assessment of the environmental issues and then formulation and implementation of appropriate policy responses. This is because policy responses that go with a particular type and level of environmental challenge are requisite to effectively manage the urban environment.

Poor waste (liquid and solid) management existing in urban areas would primarily be attributed to improper or inadequate responses given to it. Thus, it would be of paramount importance to investigate the response given to the urban waste management problems and pinpoint the policy gap in waste management. The researcher believed that the waste management

At least in theory, the extent of the policy response should correspond to the scale of the problem. For that reason, to reveal the policy gap it is necessary to primarily estimate the magnitude of the problem of the study areas. Therefore, the nature and magnitude of the problem of liquid and solid waste management of the study areas has been initially assessed. This is particularly important to show the level of severity of the problem of waste management. Then the extent to which the problem has achieved policy responses has been examined. Based on this basic assumption, the conceptual framework of this research has been developed in consultation to the research papers mainly of Williams (2000), Bartone, et al. (1994), Henry, et al. (2006) and Ogwueleka (2009).

While assessing the nature and magnitude of waste management, the researcher has mainly focussed on the key problems linked to waste characteristics (mainly waste generation, storage, collection and transportation services, and disposal or treatment has been examined. To make it more detailed and clear, very extensive assessment on waste handling practices at source and storage (receptacles /septic tanks), collection and transportation (including service coverage), the status of the disposal or treatment sites, spatial pattern of service delivery, and waste reuse and recovery practices has been carried out.

The policy response could be realized through various measures which might be considered as implementation devices. The researcher has identified three measures. These are the policy statement/ document, institutional framework/devices, and management approach. The policy document/statement, as the first measure to install/set up proper waste management system, is evaluated, if any, were examined. Similarly, the policy implementation devices which are more of institutional issues (institutional framework) and management approaches are examined The overall responses of the

policy-makers (through policy) fundamentally depend on their environmental awareness and commitment. Indeed, environmental awareness and commitment could be considered as cross-cutting issues needed throughout every decision and implementation level.

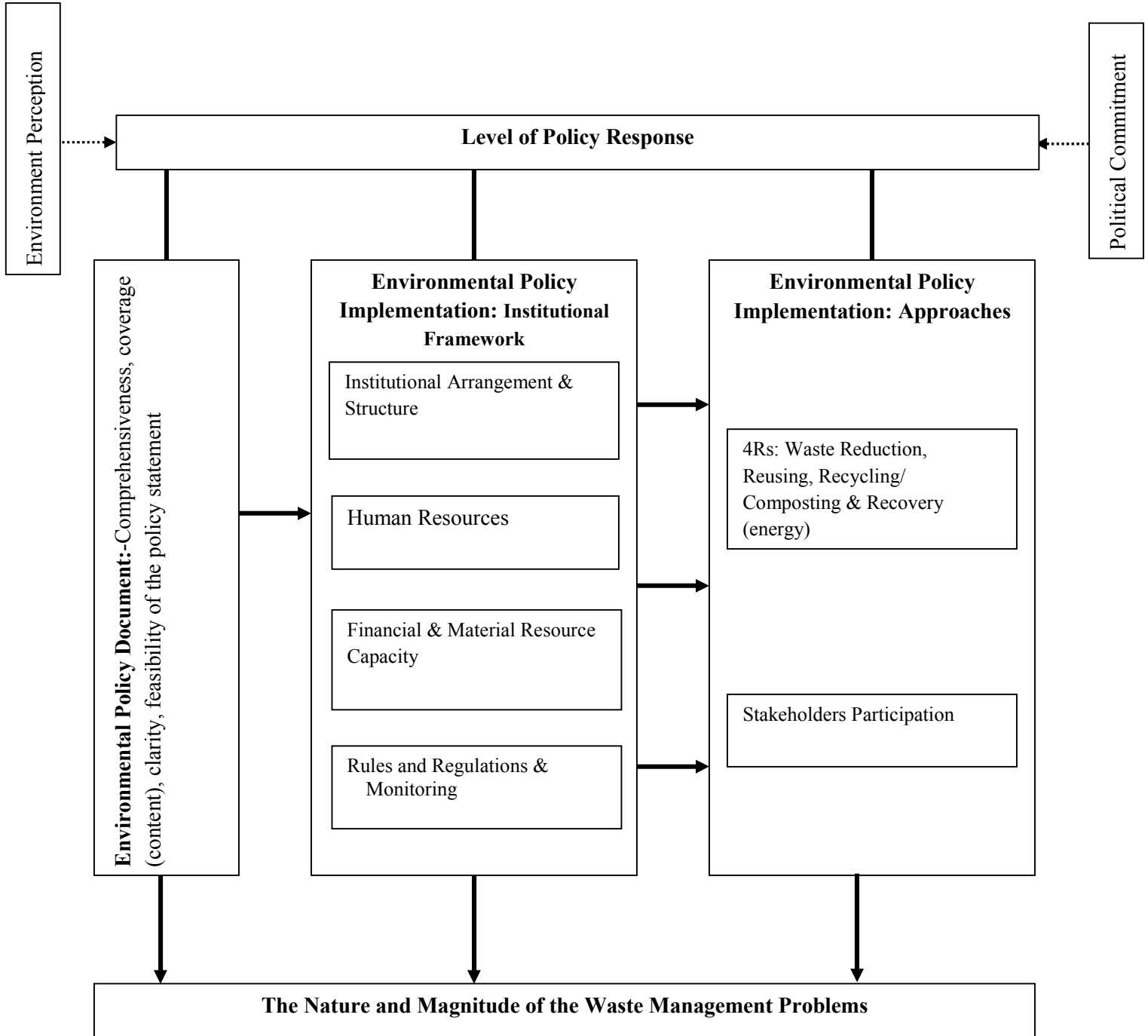


Figure 2: Conceptual Frameworks of the policy responses (designed by the researcher)

As depicted in the figure, the main variables are plainly identified in the diagrammatic or pictorial/ schematic display. On the one hand, the policy statement/document, institutional framework and management approach are basic variables of policy response which might be levelled as dependent variables; on the other hand, the on-site waste handling, collection and transportation services, and status of disposal and/or treatment scale are independent variables of waste management problems. The researcher argued that it is not so simple and clear to determine the direction of the interrelationship among the variables considered. This is mainly because the waste management problems and policy responses are mutually interrelated. On the one hand, policy response depends on the magnitude of the scale of the waste management problem; on the other hand, the magnitude of the problem depends of the extent of the response from policy. However, the researcher's overarching purpose is to reveal the extent how the urban environmental problems or waste management problem (as dependent variable) received policy response (as independent variable). The researcher believes that the level of policy responses to urban environmental management is primarily reflected on the quality and appropriateness of the policy statement formulated. Appropriateness depends on the coverage of the key issues, clarity and viability of each issue addressed in the document. This is a very essential variable for it not only determines the extent environmental issues are addressed but also it greatly determines the other two variables (institutional framework and waste management approaches). Fernandez (1998), as compiled by Atkinson et al (1999), has indicated that policy issues do deserve very much attention as they provide the political, legal, institutional, and financial frameworks.

The quality of the policy document could give the first impression on, though not conclusive, how adequate are the responses given to the particular problem. It would not be unusual to come across a town with quality policy document but with poor urban environmental management. Therefore, quality policy document cannot give absolute guarantee of proper management of solid and liquid waste. Barrow (2006) strongly argued that publishing environmental policy statements, with overall vision and goals, would be important to show intent, identify priorities and principles, and to give sense of purpose and this could be useful to inform the public but it does not guarantee sound

environmental management. However, the effect of quality policy statement on the implementation performance is vital. Publishing quality policy statement, as it is explained above, is a prerequisite for effective implementation of environmental policy for it determines the type of institutional set up, form of governance and legal frameworks required, and waste management approaches to achieve the intended policy goals. That is why the quality of the policy statement has been assessed.

The second category of response is designated as policy implementation devices which have been identified as institutional frameworks (such as organizational structure, human resources, financial and material resources and rules and regulations), and waste management approaches which mainly include the 4Rs (Reduce, Reuse, Recycle /compost and Recovery) and stakeholder participation. These are the means necessary to actualize environmental policies and are used to improve the waste management problem. Institutional arrangement, organizational structure, material, financial and human resources capacity, and duties and responsibilities versus authority, are some of the main constituents of the institutional framework. The human resource specifically refers to the size, competence, skill, commitment, motivation, attitude of the employees of the waste management sector.

Ahmed and Ali (2004:475) suggest that policy frameworks and implementation strategies must be accompanied by new forms of governance to increase efficiency and effectiveness, and to maximize popular participation in service delivery. The researcher supposes/believes that the constituent of governance such as public participation and decentralization would suffice the purpose.

One of the mechanisms through which governments could respond to environmental problems is legal framework. The legal framework specifically refers to the laws, legislations, rules and regulations, standards, enforcements, monitoring and evaluation. These are assumed to enhance the performance of waste management practice in the urban areas primarily by prohibiting illegal waste handling practices of waste generators. In other words, the legal issue should enable waste generators and processors to handle

their waste as per the standard set forth. Thus, first, their presence has been explored, and then their appropriateness and effectiveness in implementation is assessed.

The third category refers to waste management approach. Instead of sticking to traditional approaches which focus merely on the routine, technical aspects of waste management such as collection and disposal system and on material, the labour and finance capacity of the environmental agencies should shift to very strategic and innovative approaches that could bring about sustainable solution to waste management. Some of these strategic waste management approaches are waste prevention or minimization, reusing, recycling and recovery (4Rs) and participation (including privatization and partnership). In addition to their contribution to the cleanliness of the urban areas, these approaches do have some more purposes like creation of employment opportunities.

Each of the three major response categories and their sub-components is not secluded; rather due to the perceptible linkage that exists among each other, strengths or weaknesses in one would bring about similar effect on the other. It is strongly believed that the inter- and intra-category connection would have much effect on the over-all achievement of waste management. For instance, the quality of the policy document would directly impact the devices and approaches. The document should clearly indicate the institutional arrangement required, and waste management approaches emphasized. The effects of policy document and implementation devices on management approaches are also obvious. For instance, the activities of waste reduction, reusing recycling and recovery and participation of waste management should be supported by the law and legislation and requires adequate institutional capacity and good governance. For this reason, links between each response categories and constituents within and across category have been examined.

Chapter Three: Research Methodology

In this chapter, next to a brief overview of the physical and socio-economic background of the study area, the philosophical stance upheld and the methodology employed while conducting this research project are discussed in a bit detailed manner. In general, the issues pertaining to the questions ‘What to research?’, ‘Why research?’, and ‘How to research?’ are logically and meaningfully addressed in this research. Primarily the researcher has tried to explore the theoretical background of research philosophy and its relevance to research methodology. Next, the philosophical position and the subsequent methodological approaches, strategies and methods of this research undertaking have been stated. Lastly, corresponding to the research question/s, the philosophical position and research approach, strategy, methods of research employed have been clearly identify and discussed.

3.1. Background of the Study Area

Bearing in mind that plainly clarifying of context of study area could facilitate the reader’s understanding of the thesis, the researcher has tried to illuminate the socio-economic and physical backgrounds of the study area to the readers of the thesis. The physical and socio-cultural aspects of the study which are of importance to the analysis of data and understanding of the results of the study are discussed in this chapter. These include the physical constituents such as locational and agro-ecological features, and socio-economic aspects like population, urbanization, economic, education, health, and water supply of the study areas.

3.1.1. Physical Background

Location and area

The Federal Democratic Republic of Ethiopia (FDRE) is one of the African countries located in the Horn of Africa. It is bounded by the Sudan in the west, Eritrea in the north, Kenya in the south, Somalia in southeast and Djibouti in the east. Ethiopia consists of nine national regional states and two urban administration regions where Addis Ababa is the

capital city of the country. The National Regional State of Tigray, which is one of the nine national regional states, is found in the northern tip of the country and shares boundaries with Eritrea in the north, Sudan in the west, Amhara Regional State in south-west, and Afar Regional State in the south. Astronomically, it is located between 12° and 15° N, and 36° 30' and 40° 30'E. Its total area is 54,572.62 square kilometres (Tigray Bureau of Agriculture and Rural Development, 2006).

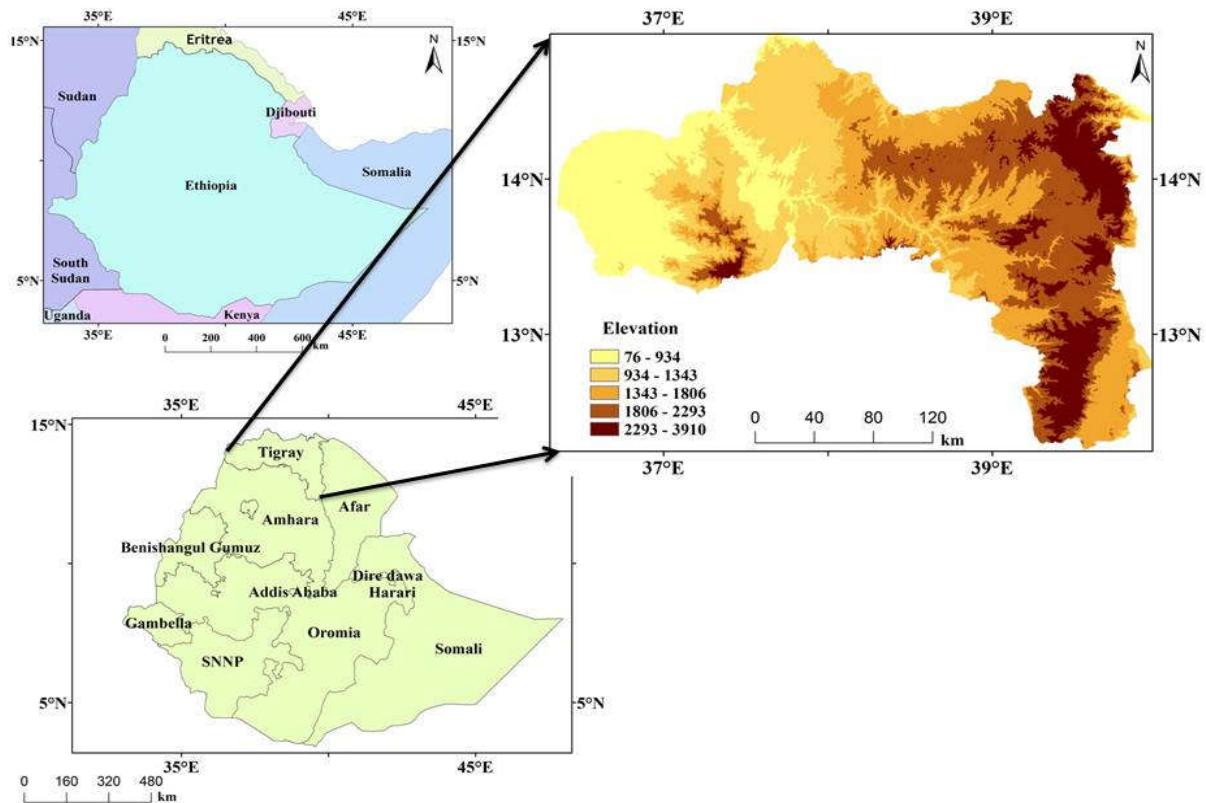


Figure 3: Map of Ethiopia and its international boundary (upper left), National Regional States of Ethiopia (lower left), and Tigray National Regional State (upper Right)

Source: Prepared in Geography lab based on the shape file prepared by Tigray National Regional State, Bureau of Finance and Planning

The National Regional State of Tigray, with a total area of 54, 593 square kilometres or 5, 459,300 hectares, has been divided into six main administrative zones and one special

administrative zone such as the Southern zone, Eastern zone, Central zone, Northern zone, North-western zone and South Eastern zone and the Special zone of Mekelle city. These zones are further sub-divided into *woredas*. Accordingly, the region as a whole comprises 52 *woredas* of which 11 are towns and 7 are sub-cities that received the status of *woreda*. The *woredas* in turn comprise *Tabias* or *Kebeles* which are the smallest administration units. Totally, the region has 767 *Tabias (Kebeles)* (Ethiopia, 2008; Tigray Bureau of Planning and Finance, 2008).

3.1. 2. Socio-economic Background

3.1. 2.1. Population and Urbanization

As it is common in most regional states of the country, the population of Tigray National Regional State is growing rapidly. On the average, the population is growing at about 2.5% annually. According to the projection made based on the latest National Population and Housing Census of 2007, the total population of the Tigray National Regional State in 2016 was 5,151,998, of which 1,331,000 were living in urban areas of the region. Mekelle, the regional capital, alone housed 340,858 persons in similar period. For the same period, Adigrat and Shire Endasilassie stand second and third largest towns populated by about 90,658 and 74,503 persons, respectively.

Of the nine main regions of the country, Tigray regional state has the third highest level of urbanization. While the country's level of urbanization was about 19.8% in 2016, the corresponding figure for the Tigray National Regional state was about 25.8%. The first and second largest urbanized regions are Harari Regional State (55.4%) and Gambela Regional state (33.2%), respectively. However, unlike Tigray, which has a total population of more than 5 million people, the Harari and Gambela regional states have by far smaller populations, which are 240,000 and 422,002 persons, respectively.

According to the proclamation No.276/2016 of Tigray National Regional State, the region has recognized totally 110 towns classified into three basic classes. These three basic classifications of towns are regio-policy, town and emerging town. Accordingly, one regio-policy, eleven towns and ninety eight emerging towns have been recognized by the

proclamation. In turn, the towns including the regio-policy are classified into three levels (level one, two and three towns) while the emerging towns are of three levels (level one, two and three emerging towns). To qualify for the status of 'regio-policy', the city should have a population size greater than one hundred fifty thousand and less than or equal to one million (150,001 – 1,000,000) population. For level two and three towns, the population size required is generally greater than twenty thousand but less than or equal to one hundred fifty thousand (20,001- 150,000). Similarly, emerging towns are towns with a population of two thousand and above but less than twenty thousand (2000 – 20,000). In view of this criterion, Mekelle has got the status of regio-policy. In the same vein, eight towns, such as Adigrat, Shire Endasilassie, Axum, Adwa, Alamata, Wukro, Maichew and Humera have been identified as level two towns. Moreover, three towns such as Sheraro, Korem and Abiyyi Addi have been designated as level three towns. On the other hand, the rest ninety eight towns are designated as emerging towns and are also classified into three levels such as level one, two, and three emerging towns (Tigray National Regional State proclamation No. 276/2016).

As it has been stipulated in the proclamation, the region has a large number of urban centres with different status. Therefore, provided that there will be more potential rural population (high potential rural urban migrants) and rapid urbanization process prevailing in the region, it would be more likely that more population will be added into the urban areas in the years to come. This will pose pressure on the urban managers or local administrators to furnish more services including waste collection and disposal services to their residents. In 2016, for instance, about 1,331,000 (25.83%) people inhabited the urban centres of the region. During the same year, more than 32% of the urban population of the region resides in Mekelle and Adigrat (study areas) alone.

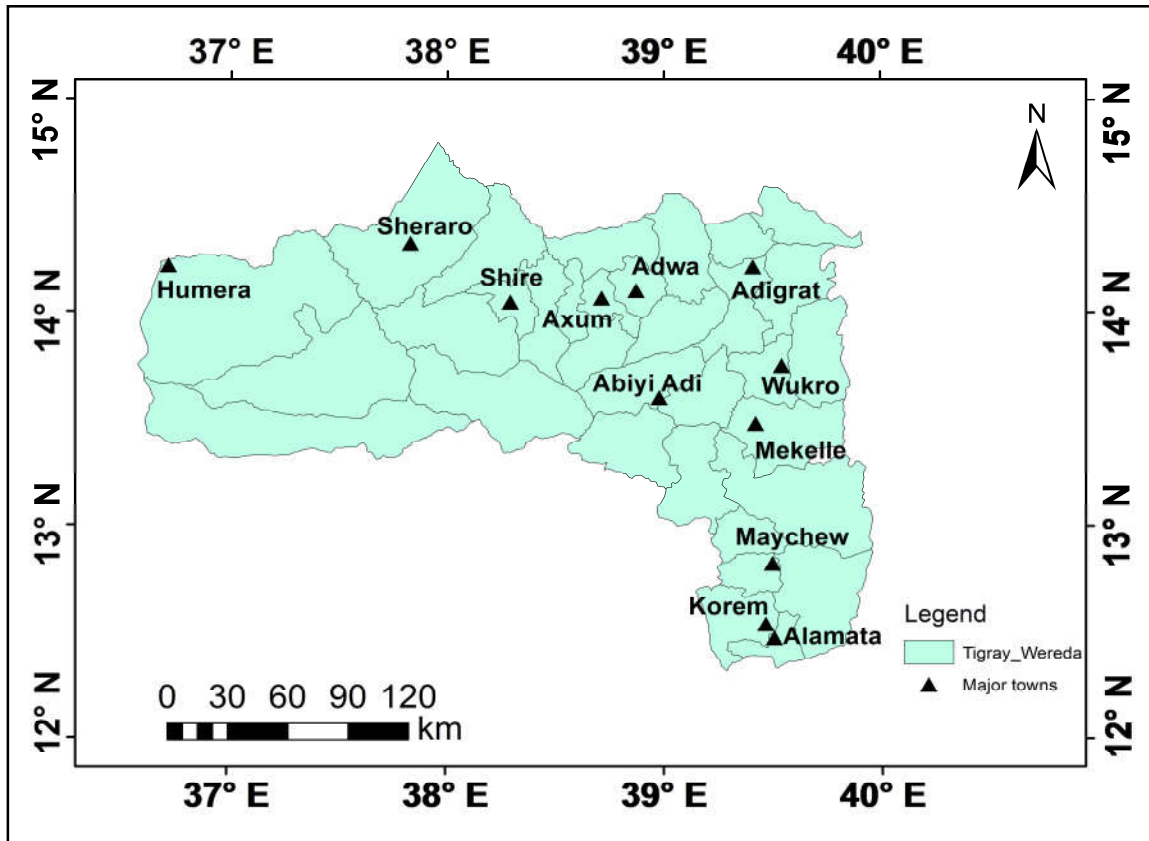


Figure 4: The major towns of Tigray National Regional State with a population greater than 20,000

Source: Worked at Geography lab room based on the database of Finance and Planning Bureau of Tigray National Regional State

3.1.2.2. Economic Background

Ethiopia's economy is chiefly agricultural, where more than 75% of the country's population is employed in the sector. Agriculture is the backbone of the regional economy. It accounts for more than 50 % of its GDP and employs more than 75% of its labour force for the years prior to 2006. Ethiopia's economy is chiefly agricultural. Agriculture has been the dominant sector accounting for over 50% of GDP share and 85% of employment for decades as the manufacturing sector contribution to GDP and employment stagnates at lower levels. Nevertheless, gradually, Ethiopia is getting an economic structure which is shifting from the traditional agriculture sector to the modern service sector. The service

sector accounts for the lion's share in terms of the structure of GDP (46.6%) in 2014/15 taking the lead from the agriculture sector (Kabeta & Sidhu, 2016).

Structurally, the service sector has slowly taken over the lead from agriculture in terms of its contribution to the gross national product. In 2012/13 the respective shares of agriculture, industry and service sectors in the GDP stood at 43%, 12% and 45%, respectively. The share of the service sector to GDP increased from 38% to 45% in the past 10 years while the share of agriculture declined from 52% to 43% in the same period. However, agriculture will continue to be the main source of employment as the service sector has not been able to generate much employment. Meanwhile, the industry sector has maintained modest increments over the years in terms of value added (Keeley & Scoones, 2014).

Ethiopia has registered remarkable economic performance with annual growth averaging 10.9% over a period of ten years that lasted from 2004/05 to 2014/15. The growth was registered in all sectors, but at different growth levels/rates. During this period, a structural change was observed as agriculture declined in its share and the services sector began to dominate the economy. Indeed, all sectors have grown in the last few years but at different rate. The growth in the industry sector was very strong in the past three years. This sector was the highest performer in 2012/13 by registering 18.5% annual growth rate, which was beyond the construction boom and expansion in mining and manufacturing sub-sectors. Agriculture grew by 7.1%, recovering from 4.9 % growth in the previous year mainly attributed to increased crop production as a result of increases in productivity and expansion of area under cultivation (Kabeta & Sidhu, 2016).

The main reasons for the increase in the agricultural productivity and production were favourable weather and good rainfall, strengthened agricultural extension services, better access to agricultural inputs, improved access to market and pursue of enhanced policy and advocacy. In 2012/13, the service sector registered 9.9% annual growth and stood out in terms of its contribution to the overall output.

Table 1: Trends in Selected Economic Indicators (percentage growth rates)

Year	Real GDP (%)	Agriculture (%)	Industry (%)	Service (%)	GDP per capita in US\$
2006/07	11.8	9.4	9.5	15.3	270
2007/08	11.2	7.5	10.1	16	359
2008/09	10	6.4	9.7	14	419
2009/10	10.4	7.6	10.6	13	377
2010/11	11.4	9	15	12.5	389
2011/12	8.8	4.9	17.1	10.6	510
2012/13	9.7	7.1	18.5	9.9	550
Average	10.47	6.4	12.93	13.04	

Source: **UNDP Ethiopia's Policy Advisory Unit, 2014**

The service sector for the years between 2006/07 and 2012/13 (Table 1), the service sector has grown on the average by 13.04%, whereas the average annual growth for industry and agriculture has been 12.93% and 6.4%, respectively. Similarly, the real GDP has grown on the average at 10.47% annually for the same period. Moreover, the GDP per capita has grown from 270 in 2006/07 to 550 US\$ in 2012/13.

Education and Health

In light of the environmental problems in general and cleanliness problems in particular, the educational and health status of the region (and the urban areas) are more relevant issues that need to be explored. Undoubtedly, cleanliness at household level and neighbourhood level is directly related to the level of education the household or the neighbourhood occupants attained. Similarly, health institutions and facilities would have a lion's share in influencing the waste generators to properly handle their waste as well as the respective public institutions that are in charge of providing waste collection and disposal services to keep the cleanliness of the city. Moreover, health institutions play vital role in curbing the effects of insanitation or dirtiness of the urban environment.

The status of education in the region could be assessed using more refined indicators, but the researcher has decided that for this research purpose, the school-student ratio and enrolment rate suffices the purpose. Mainly because of the increase in the population size

of the region and the attention it received from the policy and decision makers of the region as well as the country as a whole, quantitatively there has been significant change in educational facilities and participation in schooling since the EPRDF came to power in 1991. For instance, as indicated in Table 2, the participation of students has steadily increased from the year 2000 to 2008. The data in the Table also show that, except for the GER (Gross Enrolment Rate) of the primary schools, both GER and NER (Net Enrolment Rate) have smoothly increased for all grade levels during the same period. Higher NER has been recorded in 2008 E.C for all grade levels than in 2004 E.C. The GER for grade levels 9-10 and 11-12 has also increased from 2004 to 2008 E.C. Similarly, as the number of enrolled students increased, the number of both primary and secondary schools has increased though the primary schools establishment rate was not proportional to the rate of growth in enrolment.

Table 2: Gross and Net Enrolment Rates in all grade levels (Grade1-8, 9-10, and 11-12) in 2000, 2004, and 2008 E.C.

A. Grade 1-8

Year	School Age Population (age7-14)	Enrolment (Grade 1-8)		Enrolment Rate (Grade 1-8)		Number of Schools
		Gross	Net	Gross Enrolment Rate	Net Enrolment Rate	
2000	N/A	990,895		105.9	N/A	1775
2004	1004313	1006973	909542	100.26	90.56	1995
2008	1099970	1134460	1068802	103.14	97.17	2125

B. Grade 9-10

Year	School age population (15-16)	Enrolment (Grade 9-10)		Enrolment Rate (Grade 9-10)		Number of schools
		Gross	Net	Gross Enrolment Rate	Net Enrolment Rate	
2000	N/A	92648	N/A	46.89	N/A	84
2004	222504	122385	81312	55	36.54	132
2008	245928	171290	129144	69.65	52.51	188

C. Grade 11-12

Year	School age population (17-18)	Enrolment (Grade 11-12)		Enrolment Rate (Grade 11-12)		Number of schools
		Gross	Net	Gross Enrolment Rate	Net Enrolment Rate	
2000	N/A	23059	N/A	N/A	N/A	84
2004	230404	28725	18545	12.47	8.04	132
2008	225392	41731	31318	18.51	13.89	188

Source: Tigray Bureau of Planning and Finance, 2000, 2004 and 2008 EFY

Due to the deficiency of data, the researcher could not show full picture of the region with respect to health sector. However, he tried to show the number of health institutions existing in the region by type, with the anticipation that such data might provide some information on the extent to which health institutions are accessible to the beneficiaries. According to the statistical bulletin published by the regional Finance and Planning Bureau in 2008 EFY (Ethiopian Fiscal Year), there were 13 general hospitals, 19 primary hospitals and 1 referral hospital in the region. When examined in view of the size of beneficiaries

and hence the pressure exerted on the hospitals, the findings shows that on average, nearly 161,000 persons are dependent on each primary or general hospital. In view of the fact that the region has only one referral hospital, it means that it is serving the total population of the region which is 5,151,998 and substantial proportions of the people of the adjacent regional states, namely the Amhara and Afar Regional states. In addition to the hospitals, there are numerous health centres and health posts. The same sources indicate that a total of 198 health centres and 166 health posts are presently providing lower level health services. This means that on average, one health centre is serving 26020 persons while one health post is serving 31,036 persons. In view of the fact that either type of health institution is generally expected to serve a maximum of about 20,000 persons, the disparity that is observed between plans or performance is not that much alarming. Nonetheless, the fact remains that the problem of working over capacity is relatively more pronounced in the case of the health posts as compared to that of the health centres. The region also has a total of 238 clinics which are in turn divided into three categories (primary, medium and specialty clinics) depending upon the quality of services they provide. These health facilities are in most cases trying to fill the gaps (in accessibility and quality of services) that exist basically among the lower level health institutions.

Urban water supply

One of the key services provided in urban areas is water supply. The key role of urban water supply is not only to use it for drinking and preparation of meals and washing, but also its contribution to ensure sanitation at household level as well as neighbourhood and city level is vital. Particularly, the problem of liquid waste often gets more complicated with the shortage of potable water in cities and towns. As the health records of 2008 EFY (Ethiopian Fiscal Year) indicate, one of the top ten killers of (in a second position) is 'diarrhoea all forms'. The problem is particularly more severe for children under 5 years of age, outpatients and inpatients that stand first and second, respectively. This plainly implies that there is a serious problem of insanitation and unhygienic condition which are more likely linked with lack of access to pure potable water and poor waste management conditions.

Urban water supply data of the region indicates that there is serious problem of shortage of water in most of its urban areas. The problem is continuing to deteriorate from time to time. In 2006 EFY, for instance, the average urban water supply scheme and access coverage data showed that the average water supply coverage of 54 towns of the region was found to be only 63.89%. In fact, there was wide disparity among the urban areas in urban water supply (access coverage) which ranges from 8% in Adishohu and Agbe towns to 100% in Humera, Wajja Temuga, Gijjet, Haik Meshal, Bezet, Adwa, Abiyyi Adi, Inticho, and Endaba Guna towns. The access coverage for the study areas was 61% (below average) in Adigrat town and 80% in Mekelle city (Tigray Bureau of Planning and Finance, 2006).

Whereas in the year 2008 EFY, two years after, the water supply of most of the urban centres of the region has significantly declined. Using the individual coverage data of 55 urban centres, the researcher has calculated the average urban water supply coverage of the region as 43.1% only. The water supply of most of the urban centre, even of those which had relatively better supply, has declined drastically within two years. Most of the urban centres are in threatened or critical situation of water shortage. Access coverage ranges between 12.7% in Addi Nebried town and 13.3% in Nebelet town, and 100% in Adwa town. Similarly, the water supply coverage of Mekelle and Adigrat has fallen to 75.3% and 34.6%, respectively (Tigray Bureau of Planning and Finance, 2008).

3.1.3. Waste Management Institutional Framework

In consequence to the rapid urbanization, increasing concentration of production activities and a change in the consumption behaviour (consumerism) and in the way of life particularly of urban residents, urban environmental degradation has continued to be the point of concern of public governments and residents as well. It is well-known that the huge municipal waste generated in the urban areas is the most serious causes of the environmental degradation. In addition, they are posing severe challenges on the health of human beings and animals and the quality and aesthetic value of the environment. Cognizant of the impacts of the environmental degradation, the public administrators have

established different public organizations which bear the responsibility to handle the problems.

Among which the Environmental Protection Agency, the Health Sector (particularly the Sanitary Section), and the Sanitation and Beautification Department are more concerned on environmental problems of the urban centres. Though overlapping of duties and responsibilities and duplication of tasks are common problems of the offices and sectors, the Environmental Protection Agency and Health Office claim themselves that they are mandated with regulatory rather than operational works. On the other hand, the Sanitation and Beautification Department which is organized at a department level in the Bureau of Urban Development, Industry and Trade (BUDIT), and the Municipalities up to *Tabia* level is responsible for both regulatory and operational works within their respective urban territory.

For example, the Environmental Protection Agency is more concerned with pollution issues, whereas Health Offices are more concerned with sanitation and cleanliness of the urban areas but still the regulatory aspects. On the other hand, the Department of Sanitation and Beautification is involved in both operational and regulatory works of waste management in the urban areas. One of the duties and responsibilities of the Sanitation and Beautification Section is to ensure safe and proper collection and disposal of wastes generated in the city or town to ensure the cleanliness and sanitation of the urban areas. Moreover, it regulates the way how wastes are properly and safely handled at sources and disposed off on landfills. The Sanitation and Beautification sector is solely concerned to manage properly the wastes produced or generated in the urban centres. Indeed, the Sanitation and Beautification office, as the name itself indicates, is responsible for enhancing the beauty of the cities and towns partly by developing and protecting urban green areas.

All municipal administrations in the region have their specific Sanitation and Beautification sectors. And each sector has a man power size and professional mix as defined in the Business Process Re-engineering (BPR) document. As per the recently revised BPR, totally 465 permanent employees are needed in all urban centres in the region. However,

as it is indicated in the annual report of the Bureau of Urban Development, Industry and Trade (BUDIT), Department of Sanitation and Beautification (DSB), the man power demand of the section has never been fulfilled due mainly to reluctance and weaknesses of the local administrators. As indicated in the Annual Reports of the Department of Sanitation and Beautification of the Region, for instance, it was only 68% (291) of the manpower demand of the urban centres of the region that was fulfilled in 2009 EFY.

The organization which is in charge of environmental issues is the Environmental Protection, Land Administration and Land Use Agency which was considered to be an integral part of the Regional Agricultural Bureau. There is also a Sanitation and Beautification Department within the Regional Bureau of Urban Development, Industry and Trade. However, there is no clear demarcation in the duties and responsibilities between these two offices; none of them has direct, functional line of command and hierarchical linkage with the lower level offices established at the city level and sub-city and town levels.

3.2. Research Philosophy and Methodology (Overview)

The starting point of a research project is to define a research question or problem that is the research topic. By so doing the 'what to research?' question would be answered. Well formulated research problem is prerequisite for a good research project. And it is the first challenge for a researcher to adopt a critical attitude to research design and the solution for this lies in the initial formulation of the research problem (Flowerdew & Martin, 2005). For that reason, the researcher has primarily tried to define primary the main research question of the study as 'what specific policy responses have the waste management problems of the urban areas of the region received to date?' To this end two sub-research questions are formulated: 'What is the nature and magnitude of the waste management problems in the urban areas of the Tigray Region?' and, 'To what extent have these problems received appropriate and adequate policy responses?'

Once the key research question is determined, the researcher needs to adequately address the question 'why research'; that is to determine the philosophical grounds behind his research. Philosophy underlies the design of any piece of research which, in turn, must

be appropriate to the questions or problems that prompt the research work. In short, while doing a research, the researcher should answer the question 'what philosophical assumption has grounded his research work?' This question directly demands the researcher to explore the philosophical assumption and make a choice and declare his philosophical position. Making philosophical choices is highly recognized as a basis to the research project.

To show how a research philosophy is important in research project, Flowerdew and Martin (2005:10) pointed out that "as grammar is to language, philosophy is unavoidable to research, whether researchers recognize it or not". They further explained that "just as we cannot speak a language successfully without following certain grammatical rules, so we cannot conduct a successful piece of research without making certain philosophical choices. Philosophy, like grammar, is always there."

Therefore, it is apparent that to decide the methodology such as the approach, and the methods including data collection instruments, sampling procedures and analysis methods, the researcher has to determine the research philosophical basis. The research philosophy adopted is founded on important assumptions about the way in which we view the world. It is these assumptions that underpin the research approach, methodology and the methods chosen. Generally, philosophy is concerned with views about how the world works and it, as an academic subject, focuses primarily on reality, knowledge and existence. The way we conduct a research is more likely to be influenced by the way we look at the world. Therefore, philosophy or paradigm, which refers to way of looking at the world, is very much important concept in research doing that guides our research work (Mason & McBride, 2014).

The theoretical paradigm or philosophical assumption has three basic components such as the ontology, epistemology and methodology. The theoretical paradigm or `philosophical assumption of each of these components is identified based on the questions they raised and the relative responses provided. These questions include 'what is real' (which refers to the ontological assumption)? How do we know about the world

(which makes clear one's epistemological position)? And what approaches and methods should we use (which clearly indicates the methodology)?

Both ontological and epistemological assumptions are commonly considered as a person's world view, which significantly influences the person's research approaches and methods; methodology in general. The nature of the world (ontology) adopted by an enquirer will affect the belief about the nature of knowledge in that world (epistemology), which in turn will influence the enquirer's belief as to how that knowledge can be uncovered (methodology).

Ontology is the study of being (Crotty, 1998). Ontological assumptions are concerned with what constitutes reality, in other words, *what is reality*. Researchers need to take a position regarding their perceptions of how things really are and how things really work (Scotland, 2012).

Based on their ontological belief, researchers could also be classified into either Objectivists or Subjectivists. The philosophical assumption of objectivism is that social entities exist in reality external to social actors concerned with their existence. Objectivists believe that observation, reason and experiment are the best means of understanding human behaviours and thus are sources of true knowledge. According to objectivist ontology reality is given and is measurable using properties which are independent of the researcher and his instrument. In short, knowledge is objective and quantifiable.

On the other hand, as Krauss (2005:758) indicated, 'the term epistemology comes from the Greek word *epistêmê*, which means knowledge. The term epistemology, when defined in simple term, is the philosophy of knowledge or how we come to know. Scotland (2012:10) pointed out that the main concern of epistemological paradigm is the nature and forms of knowledge and how it can be created, acquired and communicated.

The researcher's answer to the questions 'What is the relationship between the knower and what is known?', 'How do we know what we know?' and 'What counts as knowledge?' informs the epistemological position of the researcher. This implies that researchers would answer these questions differently according to their epistemological position. Based on

epistemological assumptions, two distinct, basic types of positions could be identified: Positivists, and Interpretivists (Krauss, 2005).

Interpretivism epistemology acknowledges the need for the researcher to understand differences between humans in their roles as social actors. The researcher as part of the social actors plays his/her own role in a particular social works and interprets his or her everyday social role in line with the meaning he or she gives to these roles. Likewise, the researcher interprets the role of others in line with his or her own set of meanings (Mark, et al., 2009). Interpretive epistemology regards knowledge and meaning as the results of interpretation. Therefore, it is arguable to accept objective knowledge which is independent of thinking and reasoning of humans. The interpretive epistemology is one of subjectivism which is founded on real world phenomena and argues that the world does not exist independently of our knowledge of it.

According to interpretive assumption, the researcher tries to understand phenomena through the meanings that people assign to them. Moreover, one of the typical features of interpretive paradigm is that it focuses on the need to undertake analysis in context.

Subjectivism is the philosophical stance, which views that social phenomena are created from the perception and consequent actions of social actors. What is more, this is a continual process in that through the process of social interaction, these social phenomena are in a constant state of revision (Mark, et al., 2009).

Thus, the way the researcher perceives reality influences his or her thinking on how knowledge is gained and the process how s/he could obtain such knowledge.

Researchers with positivist or objectivist orientation regard themselves as unimportant and independent entity in their research as if they are detached from what they are studying. They argue that the world exists and is knowable and underline quantitative methodology that is objective to discover it with more emphasis on measuring variables. The data collection techniques focus on gathering hard data in the form of numbers to enable evidence to be presented in quantitative form. Research findings are usually represented quantitatively in numbers which speak for themselves (Tuli, 2011).

On the other hand, the interpretivist or subjectivist researchers who see reality as human construct views reality and meaning making as socially constructed and that people make their own sense of social realities. The research approach they employ in data collection, sample selection and sampling procedures, describing and interpreting social realities is qualitative. Moreover, the research findings in qualitative approach are usually reported descriptively using words. The qualitative research methodology treats people as research participants and not as objects as in the positivist research approach. This methodology enables the participants to make meanings of their own realities and come to appreciate their own construction of knowledge through practice (Tuli, 2011).

Based on the relationship between the researcher and what is being researched is viewed as independent of each other by the researchers who advocate quantitative approach, whereas those researchers who promote qualitative approach viewed such relationship as interactive and inseparable. The distinction between subjectivist and objectivist researchers goes beyond merely the use of numerical data versus non-quantitative data or close-ended questions versus open-ended questions. Rather, the distinction refers to several things at the same time: the general ideological orientation (philosophical assumptions) underlying the study, the method of data collection applied, the nature of the collected data and the method of data analysis used to process the data and to obtain results (Dörnyei, 2007).

The philosophical debate is ultimately framed in terms of a choice either the positivist or the interpretivist research philosophy and further into quantitative or qualitative research approaches. However, it is widely accepted that choosing one position or the other is somewhat impractical. It is argued that a better understanding of a complex phenomenon could be achieved by simply converging numeric trends from quantitative data and specific details from qualitative data. The importance of words to add meaning to numbers and the numbers to add precision to words can be clearly recognized in mixing the qualitative and quantitative approaches in research projects. In other words, by using both quantitative and qualitative research approaches, the researcher could bring about the best of both paradigms and thus combining the strengths of both research approaches. Furthermore, it

is believed that while combining these approaches (specifically the qualitative and quantitative), there could be an opportunity to employ the strengths of one approach to overcome the weaknesses of the other approach used in the study (Dörnyei, 2007). Therefore, it is a mixed method approach that possesses such quality.

We currently are in a three methodological world, with quantitative, qualitative, and mixed methods research all thriving and coexisting (Johnson, et al., 2007). It is possible and highly appropriate to use mixed approach, both quantitative and qualitative, within one research. It is therefore plainly noted that a researcher in a particular study should not think of a philosophy adopted as opposite options but as it is a continuum. Wherein at some points the knower and the known must be interactive, while at others, one may more easily stand apart from what one is studying. A researcher with such a view would adopt a pragmatist's position (Mason & McBride, 2014).

Pragmatism argued that the research problem is more important to determine the research method which is thought to be employed than the research philosophy. Thus, the researcher could use all possible approaches to understand the problem (Creswell, Plano Clark, et al., 2003). The most important determinant of the research philosophy adopted is the research question- one approach may be 'better' than the other for answering particular questions (Creswell, Plano Clark, et al., 2003; Mason & McBride, 2014). As it is not committed to only one philosophical assumption and approach, pragmatism upholds mixed methods research approach where the researcher is able to draw freely from both qualitative and quantitative assumptions when they are engaged in research project. Pragmatism as a distinct philosophical position gives individual researchers a freedom of choice. It is strongly argued that researchers are 'free' to choose the methods, techniques, and procedures that best meet their needs and purpose and research problems (Creswell, Plano Clark, et al., 2003).

In support of this view, many writers have said much about the importance and quality of pragmatic views and mixed methods approaches; among which Symonds and Gorard (2008:3) have explained that pragmatism or the 'philosophy of free choice' is the most appropriate epistemology for mixed methods. They further indicated that with the

additional strength given by the adoption of pragmatism, mixed methods was recently claimed to be a 'third paradigm' in a trinity of otherwise incommensurable approaches. Mixed methods, by getting the most out of the strengths of each paradigm along with counteracting their weaknesses, had been the most appropriate approach in doing research (Symonds & Gorard, 2008).

Mixed methods research has been defined as

the type of research in which a researcher or team of researchers combine/s elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration (Johnson, et al. 2007:123).

3.3. The Researcher's Philosophical Position and Methodology

Having informed from the extensive literature focusing on the idea of philosophical assumption or theoretical paradigm and its significance in academic research, the researcher has come to recognize the need to identify and declare the philosophical position that underpins his research work. While determining his philosophical position, the researcher has made decisions among different choices. One of these choices is the philosophical perspective he has to hold in framing the research project. This is a very essential step in doing a research project because it is argued that research should not be methodological led, rather that methodological choices should be consequential to the researcher's philosophical stance and the social science phenomenon to be investigated (Flowerdew & Martin, 2005). This means is that the researcher has to establish a meaningful match among the three main aspects of research (research problem, philosophy, and methodology- approach and methods), and this implies that research methodology emanates from the researcher's research problem and philosophy.

In response to first questions (the 'what to research?') the research tried primarily to identify and formulate the research problem or research question. Alongside the research question the researcher has developed the key and secondary objectives and questions.

The primary objective of the researcher is to assess the extent to which urban environmental problem has received policy responses in the region. More specifically, the key question is 'how waste management problems have received adequate and appropriate policy responses in the urban areas of the region in general and the two major towns (Mekelle City and Adigrat Town) in particular?'

Once the researcher has clearly defined the research problem, it would be rather straightforward to raise the question 'how is the study to be conducted' in order to answer the research question. However, it has been clear that to answer the how to research question it first requires the researcher to explore the alternative philosophical assumptions and make a choice and position oneself. These philosophical assumptions in turn dictate the researcher how he should conduct the research, that is how to choose the methodology including the research approach and methods.

As a starting point or preliminary condition to the process of making research philosophical choice, the researcher has clearly articulated his belief. Based on his literature consultation on the arguments and distinctions between qualitative and quantitative approaches and their philosophical backgrounds, the researcher has been convinced by the argument that neither of them is superior nor inferior to other. In other words, one research approach is not better than the other. Rather, one approach or method could do better in doing one thing and the other in doing different thing. Moreover, the so called 'better' approach and method depends on the research question(s) which the researcher seeks to answer. One approach could be more appropriate to answer a particular research question or objective than the other (Mason & McBride, 2014). This implies that these two approaches could complement one another. The researcher has welcome the idea that neither the quantitative nor the qualitative approach and method is essentially better than the other to his research project. Moreover, he recognized that his research question and objectives could not be adequately addressed by either of them alone. And its sustainability needs to be decided by the context, purpose and nature of the research problem of the study in question.

Creswell (2003:11) also argue that *“instead of approaches and methods being important, the problem is most important, and researchers use all approaches to understand the problem”*. Better understanding of a complex phenomenon could be achieved by merging vast numerical data and specific details of qualitative data. In other words, words can be used to add meaning to numbers and numbers can be used to add precision to words. In short, quantitative and qualitative inquiry can support and inform each other so that the researcher would be able to understand better the research problem (Dörnyei, 2007). Likewise, the basic research question or key objective in this research basically requires both quantitative and qualitative data; both are equally necessary to carry out interpretation of results meaningfully thinking that one data type is complementary to the other data type. This implies that the researcher’s choice is a third approach, which is relatively recent approach, called mixed methods.

Mixed methods not only acknowledge the significance of quantitative and qualitative research but they also become an influential third research approach which provides the most informative, complete, balanced, and useful research results (Johnson, et al., 2007). It has been clear that mixed methods of research entails quantitative and qualitative data collection, analysis, and inference techniques combined according to the logic of mixed methods research to address one’s research question(s) satisfactorily. The mixed method approaches have recently risen to prominence. The reason why more researchers are opting for this type of research approach is that both qualitative and quantitative data are simultaneously collected, analyzed and interpreted.

To assess the nature and magnitude of the waste management problem of the two urban areas, the researcher mainly employed questionnaire survey wherein many of the information were collected from the residents of the respective urban areas. Besides, considerable size of information was collected from records, field observation and key informants. In this regard, the qualitative data collected from key informants have been used to complement as well as to triangulate the questionnaire data. To examine the policy measures which come into effect by the responsible bodies to solve the waste management problems prevailing in the study areas, the qualitative approach was mainly

used. Both quantitative and qualitative approaches have been used concurrently and neither only quantitative nor only qualitative approach serves my research work but a mixed one.

The choice of a philosophical ground which backs mixed methods research approach is straightforward. It is neither objectivism (quantitative approach) nor subjectivism (qualitative approach) alone could adequately answer his research question. Therefore, as he has already given recognition to the importance of research problem (research question) and to mixed methods to be suitable approach, the philosophical orientation of this research could neither be pure objectivist nor pure subjectivist. Pragmatism clearly argues that the most important determinant factor of a research philosophy adopted is the research question.

The theoretical paradigm underpinning the mixed methods research approach is pragmatism. In short, the primary philosophy of mixed research is that of pragmatism. Pragmatism which is 'the philosophy of free choice' is widely believed to be the most appropriate epistemology for mixed methods. This is because pragmatism, as it has been discussed above, is not committed to any one system of philosophy and reality. It applies to mixed methods research in that inquirers draw liberally from both quantitative and qualitative assumptions when they engage in their research (Creswell, et al., 2003).

In a nutshell, based on the nature of his research question(s) and the benefits which could be acquired from the research approach, the researcher has determined to employ mixed methods approach and applied it in his research project. Accordingly, he developed his research design which corresponds to his research approach. In general, mixed methods research involves collecting, analyzing, and interpreting quantitative and qualitative data in a single study or in a series of studies that investigate the same underlying phenomenon.

The importance of well-designed research procedures for rigorous, high-quality studies has been highly recognized. This is because rigorous research design guides in deciding the methods that the researcher must make during his or her studies and set the logic by which he or she makes interpretations at the end of studies (Creswell & Clark, 2007).

Research design can be thought of as the *logic* or *master plan* of a research that throws light on how the study is to be conducted. It shows how all of the major parts of the research study– the samples or groups, measures, treatments or programs, etc–work together in an attempt to address the research questions. It gives directions from the underlying philosophical assumptions to research design, and data collection.

Research designs are procedures for collecting, analyzing, interpreting, and reporting data in research studies. They represent different models for doing research, and these models have distinct names and procedures associated with them. There are four major types of mixed methods research design: Triangulation design, embedded design, explanatory design and exploratory design. Triangulation design has been the primary preference of the researcher in this study because he believed that it better meets his interest. The basic interest of the researcher is to explore different data from different sources for two purposes. The first purpose, as noted by Cresswell and Clark (2007), is to have different but complementary data on the same topic /issue. To this end the questionnaire survey, which predominantly consists of objective questions, has been employed to collect quantitative data to appraise the scale of the waste management problem against the overall public services and on-site handling systems. Specifically, data pertaining to waste collection and disposal services, controlling and monitoring services, awareness creation activities, waste handling practices of waste generators are collected using questionnaire survey. But it has not been possible to fully answer the key research question (or all research questions) or to achieve the main objective (or all research objectives) of the research using the data collected from the household respondents using the questionnaire survey only.

The second purpose is, therefore, to collect data from other sources which partly complement the deficiency and partly are sole sources of data to the research objectives/questions pertaining policy issues from the officials and decision makers/officers and experts. The policy related issues or objectives need qualitative data which would be collected from the key informants. So, parallel to questionnaire survey, the researcher has collected data related to policy measures from the responsible bodies which are more or less qualitative in nature (Note: the key informants have not been

included in the questionnaire survey). Hence, the very intent of the researcher to use the triangulation design is to compare and contrast the quantitative statistical results collected from secondary data sources and mainly from households using questionnaire survey and the qualitative data analysis (using thematic content analysis) results. When considering the procedure, both the quantitative and qualitative methods are implemented at the same timeframe; it means is that data collection and analysis of the quantitative data and qualitative data are conducted concurrently but separately and quantitative survey results and the qualitative key-informant interview findings are converged during interpretation. Such type of triangulation design model is referred as convergence model.

In short, to maintain the wholeness of the answer to the research question, the researcher used triangulation design which is one of the four types of mixed methods designs. Likewise, the researcher has made preference to the convergence model of triangulation design (concurrent procedure) which involved data collection and analysis both requires him to collect and analyse quantitative and qualitative data separately on the same phenomenon, but to converge the different analysis results during interpretation.

3.4. Research Methods

3.4.1. The Nature and Sources of Data

The research has used both primary and secondary data sources. Generally, the primary data sources for this research are the key stakeholders of the urban environmental management who are thought to have a role directly or indirectly in protecting or damaging the respective urban centres. These key stakeholders of urban environmental managements are broadly classified as waste generating entities, environmental service providers and beneficiary, policy and decision makers, environmental protection regulators and supervisors, and civil societies including small and micro-enterprises which are directly or indirectly involved in environmental issues. When explained in more detail, the researcher has tried to involve residents from residential areas, commercial areas, and public and private institutional areas who are thought to be waste generators and waste collection service beneficiaries. Moreover, an effort has been made to include the employees in government environmental offices and institutions. For example,

Municipality and Bureau of Urban Development, Industry and Trade (BUDIT) of the Region, and more specifically, the Department of Sanitation and Beautification which are directly in charge of environmental service delivery, regulation, and monitoring and evaluation, and policy and decision making pertaining to environmental management issues have been considered in selecting research participants. The last but not the least important source of data used in this study is the field where the real waste management problem is clearly reflected.

More specifically, household heads (with more preference for females), dwelling in Mekelle and Adigrat have been used as a source of the primary data. Where possible the data collectors were explicitly expressing their preferences to female household head. This is because the researcher strongly believes that the status of being head of a household in a family is not limited to only males or females. In the presence of both sexes (mother and father), either of them can act as head of the household head (or play the role of household head) for particular purpose. Likewise, experts, heads and officials of the Sanitation and Beautification sectors of the urban centres (Mekelle and Adigrat) and the Region have been consulted.

The secondary data sources used in this study are mainly documents, reports, and literatures collected from relevant offices and research centres. Primarily, documents and records and annual reports pertaining mainly to waste collection, disposal, 4Rs (reduction, reuse, recycling and recovery), human and material resources and organization structure of the Sanitation and Beautification sector in Mekelle and Adigrat municipalities and the region are used as secondary (usually unpublished) data sources. Moreover, policy documents, legislation, proclamation, guidelines and guiding principles, manuals, etc pertaining to urban waste management in the towns and the region have been part of the main secondary data sources. Socio-economic and demographic data have also been taken from Central Statistical Authority, and Finance and plan Bureau of the Region.

3.4.2. Primary Data Collection Instruments and Procedures

It is noticed that while deciding about the method of data collection to be used for the study, the researcher should keep in mind two types of data viz., primary and secondary.

The primary data are those which are collected afresh and for the first time, and thus happen to be original in character. The secondary data, on the other hand, are those which have already been collected by someone else and which have already been passed through the statistical process (Kothari, 2004). These are of various types.

It is clear from the discussion made above that the researcher has declared to employ mixed methods approach where both quantitative and qualitative approaches are merged in a single research project. In fact, the merging of these approaches could take place at different phase of the research work such as at data collection, analysis, or interpretation phase. But for this research purpose, the researcher has merged the quantitative and qualitative data at interpretation stage only. This implies that both data types are collected separately, and it has also been clear that data types are collected concurrently (at the same-timing). Therefore, while the questionnaire is given to the households who have been willing to participate and hence have been selected, the in-depth interviews have been conducted on a 'critical case' with participants who have key position and who are more knowledgeable persons about the activities and operation of waste management in the urban areas.

Varied types of data collection instruments are available in different literature that could be employed in mixed methods approach to collect both quantitative and qualitative data. Of which, the researcher has selected with caution the instrument(s) for his study keeping in mind the nature, scope and object of the study, the fund at hand, and the precision required (Kothari, 2004). In view of that, the researcher has chosen and employed the semi-structured questionnaire, the semi-structured interview, and field observations to collect the primary data of both types for his own study. The researcher believed that these data collection instruments could comply with his research problem, philosophical position and methodological approach.

Questionnaire design and administration

The format of the questionnaire booklet consisted of the main elements like the title, general introduction and greetings (in advance), specific instruction, and questionnaire

item. The main purpose of the questionnaire is to collect information on the nature, type and magnitude or scale of the waste management problem in the study area. More specifically, the questionnaire consists of questions pertaining to the collection and disposal services provided and environmental rules and regulations implemented by the responsible body, specifically the Sanitation and Beautification sector at city, sub-city and town level and their *Tabias* or *Kebeles*. Moreover, the information that focus on the waste generators' practices (on-site waste handling) have been collected from residents through unstructured questionnaire.

With regards to the issue of questionnaire design, it mainly focuses on the determination of question items and wording of questions. Regarding to wording of questions, the researcher, as suggested by Kothari (2004), has considered thoroughly the appropriateness of the questions in view of the nature of information sought, the sampled respondents and the kind of analysis intended. He has also decided to use both close- and open-ended questions. Likewise, viewing that questionnaire must contain simple but straightforward directions for the respondents so that they may not feel any difficulty in answering the questions, the researcher has conducted a pilot study and tried to edit and modify the questionnaire. Significant number of questions which confused the respondents and which, owing to lack of access to information, could not be answered by the respondents have been restated and omitted. Regarding to response rate, except for the few blare and irrelevant (from the view point of the types of participants) questions, negligible number of questions and zero attrition rates have been recorded.

The other issue related with questionnaire design is the determination of the question items. The question items are basically close- ended items where the respondents are not required to produce any free writing except to choose one of the given alternatives. The questionnaire has also contained very limited open-ended questions where open spaces are provided for the respondents to fill in so that respondents get freedom to express their opinion. The close-ended item types consist of questions of different forms such as dichotomous questions like True-False, multiple choice questions, and ordinal measurements (rating scale) like Likert Scales. In fact, the Likert Scale is a predominant question format used in this research questionnaire.

The procedures used to administer the questionnaire may bring a particular study to a wrong direction unless the researcher has properly and adequately considered it. The significant role of the questionnaire administration is well recognized in affecting the quality of drawn response of the respondents. Basically, the researcher has used interviewer-administered questionnaire where the research assistants have interviewed each respondent and mark his or her choice on the booklet. This method has been chosen by the researcher mainly for two reasons. One reason is that most of the households, as it is indicated in the census report, are either not able to read and write or are not much capable enough to read and write. The second reason is to reduce the attrition rate of questionnaire booklets; in other words, this is done to ensure high response rate.

The research assistants (seven females and five males, and all grade 11 and above) are recruited from both study areas (Mekelle and Adigrat) to collect data through the questionnaire from their respective areas. Research assistants were trained on how to approach the research participants and how to administer the questionnaire alongside the detailed clarification on the each of the question items depicted in the questionnaire booklet.

In-depth Interview

Although there is a range of qualitative research techniques available for researchers, the current researcher has used an interview as one of the most important instrument to collect primary data in this study. The interview method of collecting data involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses. When the researcher decided to use and implement interview as an instrument to collect primary data, it automatically reflects that he abandoned looking human subjects as simply manipulable and data as somehow external to individuals which is different from the objectivist view, but regards knowledge as something which could be generated from conversation between humans as being subjectivists. The central premise of the researcher to use interview is that human interaction is among the most important source of knowledge and he recognizes the significant role of the social context in the research data.

An interview is not an ordinary, everyday conversation. Unlike any personal and an everyday conversation, interview made for a research purpose has a clear and specific purpose. It is question-based conversation whereby the interviewer almost exclusively asks questions and the interviewee responds to each question explicitly and as detailed as possible. To this effect, as it is recommended in literature sources, the researcher has set up, and of course abided by, 'rules of games' in his interview (Cohen, Manion, & Morrison, 2007, 2013).

Empirical and theoretical evidence showed that there are varieties of interview techniques available for the researcher, among which, the researcher has used personal interview wherein the interviewer asked questions in a face-to-face contact. This implies that the nature of interaction between the interviewer and interviewee was not through internet or telephone or other electronic methods. In other words, the interview has taken place in the form of direct personal investigation where the interviewer collects the information personally from the relevant sources. The researcher also wants to make it clear that the interviews were conducted on a one-to-one basis whereby the interviewer met one, single interviewee at a time. Despite the fact that the interviewer usually initiates the interview by asking questions, rarely the interviewees were also allowed to ask certain unclear questions and the interviewer (researcher) responded their questions.

Interviews could be classified in different ways. One way of classification is into structured, semi-structured and unstructured interview. The researcher has used a semi-structured interview. Semi-structured interviewing, which combines the characteristics of both the structured and unstructured interview, is perhaps the most common type of interview used in qualitative social research. As noted by Dörnyei (2007), it would be appropriate to use semi-structure interview as an instrument of data collection provided that the researcher has good enough knowledge about the phenomenon or the case to be studied and is thus able to develop broad question about the topic rather than using ready-made response categories that deter depth and breadth of respondent's narrative. Accordingly, the researcher preferred semi-structure interview believing that he has got ample general idea about waste management of urban areas while he was working his master thesis on

domestic solid waste management in Mekelle city in 2002, and later has worked in one of the municipal departments, specifically, the Department of Sanitation and Beautification in Mekelle city for nearly two years. Moreover, the researcher has been involved as a project team member, as geographer and an environmentalist in waste management study and planning in the preparation of the current Structural Plan of Mekelle City. Consequently, the researcher has preferred and employed semi-structured interview.

As it is required in semi-structured in-depth interview, the researcher has prepared a list of themes and questions in advance. Likewise, as it is recommended by Cohen & Manion (2000), the researcher (and also interviewer) has asked the same question to all interviewees, but slight difference in order and wording in content as per the duties and responsibilities and exposure of the informants. In other words, at times, themes and questions are reorganized depending on the specific organizational context; there were some questions that were added to (which could supplement the main questions with more explanatory and illustrative sub-questions) or omitted from certain respondents depending on their responsibility and duties and their exposure (Mark, et al., 2009).

With the assumption that, as a result of the position they have been assigned to, they have more access to environmental (more specifically to waste management) policy and management issues, the researcher has interviewed environmental policy and decision makers, managers and heads and experts of Sanitation and Beautification Sector placed at regional level and city /town level, and sub-city and *Kebeles* level.

For a successful implementation of the interviewing tasks, the researcher has strived primarily to create a friendly atmosphere of trust and confidence, and to convince the respondents and help them to make informed decisions to participate in the research. By doing so, the interviewer was able to make the respondents feel at ease while they were talking and discussing with him. The time taken for each informant interview was on the average about one and half hours. For the reason that all of the works of interviewing are conducted directly by the researcher, the issue of sincerity, honesty, impartiality, etc which usually arise in connection to assigned interviewers has not been a challenge.

Field Observation

Observation as an instrument gives an opportunity to the researcher to look at what is taking place in site rather than at second hand and collect 'live' data from 'live' situations (Cohen, et al., 2007, 2013). Observation could be classified into two: participant observation and non-participant observation. Participant observation refers to the type of observation wherein the researcher-participant participates in the activities of a group being observed in the same manner as its members, with or without their knowing that they are being observed. This implies that the participant observer conducts observation from the inside and hence the researcher is an integral part of the environment being observed. On the contrary, in non-participant observation, the researcher does not participate in the activities being observed; s/he simply conducts observation from the outside without any interaction with that being observed. When it comes to this study, the researcher has conducted observation as a non-participant observer wherein the researcher conducts observation from the outside.

While using observation, it is believed that the researcher would be able to describe the existing situations using his five sense organs and see things that otherwise are unknowingly missed by him (research participant). For this reason, the researcher has decided and employed observation as one of the main data collection instrument. In principle, observation presupposes the purposeful, systematic and selective way of utilization of all the sense organs (Singh, 2006). Hence, for this research purpose, random watching, listening and smelling has been undertaken while collection crews were collecting waste from door to door and disposing on landfills, and on the condition of the transfer stations, landfills, illegally dropped wastes on open areas, water courses, streets, liquid waste seepages and spilling over liquid waste dumping areas, public toilets, and so on.

In Mekelle City, personal field observations have been carried out by the researcher himself, focusing on waste handling system of the waste generating entities. These include big establishments and institutions like Mesfin Industrial Engineering, Mekelle University (Addi Haqi and Ayder Referral Hospital campuses, etc), waste collection and

transportation system of both the MSEs and the Municipal office, public toilets, disposal sites (both solid and liquid waste disposal sites), waste reuse and recycling sites, rainstorm drainage canals and the water courses and open dumping sites. Moreover, relatively poorly served and hence unclean localities, and better-served areas of the respective urban areas have also been part of the areas where field observations have been carried out.

The most affected settlement areas have been visited repeatedly by the researcher. These areas include Jibruk, *Kebeles* 14 and 15, the ex-military dwelling neighbourhood of *Kebeles* 18 where the septic tanks have exploded and liquid waste openly flows over surface to the nearby river courses (which has also been and continued to be the main source of conflict among the owners (waste generators), the nearby community and the responsible bodies for so many years). The researcher has also conducted visit mainly in the centre of the city which may be considered as central business district areas where mishandling of liquid waste (overflow and exploding, and seepages of toilets, use of open toilets, etc) are common phenomenon.

Likewise, the researcher has gone through the same process as he did in Mekelle City to collect data through field observation in Adigrat town. First, he tried to identify the activities or processes, areas or places that could show an overall picture of the waste management. Then, keen observation has been undertaken on the collection and disposal system, disposal site, the water courses, illegal open dumping sites, and the old settlements like *Kebeles* 01 and 02 and *Kebeles* 06 where traditional local drinks are most commonly found. The type of observation employed was non-participant observation where the researcher, unlike to participant observation, has not been involved in the activities but he simply remained as active observer, watching, listening and smelling the phenomenon.

Generally, through observation, the researcher was able to generate valuable information about the condition and the way how waste is handled by generators (at source). The door to door waste collectors serve the community; the status and management system of the public toilets, the river courses and storm drainage canals; the location, status and

management system of the disposal sites (both solid and liquid waste); the way how and scale of operation and capacity of waste reusing and recycling (particularly composting), collection of used plastic materials and metallic materials for reusing and recycling are undertaken.

While conducting observation, the researcher has tried his best to minimize/reduce, as it is recommended, the Hawthorne effect to the minimum. This is because it is believed that when individuals or groups become aware that they are being observed, they may change their behaviours (either to conceal or overstate their typical nature) and this could have positive or negative effects on the study result and researcher's judgment (Singh, 2006).

One very important issue regarding observation as an instrument of data collection for research is that the recording method of observation. In this study, the researcher as an observer is thought to not only watch, listen and smell but also to record the activities, processes and features of what has been observed. Though there are different methods of recording observation, the researcher has made his choice for a particular method of recording of his observation mainly depending on purpose of his observation. His purpose is to supplement his qualitative data attained through interview. Accordingly, the researcher has used the descriptive recording method wherein he made brief notes while observing the different aspects such as activities, processes, features, places or sites. Then, the research has made complete and detailed notes immediately. In fact, the actual work of observation and note-taking has been preceded by short guiding questions and criteria against which the feature being observed was examined.

3.4.3. Sample Design: Sample Size and Sampling Techniques

It is generally argued that in addition to the instrumentation appropriateness, the suitability of the sample design (including sample size and sampling strategy) determine the quality of a research (Cohen, et al., 2007, 2013). A sample design is a definite plan for obtaining a sample from a given population (Kothari, 2004). It specifically refers to the techniques or procedures adopted by the researcher to define the number of items to be included in the sample (which is known as sample size) and to select the items for the sample. In fact, the sample design has been determined before data are collected.

Generally, while he was making a sample design (an overall planning) of his research, the researcher has made several critical decisions with respect to various factors, among which decisions regarding the sample size, the representativeness and the sampling strategy to be used in his study received significant attention. The main target of sample design is to form a sample which is a small group or subset of the total population selected. The sample may have a specific number of elements (sample size) which may be decided primarily based on the research approach employed and it would be selected using a specific sampling strategy (sampling techniques).

Sample Size

Literature indicates that there is no clear-cut answer as to how precisely large the sample should be because the correct sample size depends, among others, upon the purpose of the study and the nature and size of the population. However, there are general principles associated with the type of research approach employed which guide the researcher's decision on the sample size. The research approach employed has given the researcher the basis to decide on how large his sample size should be. It is well remembered that mixed methods approach which combines both quantitative and qualitative approaches is used in this study. Each of these two approaches has its own guiding principle in fixing sample size; quantitative approach concerns more on representativeness of the sample whereas qualitative approach gives more weight on the richness of information which would be obtained. Accordingly, given that both approaches (quantitative and qualitative), and different instruments and thus different samples are used, the researcher needs to fix different sample sizes for the different samples in accordance to the types of approach and data collection instruments.

Likewise, the researcher has considered the nature and size of the population as criteria to fix the sample size though there are some more criteria which could be considered while sample size is determined. While determining the sample size, the researcher has also made decisions on the composition and number of samples. He primarily tried to fix the number of samples corresponding to the types of instruments used (questionnaire and

interview). For both instruments, two samples are formed; each sample has varied sample size and distinct composition.

The researcher has taken three facts into consideration while he was fixing the sample size. To determine the sample size for the questionnaire survey (which is basically quantitative in approach), the researcher has primarily tried to consider the principle of representativeness. To this effect, it becomes necessary to have sizable sample units to ensure representativeness. The other fact considered in the process to fix the sample size is the usual incidences of non-response, attrition, etc of participants (response rate). Some of the respondents could fail to return questionnaires, drop-out the research, or return incomplete or spoiled questionnaire. This implies that, it would be advisable for the researcher to overestimate the size of the sample required (Gorard, 2003). On the other hand, the researcher has recognized the research costs in terms of money and time which could incur. The size of questionnaire also needs to be considered while determining the sample size. The researcher believes that the size of his questionnaire is very vast that contains more than 180 questions in 15 pages. Though it is difficult to weigh the cost and value of additional information, the researcher well recognizes the cost in terms of money and time he would bear for large sample size. Therefore, by acknowledging the importance of all these facts, the researcher has tried to harmonize these facts and has decided to use medium sample size, which is neither so large nor so small. Consequently, he decided his sample size to be 450 households for the questionnaire for both urban centres. The composition of the sample for the questionnaire is one and the same such as household heads which could be female- or male- headed household.

For his in-depth interview, the researcher has fixed five informants who are selected from the two urban centres and from the Regional Bureau. As it is indicated in Table 3, the informants were selected from the relevant offices. More specifically, the key informants those who are involved more in the waste management activities in the city and town, and in the Region. Higher experts including heads of the Beautification and Sanitation Departments (or Core processes) are selected from the two urban centres and the regional office.

Table 3: Selection of Key Informants

No.	Representing Stakeholder	Number of interviewees		
		Mekelle City	Adigrat Town	Regional Office
1	Sanitation and Beautification Core Process of the City and Town(Centres)	1	1	
2	Sanitation and Beautification of the Core Process (Department) of the Sub-cities and <i>Kebeles</i>	1	1	
5	Sanitation and Beautification Core Process of the Region			1
	Total informants (Sample size)	2	2	1

Sampling technique

Right after the decision on how large the sample should be, the researcher has determined the sampling techniques he intends to apply. The researcher has been confronted with various types of sampling procedures, which are mainly classified based on certain factors like the representation basis and the selection technique employed. Primarily, the researcher has decided to use two samples such as sample one for questionnaire and sample two for interview. As stated earlier in the proposal, the researcher has used probability sampling techniques to select sample units of questionnaire sample whereas for the interview sample he used non-probability sampling techniques to select sample units.

The sample may also be classified on element selection basis into two such as restricted or unrestricted. The researcher has formed the different samples in such a way that each sample element is drawn individually from the population and such samples are known as 'unrestricted samples' (Kothari, 2004).

Generally, in this study, the researcher has used different sampling techniques and procedures to select the sample units of the different samples. Above all, the researcher has used multi-stage sampling techniques which involved different sampling techniques

and procedures in step by step procedures. Primarily, he tried to identify the urban centres with at least the status of a town and above in the Regional State of Tigray. Next, based on the census results of the latest national census (2007), the two largest urban centres (in terms of their population size) were purposely selected. The rationale behind purposively selecting urban centres with larger population was that, as it has been indicated in numerous literature sources, larger urban centres are more affected by urban environmental problems than smaller ones. In other words, large urban centres usually experience environmental management problems more severely and thus they need more attention. The reason is that the severe environmental management problems are mainly attributed to the concentration of population and economic activities. Then, sampling procedures continued phase by phase to select respondents (for the questionnaire) and key informants (for the interview).

In short, the researcher has gone through different sampling phases and employed different sampling procedures to get particular research participants. At the first stage, the researcher has used clustered sampling procedures to select sample urban centres (clustered samples). Subsequently, based on the types of instruments and approaches employed, varied types of sampling procedures were applied to select research participants. Research participants in the questionnaire survey, and interview were selected using different sampling procedures and are discussed separately below.

Sampling procedure to select respondents in the questionnaire survey

More specifically, as it has been clearly explained above, the researcher has employed multi-stage sampling procedures which involved a variety of sampling techniques at different stages including probability and non-probability sampling techniques. First, all the urban centres, which have achieved the status of municipality in either way, of the regions are exhaustively identified as clustered areas and then two urban clusters were selected mainly based on the size of their population as per the 2007 census results. This implies that the sampling procedure used to select these two urban centres is purposive sampling. According to the population data projection of 2011, the two largest urban centres in the region are Mekelle (which is the capital city of the region) and Adigrat (the zonal capital of

the Eastern Administration Zone of the Region) which at that time had a total of population of 261,177 and 69,664, respectively (Ethiopia, 2008)

For the questionnaire survey, following the long clustered sampling procedure which involves classifying the urban population into geographical sub-divisions such as urban centres (cities or towns), sub-cities or *woreda*, *Kebeles*, inner and outer zones and then building blocks, and finally sample units (Household heads) were selected. At the first phase, as it has been shown above, cluster cities/towns were selected using non-random sampling technique, specifically purposive sampling based on their population size. These were Mekelle and Adigrat which were first and second populous towns, respectively, of the region. Next, sub-cities and *Kebeles* were selected randomly using simple random sampling technique.

The sample households were selected from each of these urban centres proportional to their population size. The population size of Mekelle (261,177) is almost 3.75 times that of Adigrat's population (69,664). Accordingly, for the questionnaire survey, 330 and 120 households have been selected from Mekelle and Adigrat, respectively. Mekelle city is divided into seven sub-cities and the sub-cities are in turn classified into totally 33 *Kebeles*. Likewise, Adigrat is classified into six *Kebeles*. Sub-cities and *Kebeles* are selected randomly using simple random sampling technique, whereas, the inner and outer areas are defined and selected purposely. Accordingly, four sub-cities such as Hadnet, Hawelti, Kedamay Weyyane and Semien sub-cities are selected randomly in Mekelle, and then one inner and one outer *Kebeles* or areas are defined for each of these four sub-cities. Similarly, in Adigrat *Kebeles* 01, 03 and 06 are selected randomly and then inner and outer areas are defined and selected purposively.

Finally, housing blocks within each selected inner and outer zones are identified rationally and then sample households were selected using systematic random sampling technique. Since the demarcation of the inner and outer zones has been carried out arbitrary (and it did not fit into the official demarcations), it becomes very difficult to know the total population size of each of the inner and outer zone of the sub-cities and *Kebeles*. Indeed, the classification system mostly coincided (overlapped) with the official spatial

administrative units. As a result, the researcher has shared the total household size of the city and the town, owing to lack of access to reliable data, virtually equally to their respective inner and outer zones. It means is that in Mekelle from each sample sub-cities (inner and outer), 80-82 households were selected, while in Adigrat from the three *Kebeles*, 40 households each (20 from inner and 20 outer zones) were represented.

Sampling procedure to select interviewees

As stated previously, the researcher has decided to employ interview as a key data collection instrument to collect his qualitative data. In light of the purpose to employ informants and the challenge of time and cost which the researcher could possibly face, the researcher has not only fixed limited number of sample size but also employed very simple but rational sampling procedure. The very idea to employ informants is to gather as rich data as possible. Briefly stated, the intention of the researcher is to select information-rich informants or resource persons. Hence, because qualitative research is more concerned on how appropriate the participants or resource persons are to provide rich and varied information, the researcher has been forced to use purposive sampling techniques to select interviewees. The interviewees who are thought to be key resource persons, owing to either the position they hold, or their active participation or work experiences they have in related activities, have been selected purposively. From the most relevant offices, like the Sanitation and Beautification at town level and in the sub-cities and *Kebeles* environmental experts with relatively longer work experiences have been selected. Moreover, using the same criteria one environmentalist from the Sanitation and Beautification Core process in the Bureau of Urban Development, Trade and Industry has been selected. More specifically, four informants from the two urban centres and one from the regional office are selected.

3.4.4. Data Analysis

The data analysis and interpretation has been undertaken in accordance to the research approach employed in this research project. As stated before, the researcher has employed a mixed methods approach that combines both quantitative and qualitative data and methods of data analysis in a single research project. However, though there are

various options where merging of methods could be undertaken, in this study the researcher has merged both methods (quantitative and qualitative) during the interpretation phases. This implies that data collection and analysis are conducted separately but concurrently.

Thus, based on the nature of the data collected, the researcher employed two methods of data analysis such as quantitative and qualitative data analysis. In other words, all the relevant data collected from various data streams (interviews, observations, questionnaires) pertinent to the particular research questions are analyzed separately. This has enabled the researcher both to complement and triangulate the data from different sources.

To this effect, on the one hand, the researcher employed the quantitative data analysis method for the data collected through questionnaire primarily. The key purpose of the questionnaire survey is to assess the nature and magnitude of the waste management problems of the urban areas. On the other hand, the qualitative method was employed to analyze the data collected through interview which were primarily used to examine the extent how the waste management problems have received policy responses. As a complementary, the qualitative data have also been used to triangulate the questionnaire data. Finally, both the quantitative and qualitative data analysis results are interpreted altogether.

Quantitative Data Analysis

The quantitative data are primarily referring to the data collected through questionnaire from household heads selected from the study areas. To analyse the questionnaire data two quantitative data analysis techniques have been employed. These are descriptive and interpretative techniques. Analysis of the quantitative data (questionnaire data) was supported by a soft ware called SPSS version 24. To analyse using SPSS, the raw data has primarily passed through all the preliminary processes. Based on the questionnaire booklet, a codebook has been prepared before data entry was conducted. The main purpose of doing this is to create data file, which is ready for entry and analysis. While preparing the codebook, the researcher has accomplished two main tasks such as

defining variable names and coding of responses or variables. Once the codebook has been prepared, the researcher has processed the data to creating data files and entering the data so that the data file is ready for a final analysis. Finally, the researcher has conducted screening and cleaning of data including identifying and correcting of errors like missing data.

The researcher perceived that the data collected and entered into computer particularly the questionnaire data were so large and created difficulties to manage. So, a mathematical technique called principal component analysis has been used. As explained detail in the next heading, this model is used of on purpose to reduce the number of variables to a manageable size.

Principal Components Determination

Indeed, the researcher has developed a questionnaire with so many and question items (which are more or less equivalent to variables) not merely because he has been very optimist but also because of the nature and complexity of the (research) problem. The researcher also believed that such large number and varied types of questions could adequately address his research objectives. However, recognizing the difficulties he could face while working with such huge data analysis, the researcher has employed analytical technique called principal component analysis (PCA) or Factor Analysis (FA) to primarily minimize the size of the variables. Generally, factor analysis is useful for three purposes: first, to understand the structure of a set of variables; second, to construct a questionnaire to measure underlying variables; and thirdly, to reduce data set to a more manageable size by retaining the original information as much as possible (Field, 2013). However, the basic need of the researcher to employ factor analysis technique in this study is to reduce his data set to a more manageable size. As it has been explained by Pallant (2011:122), the factor analysis is mainly used as data reduction technique. It does this by looking for 'clumps' or groups among the inter-correlations of a set of variables. The large number of items or questions included in the questionnaire are refined and reduced to a smaller number of coherent and more manageable numbers of variables or questions before the researcher uses them in other analysis.

Pallant (2011:122) noted that '*factor analysis is used as a general term to refer to the entire family of techniques*'. It includes different techniques among which principal component analysis (PCA) and factor analysis (FA) are the most common. These two techniques, though they are similar in many ways and often used interchangeably, differ in a number of ways.

Factor analysis could indicate to any of its family of analysis including Principal Component Analysis (PCA) (Pallant, 2011); but in this study the researcher may have used the term 'factor analysis' only to indicate PCA. In this research project, the researcher has chosen PCA for various reasons. At the outset, in principal components analysis the original variables are transformed into a smaller set of linear combinations, with all of the variance in the variables being used. It is suggested that principal component analysis is more preferable because it is psychometrically sound and mathematically simpler, and it avoids some of the potential problems with 'factor indeterminacy' associated with factor analysis (Pallant, 2011). Moreover, if one simply wants an empirical summary of the data set, PCA is the better choice (Tabachnick & Fidell, 2007).

Though the general term for the outcomes of the factor analysis is referred as factor, in this study, the term component has been used to indicate the outcomes of the principal component analysis method. The process of determination of the principal components using principal component analysis involves different steps. The first step involves determination of the factorability of the data or suitability of the data for factor (principal component) analysis. Accordingly, the researcher has examined his data whether or not it is suitable for PCA based on the sample size, and the strength of the relationships among variables (or items) (Pallant, 2011). Moreover, the researcher has to use two statistical measures such as Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy. Bartlett's test of sphericity should be significant ($p < .05$) for the factor analysis to be considered appropriate. The KMO index ranges from 0 to 1, with .6 suggested as the minimum value for a good factor analysis (Pallant, 2011).

In view of the sample size, there is no an overall consensus on the reliability and on how large it should be. Nevertheless, there is a general agreement that the larger the sample size, the better factorable it would be. Some literatures recommend that sample size greater than 300 would be suitable for factor analysis. When examined in line with this principle, the researcher's data do comply with the sample size criteria wherein the researcher used 450 sample units. On the other hand, as the strength of the inter-correlation among items is considered, it is suggested that there should be correlation coefficients greater than 0.3 as many as possible in the correlation matrix. In view of that, the researcher has found as many coefficients with greater than 0.3 that confirm the factorability of his data.

Besides, the researcher has employed the statistical measures to assess the factorability of his data. In principle, data would be suitable for factor analysis only if the Bartlett's test of sphericity is significant ($P < .05$). On the other hand, the value of the KMO ranges from 0 to 1, and it is recommended that data will be more appropriate for factor analysis if the value of the KMO is not less than 0.6. Accordingly, the researcher calculated both the value of KMO and Bartlett's test of sphericity using SPSS program and has proven the factorability of his data.

The second step in factor analysis is factor extraction. '*Factor extraction*', as (Pallant, 2011:183) pointed out, '*involves determining the smallest number of factors that can be used to best represent the interrelationships among the set of variables*'. Though there are many approaches useful to decide and identify the number of underlying factors, he indicated that principal component analysis is the most commonly used approach. While determining the number of factors which he or she thought that they could describe the basic relationship among the variables, the researcher is forced to reconcile two conflicting interests such as, on the one hand, the interest to get the solution in a simple way with as few factors as possible; on the other hand, the interest to explain as much of the variance in the original data set as possible (Pallant, 2011).

The researcher has employed two techniques that could help him to decide the number of factors to be extracted: Kaiser's criterion and Scree test. The Kaiser's criterion which is

also called eigenvalue rule is the most commonly used technique. The eigenvalue rule states that only factors with an eigenvalue of 1.0 or more are retained for further investigation. The eigenvalue of a factor refers to the amount of the total variance explained by that factor. Whereas, scree test involves plotting of eigenvalue of the factors and inspecting the plot to find a point at which the shape of the curve changes direction and become horizontal. The principle of the scree test is to retain all factors above the elbow, or break in the plot since these factors are believed to contribute most to the explanation of the variance in the data set (Pallant, 2011).

The final step in the factor analysis is factor rotation and interpretation. Once the numbers of factors are extracted, the next step is to interpret them. Fortunately, the factor rotation technique would help the researcher in interpretation. In addition to its major purpose, the researcher has employed factor rotation technique to help him in the interpretation. Indeed, it is believed that factor rotation does not change the underlying solution; it rather presents the pattern of loadings in a manner that is easier to interpret by simply showing variables clumping together. Literature sources indicate two main approaches to rotation.

Yet the researcher has preferred the orthogonal rotation over the oblique approach simply because it results in solutions that are easier to interpret and to report, though, unlike to oblique approach, orthogonal approach assumes, usually wrongly, the underlying constructs or components are independent or not correlated. However, in practice, it is believed that the two approaches (orthogonal and oblique) often result in very similar solutions. Within each of the rotation approaches, there are categories of rotation methods. In this research project, the researcher has used the Varimax method which is one of the categories of the orthogonal approaches. Finally, the researcher has extracted three components based on Varimax method.

Descriptive statistics

Once the factor analysis has been carried out and components (factors) are extracted and interpreted, varied types of (descriptive and interpretative) statistical techniques are used to show the nature and scale of the waste management problems of the urban areas. For most part of analysis of the questionnaire data, descriptive analysis such as rates and

percentiles are used. But for some variables correlation coefficients has been calculated. Primarily, from the view point of waste management principles, waste collection and disposal systems should correspond to the waste characteristics of the respective urban area. Put differently, there should be a clear understanding that types and scale of waste management (more specifically, the types and scale of waste collection and disposal system) should match up with the characteristics (such as the nature, composition, and generation rate) of waste of the respective urban areas. Hence, first, the researcher wanted to assess the extent to which the growth of collection and disposal service copes with the increasingly rising generation rate; the researcher has calculated the annual average waste collection coverage and compared with the waste collection coverage claimed by the institution as shown in their records. Second, he also assessed the relationship between the magnitude of waste generation and waste collection which is in essence waste collection 'coverage'. By so doing, the researcher has been able to estimate the total amount of waste left over in the city or town uncollected within the last six years. Moreover, to assess the quality of waste management services in place in the study areas, the spatial disparities in (waste collection) service delivery, if any, among communities due to either differences in proximity or location (inner vs outer parts of town), socio-economic status (wealthiest vs poorest neighbourhoods, authorities' vs common folk's neighbourhoods) and the size of the urban areas, and the community's practices regarding waste handling at sources different types of descriptive analysis techniques like ratio, percentiles, and tables have been used.

Based on the assumption that illegal acts of beneficiaries or bad practices of residents are largely the direct effect of the quality of services they received, the researcher has tried to associate the quality of service provided with the practices of the residents. The quality of services provided has been assessed based on various parameters (program cancellation, appropriateness of collection schedule, distance to collection point, etc). Likewise, residents' practices are measured in terms of the act of dropping of waste in illegal areas, open toilet practice, inappropriate storage at home, etc.). But believing that it would be more complex and time consuming to consider each parameters of service delivery and practices of community and find out association among each of them and make analysis,

the researcher has selected two parameters of collection service delivery and one key parameter of residents' practice. These are 'cancellation of collection program' and 'inappropriate timing of collection schedule' from the quality of services provision parameters. Similarly, 'dropping of waste in illegal areas' is chosen from the parameters of community practices. The data is non-parametric and hence, the researcher has employed non-parametric types of statistical correlation of which he believed that the Spearman's correlation coefficient serves his purpose. This is because the Spearman's correlation is used to determine the degree of correlation between two variables where the scale of measurement is ordinal and ranks are given to different values of the variables. Then based on the correlation coefficient, it would be possible to determine the extent to which the two sets of ranking are similar or dissimilar (Kothari, 2004).

The researcher has calculated the correlation coefficients of both variables (cancellation of collection program and inconvenient timing collection schedule) separately against the occurrence of 'dropping of waste in illegal areas' by the community. Specifically, the spearman correlation coefficient has been computed to test the extent of relationship between incidences or prevalence of cancellation of collection program and dropping of waste illegally, and between inconvenient timing of collection schedule and dropping of wastes illegally.

Qualitative Data Analysis

As it has been indicated previously, this research has employed qualitative data which have been collected through interview. To analyse these qualitative data, the researcher has employed qualitative data analysis techniques. There are wide ranges of techniques which could be employed for qualitative data analysis. Among which thematic content analysis is the most common type and it has met the demand of the researcher of this study. The qualitative data analysis has been supported by software program called Atlas ti version 7. Specifically, the researcher has used the Atlas ti version 7 manual published by Elizabeth Archer (Archer, et al., 2017). Based on the procedures indicated in the manual, the researcher has primarily prepared the data in a way that fits the program. Following the creation of the New Hermeneutic unit, the researcher assigned five primary

documents and continued working on selecting quotations, coding and creating families or themes. Finally, he came up with 108 quotations, 21 codes, and 10 families or themes and produced reports or outputs to each theme.

As stated previously, interview has been used to generate data which would be used for triangulation purpose and, as the basic sources of data, to produce outputs for certain themes or sub-chapters. For the three themes addressed in the last three sub-chapters, only interviewees have been used as a sole data collection instrument, and thematic content analysis techniques have been employed to produce outputs. Accordingly, based on the outputs produced using Atlas.ti version 7 software, interpretation of the last three themes has been undertaken. Specifically for the themes identified as policy documents, institutional frameworks and waste management approaches, interview has been the basic source of data. These data have been analysed and outputs have been generated based on which interpretation has been made.

However, the outputs of the qualitative data analysis produced using the Atlas ti software for the themes such as liquid waste collection services; public toilet service, liquid waste dumping, solid waste characteristics, solid waste collection service, landfill, and on-site waste handling were mainly employed to triangulate the outputs of the quantitative data analysis.

3.5. Trustworthiness of the Research

As discussed in the methodology part, the researcher has employed mixed methods approaches which involve both quantitative and qualitative approaches and methodologies. Because of differences in their ontological and epistemological assumptions, the quantitative and qualitative researchers require a variety of trustworthiness criteria to ensure the rigor of the findings of their study. This means that the trustworthiness or validity criteria used in quantitative and qualitative researches are identified in different terms. For that reason, the researcher has used the commonly used terms in different literature. The researcher believes that the findings of his research fulfil many of the criteria of trustworthiness or validity of mixed method research.

The researcher has tried to make his research findings comply with the trustworthiness criteria. To this effect, he has employed different mechanisms to ensure the trustworthiness of his research findings. On the whole, the researcher believes that the findings of his research fulfil many of the criteria of trustworthiness or validity. One of these mechanisms is triangulation. The researcher has tried to triangulate the data by employing different data sources, that is, data collected through different instruments such as questionnaire, interview and observation and records. The researcher has confirmed that analysis of all the data from different sources have eventually come out with similar findings. Moreover, the researcher argues that the research methods in general and the instruments in particular has been reviewed and commented several times in consultative meetings arranged by the UNISA in the presence of professors of South Africa University from relevant field of specializations. The comments and advises of my supervisor to review unclear, or obscured questions or to remove or amend ineffective and non-functioning questions in all instruments have also added to the trustworthiness or validity of the findings of this study.

As explained in the introduction part, fortunately, the researcher had a well-established link with both municipalities and their staff created while he was conducting his MA thesis and was working with them in various studies like during the preparation of the structure plans of the cities in question. This has been a good opportunity for the researcher and for his study participants to develop trust from the institutions particularly the Beautification and Sanitation Units of the region and the urban centres under study. It has also been a good chance for the researcher to gain an adequate understanding of the organization. By so doing, the researcher has tried to ensure the credibility of his research findings.

The other criterion of trustworthiness of a research is transferability. Transferability, which is equivalent term to internal validity of quantitative research, refers to the degree to which the results of qualitative research can be transferred to other contexts with other respondents. According to Li & Ma's (20014) thick description, "enables judgments about how well the research context fits other contexts, thick descriptive data, i.e. a rich and extensive set of details concerning methodology and context, should be included in the research report". To this end, the researcher believes that he has tried to describe the

context and the methodology of his research adequately. This involves the clarification of the context, research process such as the data collection process, participants' selection or sampling procedures, and methods of data analysis, and reporting of findings. In fact, it is rare to find such complementary research works undertaken. However, though it is more unlikely to fit in with other possible contexts, such thick description would enable the other researchers to make judgments about how well the research context fits to their contexts, and thus helps them to replicate the study with similar conditions in their settings.

With regards to dependability, the researcher is required to report in detail the process of the study so that a future researcher would be able to repeat the work and (but not necessarily) to gain the same results. As dependability criteria demands it, the researcher believes that he has explicitly and thoroughly explained the research design and its implementation, which includes the operational detail of data gathering (data collecting instruments), sampling procedures, and data analysis methods in the research report. In short, what has been planned (as indicated in the proposal) and executed has been explained in detail in the report.

The last trustworthiness or validity criterion is confirmability. The concept confirmability, as explained by Shenton (2004), is the qualitative investigator's comparable concern to objectivity. In view of confirmability, the researcher is required to show that the research findings are the result of the experiences and ideas or opinion of the informants, rather than his characteristics and preferences. This means that the research findings need to be free of the researcher's bias. However, Shenton (2004) argued that let alone the qualitative investigators, the quantitative investigators who believe that the use of instruments that are not dependent on human skill and perception, recognizes the difficulty of ensuring real objectivity, since, as even tests and questionnaires, the intrusion of the researcher's biases is inevitable.

This explicitly implies that efforts which could be made are only to minimize the bias as far as possible to insignificant level. Accordingly, the researcher has used different data sources for the purpose of, among others, triangulation. Triangulating of different data sources would help to raise the trustworthiness or validity of research findings. While the

researcher employs different data sources for the purpose of triangulation, he concomitantly tried to increase the trustworthiness of his research findings. By simply triangulating his varied data sources, the researcher was able to ensure the conformability of his researcher findings. This is because the role of triangulation is well emphasized to reduce significantly the effect of researcher's bias.

3.6. Ethical Consideration

Because research involves human subjects or participants, the researcher needs to consider, among others, the ethical issues of the participants. Ethics refers to the norms or standards of conduct that distinguish between the right and wrong. It helps to determine the difference between acceptable and unacceptable behaviours. The term research ethics refers to a wide variety of values and norms that are used to regulate scientific activities.

Research ethics (research and ethics jointly) is particularly interested in the analysis of ethical issues that are raised when people are involved in research as participants or research subjects. Above all, the ultimate intention of the research ethics is that all possible measures have to be taken in order to protect subjects from potential physical, psychological or social damage during the research or after the circulation of the results (Fouka & Mantzorou, 2011). In this research, human subjects or participants have been widely involved; hence, the basic ethical issues which are commonly specified in different literatures have been thoroughly considered as explained below.

According to the principle of the post graduate program of ESAC, ethical clearance and research proposal shall be prepared and evaluated and approved simultaneously. In view of that, the researcher has received approval for his research proposal and ethical clearance and continued his thesis work. Initially, as indicated in the ethical clearance, the researcher has received official letter of consent from Tigray Regional State to conduct research in its region on the topic entitled 'Policy Responses to Urban Environmental Problems: the case of Solid and Liquid Waste Management in Major Urban Centre of Tigray National Regional State'. As explained in the article entitled 'Research Ethics: A Handbook of Principles and Procedures' in 2008, the researcher has the responsibility to

ensure as far as possible that the physical, social and psychological well-being of their research participants is not detrimentally affected by the research (Committee, 2008). To this effect, the researcher has tried to conduct his study in line with the basic principles of research ethics. As indicated in The Norwegian National Research Ethics Committees (2016), the major ethical issues that researchers should take into account in conducting research are: a) Informed consent, b) Respect for anonymity and confidentiality, and c) Respect for privacy (Fouka & Mantzourou, 2011). Research ethics are more or less self-regulation mechanisms

The responsibility to respect the research ethics may be placed on different parties such as the researcher, the researched, and the institution or the research community in general. The researcher has conducted his study guided by these ethical issues. Based on the principle of informed consent, research should be based, as far as possible on the freely given informed consent of those participating in the study. The first obligation of the researcher is to provide participants with adequate information about the field of research, the purpose of the research; who is undertaking it; who has funded the project; who will receive access to the information; why it is being undertaken or the intended use of the results, and the consequences of participation in the research project (Fouka & Mantzourou, 2011). In recognition to this principle, the researcher has tried to explain the aim, the nature and importance of the research orally as well as in text in the preamble section of the questionnaire. Besides, research participants have been aware of their right to refuse participation at any time, including complete withdrawal from a research project at any stage or to refrain from answering any question that they felt discomfort with.

To conduct research ethically, it is also requisite to respect the confidentiality and anonymity of the participants. The issue of confidentiality and anonymity is closely connected. While the confidentiality refers to the management of the data or information provided by the research participants, anonymity is linked to the protection of the participant's identity. This implies that it would be hard or meaningless to maintain anonymity (participant's identity) unless the private information of the participants is kept confidential. In recognition of this fact, the current researcher has explained the participants individually and received their consent at least verbally that the information

collected and processed will be kept confidential and nobody could access the hard copy or soft copy where the raw data is written or recorded. Moreover, the researcher has told the participants that data collected from every participant will be coded so that the identity of the participants could not be identified based on the information they provided. In short, the subject's identity cannot be linked with personal responses. Based on his promise, the researcher has tried his best to respect the confidentiality and anonymity of the participants.

Ethical research also needs the researcher to respect the individual's privacy and family life. Respect for privacy aims at protecting individuals against unwanted interference and exposure. In view of this ethical obligation, the researcher has made efforts to exclude questions or restate the questions that are thought to create emotional damage or uncomfortable situation on the participants. Besides, the researcher has been very careful while he was approaching, asking questions, and fixing time and space so that the participants could feel at ease and free from any form of pressures. At the outset, the participants have been oriented that they could withdraw totally from the project or refuse to respond to question(s) that he/she feels it is too personal or harms his/her emotion. In any case, fortunately, the researcher has not come across any complains or withdrawals or rejected questions by participants in this researcher project.

Chapter Four: Results and Discussion

In this chapter, besides to the description of the background information of the respondents, the data collected through different instruments from different sources have been analysed. To this purpose different data analysis methods have been employed. Moreover, detail discussions of the results of the analysis have been made.

4.1. Background of the Respondents

The background of the respondents generally refers to the wide range of social, demographic, economic and the environmental characteristics of the research participants and more specifically to the respondents in a questionnaire survey. However, it might be irrational and uneconomical to describe all the characteristics of the respondents exhaustively. It, instead, would be important to focus on those characteristics which have direct or indirect relevance to this particular research. Therefore, the researcher has been very selective while including elements of background characteristics of respondents in his questionnaire.

As described in the following pages, basic information about the background characteristics of the respondents which have more relevance to waste management of the urban areas has been collected. Primarily the researcher would like to make clear that the 450 questionnaires have been returned back. In other words, response rate is 100%.

Gender

Gender is widely believed to be an important issue which brings difference in environmental management and more specifically in waste management. In most developing countries including Ethiopia, waste management tasks are considered as duties and responsibilities of females. When it comes to the region, it reveals more pronouncing situation. Hence, believing that they are more familiar with and knowledgeable about waste management and are more victims of the burden of waste management, the researcher has preferred to include as many (but not all in all) female household heads as possible in the sample that would be formed. Nonetheless, it was not straightforward to define sampling technique which could easily serve the purpose.

Fortunately, as indicated in the Table below, out of the 450 respondents, 327 which accounts for nearly 73% are female respondents. This implies that it is more likely that most of the participants in this research project are more knowledgeable and have adequate information about the issue they are asked about. The researcher, therefore, believes that for most of the questions informed responses have been given. Besides, the credibility of the data could be lifted up.

Table 4: Household Heads' Sex Distribution

Gender	Frequency	Percent
Male	123	27.3
female	327	72.7
Total	450	100.0

Sources: Questionnaire survey

In fact, the questionnaire has also contained few items that refer more to males. Firstly, because of cultural reasons, for instance, males are more frequently and openly visitors of public toilets and open toilets and hence it is more preferable to include male respondents. Secondly, it would not be culturally comfortable to ask directly females whether they visit public toilets and open toilets. This might be considered as a challenge in this research project. But as a way out to this problem, the researcher has tried to conduct an in-depth interview with the service providers. Moreover, the researcher has designed his questions in the questionnaire in such a way that respondents could be asked about such issues indirectly.

Educational background

The majority of the respondents lie on two categories such as the primary and secondary school completed. More than 33 % and 32% of the respondents are primary school and secondary school completed, respectively. The number of household heads who cannot read and write and who merely reads and writes is significant which totally accounts for nearly 33% of the total household heads. Most of the females are housewives, and are illiterate or are simply able to read and write. According to the census result of 2007, in the urban areas of the region, nearly 27% of 5 years old and older population has never

attended school. And for females specifically, it was significantly higher than for the total population (Ethiopia, 2008).

Educational level, among others, of the residents affects waste management in many ways. This is because there is a general understanding that educated people know more about the consequences of poor waste management and hence have more appreciation for clean environment. Moreover, people with more educational background are expected to properly handle their waste at source. Likewise, people with higher educational background demands for proper and adequate waste collection and disposal service and thus exert more pressure on the service providers and responsible bodies.

In short, the household heads with better educational background could have more observation and understanding on what is going on and what is missing in their neighbourhood and city or town with respect to waste management system. This implies that they could provide appropriate answers to the questions included in the questionnaire. With this conviction, the researcher has made an assessment of the background of the respondents and the result has been indicated in Table 5 below.

Table 5: Educational Status of Household’s Head

Alternatives	Frequency	Percent
Cannot read and write	31	6.9
Reading and writing only	117	26.0
Primary school completed	149	33.1
Secondary school completed	146	22.4
Diploma/ certificate and above	7	1.6
Total	450	100.0

Source: Questionnaire Survey, 2015/16

When it comes to the study areas, the same source indicated that both Mekelle and Adigrat have similar pattern to that of the region’s urban areas. The figure for females is higher than that of males. 19.18% and 21.85% of the population of 5 years old and above in Mekelle City and Adigrat towns respectively have never attended school which is by far larger than the figure for females. The female population of 5 years old and above in

Mekelle and Adigrat in the same year was 25.96% and 36.5%, respectively. As the number of household heads, particularly of the female headed households, who are not able to properly read and write increases significantly large, the possibility to employ self administered questionnaire survey will be lower. Fortunately, the researcher has good information earlier that the proportion of respondents particularly females (housewives) could be significantly large. Hence, to overcome such problem, the researcher has employed interview-questionnaire where the interviewer reads the question to the respondents and writes their answer on the questionnaire.

Table 6: Population 5 Years Old and Older by School Attendance and Sex (%), 2007

	Regional Total (urban+rural)*	Regional Females (urban+rural)*	Regional Total (Urban)*	Regional Females (Urban)*	Mekelle total (urban)*	Mekelle females (urban)*	Adigrat Total (urban)*	Adigrat females (urban)*
Never attended school	54.95	61.66	26.88	35.04	19.18	25.96	21.85	36.5

Source: Ethiopia, CSA (Central Statistical Authority), 2008

Household size

The relevance of household size to urban environmental management in general and waste management in particular should not be overlooked by the researchers and practitioners. Household size or number of persons living in a housing unit influences the collection frequency of both solid and liquid wastes. Usually, housing unit and household are interchangeably used where housing unit is a separate and independent place of habitation to a household. However, a house unit may be occupied by more than one household or may be partly used for establishment.

Solid waste collection service frequency provided and the size or volume of the septic tank per household are fixed by responsible bodies of the respective sectors based on the average household size living in a housing unit irrespective of the total number of dwellers in a housing unit. Therefore, housing units occupied by larger (more than the average) household size or more households could suffer more by huge volume of waste piled within ones premises. Moreover, the septic tanks or toilets which serve more people will

be exposed to frequent spill over or overflow and frequent collection by Septic suction trucks.

Hence, partly because of the reasons mentioned above, it becomes necessary to describe the household size or, the total number persons dwelling within a single housing unit (if there are more than one household). The household size or total number of persons per unit housing unit is summarized in the Table 7 below.

Table 7: Household Size and Occupants per Housing Units

		Household size	Occupants per housing unit
N	Valid	450	450
	Missing	0	0
Mean		4.67	5.63
Std. Deviation		1.532	1.948
Range		8	11
Minimum		1	1
Maximum		9	12

Source: Computed from questionnaire survey data

The average household size and/or persons per housing unit in the study area are more than the regional average for urban areas. The regional urban areas' average household size is 3.5. Whereas the average household size of the participants in the questionnaire survey as depicted in Table 7 above is 4.67. The nastiest of it, most of the housing units do have more than one household where the average number of persons per housing unit is nearly six. The minimum and maximum household size and number of persons per housing unit range between 1 and 8, and 1 and 12, respectively. This implies that the greater number of persons dwelling in a housing unit has been increasingly creating pressure on the waste management system at least at household level. When the number of persons living in single housing unit is so large, the pressure on solid waste and liquid waste storage and handling at sources will rise.

4.2. Waste Collection and Disposal Services

Obj.1. *To estimate the scale of the solid and liquid waste management service problems of the study areas.*

This sub-chapter deals with some of the basic elements of waste collection and disposal services provided in the urban areas of the region. Using dimension reduction technique called Principal Component Analysis statistical techniques called 'principal component analysis', primarily to reduce the large number of related variables to more manageable and meaningful size, the researcher primarily discussed the way how he identified the main variables and selected the principal components related to the urban waste management services. Accordingly, the three principal components such as liquid waste collection, disposal and public toilet services, solid waste collection and disposal services and spatial disparities of waste collection and disposal services are discussed sequentially.

4.2.1. Principal Components Determination

Factor analysis, as explained in the methodology part (chapter three), is used as a general term to refer to the entire family of techniques. It is also pointed out that the family of the factor analytical techniques has a number of different uses (Pallant, 2011), among which the reduction of a large number of related variables to more manageable and meaningful number before they are used for other analysis is the most common purpose of the technique and also in this particular research work. Because of such reasons, it is often called as 'data reduction' or 'dimension reduction' technique.

Factor analysis contains a variety of different techniques which are more related to each other. The principal component analysis (PCA) and Factor Analysis (FA) are particularly the most widely used parts of the general term 'factor analyses'. It is pointed out that these two sets of techniques are similar in many ways and are often used interchangeably, and often produce similar results. Both attempt to produce a smaller number of linear combinations of the original variables in a way that captures (or accounts for) most of the variability in the pattern of correlations (Pallant, 2011). However, the researcher has

chosen Principal Component Analysis (PCA) technique in this research work mainly because, *'in principal components analysis the original variables are transformed into a smaller set of linear combinations, with all of the variance in the variables being used'* (Pallant, 2011). Whereas, in factor analysis, however, factors are estimated using a mathematical model, whereby only the shared variance is analysed.

To reach at the ultimate purpose of the PCA technique, which is identification of the principal components, the researcher has gone through various steps sequentially, such as i) assessment of the suitability of the data (suitability test), ii) factor extraction, and iii) factor rotation and interpretation.

i) Assessment of the suitability of the data for factor analysis

While conducting FA/PCA, the researcher has primarily checked whether or not the data at hand is suitable for FA/PCA. Literature sources indicate a variety of criteria and techniques of determining factorability of a particular data set. Sample size and the strength of the relationship among the variables are two criterion most commonly used to determine factorability of a data set. Though an overall consensus has not been reached upon how large should a sample size be to involve FA/PCA, some recommend 300 and above sample size to conduct factor analysis. Still, others recommend the ratio of participants to the number of items such as 10 to 1 ratio to test factorability. The researcher examined his data against these two criteria, and realized that the data suffices the requirement for factorability. That is, the sample size is 450 (far larger than 300) and the ratio of cases to items is greater than 10 to 1, that is 11 to 1 ratio.

One of techniques employed by the researcher to test suitability of the data for FA/PCA is to calculate the correlation coefficients and inspecting the number of coefficient values with .3 and above. Accordingly, the researcher has calculated the correlation coefficient of each of the variable using SPSS program, but it has been very difficult to present the correlation matrix in A4 paper size. As shown in the soft copy, it is apparent that the number of correlation coefficients with a value of .3 or greater is so large. This confirms that the data is suitable for FA/PCA.

Besides, another criteria which might be acknowledged as a most convincing criteria to test the suitability of a data set for factor analysis is Bartlett's test of sphericity (Bartlett 1954), and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. In view of these criteria, the data would be suitable for factor analysis provided that the Bartlett's test of sphericity is significant ($p < .05$). And the KMO index, which ranges from 0 to 1, should not be less than 0.6 to be good for factor analysis. Accordingly, as it is indicated in Table 9-A below, the KMO value is calculated as .966, which is quite higher than the minimum value required (.6), and Bartlett's test is significant where $P < .05$ ($p = .000$). This implies that the data set is suitable for factor analysis/ principal component analysis.

ii) Factor Extraction

The second step in the FA/PCA is determination and identification of the number of factors that can be used to best represent the interrelationships among the set of variables. Different methods and approaches are there to extract (or identify) the number of underlying factors, but the researcher has chosen the Principal Component Analysis. In fact, literature sources indicate that it is up to the researcher to decide the number of underlying factors by balancing the two conflicting purposes. On the one hand, the researchers need to get simple solution with a small number of factors as possible. On the other hand, they need to explain as much of the variance of the original data set as possible (Pallant, 2011). In view of this idea, the researcher has tried to compromise these two conflicting purposes and made an experiment repeatedly to reach at most convincing solution such that the smallest possible number of factors that could explain the underlying relationship among the variables and explain maximum variance of the original data.

Moreover, the researcher has employed two techniques that help him in the decision to fix the number of principal components (underlying factors). These are the Kaiser's criterion (which is also called the eigenvalue rule) and Scree test. According to the eigenvalue rule, it is only factors with an eigenvalue of 1.0 and above that are taken as underlying factors or principal components for further investigation. The researcher has also used the Scree test which involves plotting each of the eigenvalues of the factors. Then, by inspecting the break point on the plot, the factors above the break are considered to explain the most of

the variance of the data set and hence are taken as principal components (underlying factors).

iii) Factor Rotation and Interpretation

The third and final step in FA/PCA is the Factor Rotation and Interpretation. This step basically involves the interpretation of the principal components (underlying factors) which have already been identified in the previous steps. To assist the process of interpretation, it is highly recommended to rotate the factors for it presents the pattern of loadings in a manner it becomes easier to interpret because it shows clearly the variables which clump together. Indeed, while factor rotation is conducted, it is argued that the underlying solution is not changed.

Of the two main approaches to rotation, the researcher used orthogonal approach. This is merely because, as indicated in literature sources, orthogonal rotation results in solutions that are easier to interpret and to report. In fact, the same literature sources explain that both approaches, orthogonal and oblique, '*often result in very similar solutions, particularly when the pattern of correlations among the items is clear*' (Pallant, 2011). The researcher has also made a decision on the types of orthogonal technique he likes to use. He chose the most commonly used orthogonal approach such as Varimax method. This method is particularly important for it attempts to minimize the number of variables that have high loadings on each factor.

Based on the steps explained above, the original data set has been processed using a SPSS program, and the output is presented in the following pages. Primarily, it should be noted that for the sake of simplicity and other two key reasons, the researcher has classified his questionnaire data into two broad group of data set: i) Those data that are directly related to services provided by or duties and responsibilities of the municipal offices in general and the Sanitation and Beautification Departments of the respective municipalities, and, ii) Data that are related to the practices, with respect to duties and responsibilities, of the waste generators (communities). One of the reasons is that due to the varied nature of the data set, it would be more likely and is irrational to clump together variables (or items) from both dissimilar groups. The second reason is simplicity for it

minimizes the difficulties to extract or identify components that could represent the interrelationship among diverse and many variables.

Once the question items or variables are identified and classified into the respective group of data set, the first group of data set (question items or variables directly related to service delivery) have been analysed to extract the number of underlying components using PCA method. Therefore, the extraction of the underlying principal component analysis for the first data sets has been carried out and the outputs have been presented in the following pages. However, it should be noted that the outputs presented below have involved so many experimentation to reach at the minimum number of components which explain maximum variance of the original data set.

Table 8: Syntax of the outputs of FA/PCA

The syntax of the output

```

FACTOR

/VARIABLES cncclprg imprclsch clerwmisbhv clerwrush clerwdissat inadqctrlbdp
dispInOt dispWIPr dispcmrres dispwtins rrgimimp unfmrrrg_res insgcmprn cmpcomem
shrVT hgshrchVT shrpbtlr imprlocpbtlr unhygbtlr phypoorpbtlr lkuspbltr shrH2Opbltr
irregsr

/MISSING LISTWISE

/ANALYSIS cncclprg imprclsch clerwmisbhv clerwrush clerwdissat inadqctrlbdp
dispInOt dispWIPr dispcmrres dispwtins rrgimimp unfmrrrg_res insgcmprn cmpcomem
shrVT hgshrchVT shrpbtlr imprlocpbtlr unhygbtlr phypoorpbtlr lkuspbltr shrH2Opbltr
irregsr

/PRINT INITIAL CORRELATION KMO EXTRACTION ROTATION

/FORMAT SORT BLANK(.3)

/PLOT EIGEN

/CRITERIA FACTORS(3) ITERATE(25)

/EXTRACTION PC

/CRITERIA ITERATE(25)

/ROTATION VARIMAX

/METHOD=CORRELATION.

```

Table 9: Outputs of the Principal Component Analysis

A. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.966
Bartlett's Test of Approx. Chi-Square	6999.127
Sphericity	df
	253
	Sig.
	.000

B. Communalities

	Initial	Extraction
collection program me frequently cancelled	1.000	.686
collection schedule improper timing	1.000	.633
collection crew misbehaved	1.000	.626
collection crew unnecessarily rushing	1.000	.555
collection crew dissatisfied	1.000	.611
inadequate controlling and monitoring works on SW mishandling	1.000	.546
high disparity between inner and outer town	1.000	.879
high disparity between wealthiest and poor people residential	1.000	.319
high disparity between commercial and residential areas	1.000	.778
high disparity between areas with and without institutions	1.000	.401
solid waste rules and regulations improperly implemented	1.000	.837
many residents unfamiliar to the details of enforcements and rules of solid waste management	1.000	.472
insignificant sanitation campaign	1.000	.715
sanitation campaign conducted mainly to commemorate socio-political incidence	1.000	.813
high problem of shortage of VT	1.000	.775
problem of high service charge of VT	1.000	.359
shortage of public toilets	1.000	.759
improper location of public toilets	1.000	.730
unhygienic and mishandled public toilets	1.000	.685
physically poor quality public toilets	1.000	.402
lack of adequate customers of public toilets	1.000	.444
shortage of water of public toilets	1.000	.422
public toilets provide service irregularly	1.000	.681

Extraction Method: Principal Component Analysis.

C. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.600	46.089	46.089	10.600	46.089	46.089	8.827	38.379	38.379
2	2.192	9.530	55.619	2.192	9.530	55.619	3.021	13.134	51.513
3	1.337	5.815	61.434	1.337	5.815	61.434	2.282	9.921	61.434
4	.956	4.156	65.590						
5	.819	3.562	69.152						
6	.756	3.286	72.439						
7	.702	3.053	75.492						
8	.663	2.882	78.374						
9	.592	2.574	80.949						
10	.550	2.393	83.342						
11	.512	2.224	85.566						
12	.454	1.974	87.540						
13	.421	1.829	89.369						
14	.352	1.530	90.898						
15	.329	1.429	92.328						
16	.312	1.358	93.686						
17	.297	1.290	94.977						
18	.251	1.089	96.066						
19	.231	1.005	97.071						
20	.217	.945	98.017						
21	.174	.757	98.774						
22	.158	.687	99.460						
23	.124	.540	100.000						

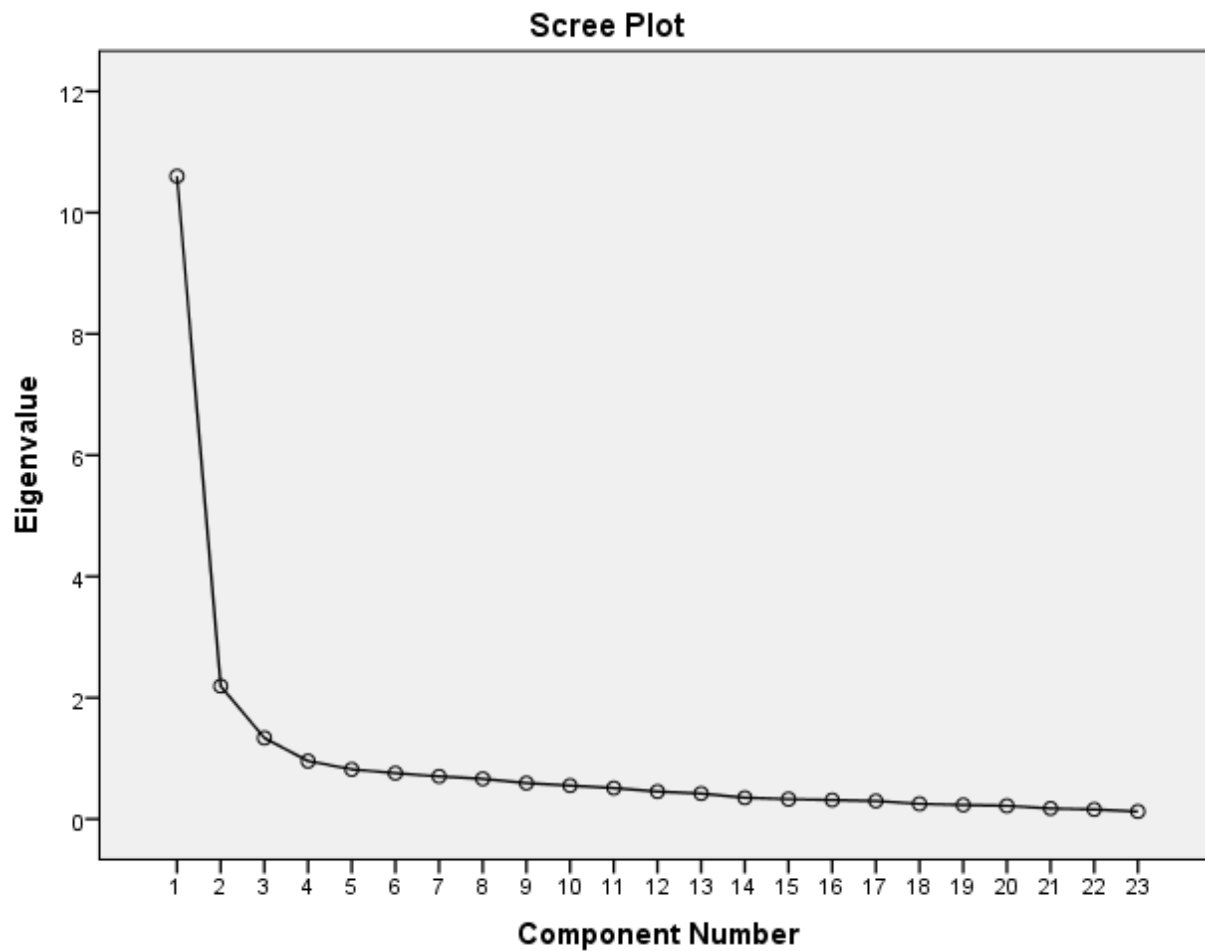


Figure 5: Scree Plot

D. Component Matrix^a

	Component		
	1	2	3
high disparity between inner and outer town	.926		
solid waste rules and regulations improperly implemented	.894		
sanitation campaign conducted mainly to commemorate socio-political incidence	.879		
high disparity between commercial and residential areas	.874		
high problem of shortage of VT	.865		
shortage of public toilets	.857		
improper location of public toilets	.839		
insignificant sanitation campaign	.825		
collection programme frequently cancelled	.824		
unhygienic and mishandled public toilets	.817		
public toilets provide service irregularly	.803		
collection schedule improper timing	.783		
physically poor quality public toilets	.586		
lack of adequate customers of public toilets		.590	
many residents unfamiliar to the details of enforcements and rules of solid waste management	.373	-.575	
high disparity between areas with and without institutions	.304	-.554	
inadequate controlling and monitoring works on SW mishandling	.499	-.543	
shortage of water of public toilets	-.324	.540	
problem of high service charge of VT	.319	-.477	
high disparity between wealthiest and poor people residential		-.414	
collection crew dissatisfied	.463		.629
collection crew misbehaved	.538		.575
collection crew unnecessarily rushing	.496		.556

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

E. Rotated Component Matrix^a

	Component		
	1	2	3
high disparity between inner and outer town	.892		
solid waste rules and regulations improperly implemented	.883		
sanitation campaign conducted mainly to commemorate socio-political incidence	.874		
high problem of shortage of VT	.843		
shortage of public toilets	.836		
high disparity between commercial and residential areas	.833		
insignificant sanitation campaign	.820		
improper location of public toilets	.819		
public toilets provide service irregularly	.796		
unhygienic and mishandled public toilets	.790		
collection programme frequently cancelled	.731		.326
collection schedule improper timing	.694		.356
physically poor quality public toilets	.626		
inadequate controlling and monitoring works on SW collectors		.673	
lack of adequate customers of public toilets		-.662	
many residents unfamiliar to the details of enforcements and rules of solid waste management		.647	
high disparity between areas with and without institutions		.620	
shortage of water of public toilets		-.580	
problem of high service charge of VT		.576	
high disparity between wealthiest and poor people residential		.520	
collection crew dissatisfied			.745
collection crew misbehaved			.720
collection crew unnecessarily rushing			.685

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

F. Component Transformation Matrix

Component	1	2	3
1	.893	.319	.319
2	.356	-.932	-.065
3	-.276	-.171	.946

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Next to the KMO and Bartlett's Test (Table 9), there is a Table labelled Communalities (Table 10.2). The communality shows the amount of variance in each item which is explained. It is believed that items with value of less than .3 do not fit well with the other items in its component. In other words, such item with low communality value does not relate to the other items. Usually, such item has to the lowest loadings on the component in which it is grouped to or clumped with. And it is advisable to remove such item (s) so that the total amount of variance explained could be increased. In fact, it is clearly explained that changes in communality values could be brought by a change in the number of factors retained. This is the reason why it is recommended to run on interpretation of communality value just after the decision on how many components to retain is finished.

In line with this agreement, the researcher has been experimenting repeatedly to increase the total amount of variance explained with a minimum number of components by removing items with less communality values (less than .3). Ultimately, as indicated in the Table labelled 'communalities', the researcher came out with items all having communality values greater than .3; where only items 'high disparity between wealthiest and poorest people residential areas' and 'problem of high service charge of vacuum trucks (VT)' have lowest communality values (.319 and .359 respectively).

It is to be recalled that the researcher has relied on the eigenvalue rule to determine the number of components required for this particular data set. To this effect, components with eigenvalue of 1 are extracted. It should also be remembered that the types of rotation technique used is Varimax orthogonal. In the Table labelled as 'Total Variance Explained',

information about the initial eigenvalue and the total variance (individual and cumulative) explained before and after factor rotation are presented. Besides, this Table showed that three components with eigenvalue above 1 (10.600, 2.192, 1.337) are clearly identified. These three components altogether explain a total of 61.434 % (cumulative) of the variance. Except that the eigenvalue after rotation are distributed slightly closer among the components extracted based on the eigenvalue rule, the total variance explained showed no change after factors are rotated.

The process of determination of principal components using the Kaiser Criterion or eigenvalue rule has the danger of extracting too many components. So, to overcome this challenge, it becomes necessary to inspect the scree plot and identify a clear break between components. Accordingly, as inspected on the Scree plot (indicated above), a slight break has been observed between the third and fourth component and hence a three-factor/ component solution has been taken as best possible.

The decision on the number of components could be more refined and reliable when the researcher is supported by the information given in the Tables entitled Component Matrix and Rotated Component Matrix. The records presented in the Component Matrix Table explain the unrotated loadings of each variable (item) on the three components. The Component Matrix Table showed larger number of items strongly loading on the Component 1 and relatively fewer items in Component 2 and 3. Precisely speaking, there are 13 items strongly loadings on Component 1, while on Component 2 and 3, there are 7 and 3 items, respectively.

The final information that is required to reach at a decision on the determination of the number of components, corresponding to the amount of variance explained, is the items' loadings on each component after the three-component solutions are rotated. In general, as it is shown in the Rotated Component Matrix Table, there is no change in the type and number of items' loading on each of the three components after factor rotation is involved except that the clustering of each variable within the respective Component has been more clearly observed.

Therefore, the researcher has reached at a decision that for this particular data set, the three-component solution is more likely to be appropriate. The name of each component is defined based on the prevalence and strength of loadings of the items clumped together. Component 1 is named as '**Liquid waste Collection, disposal and Public Toilet Service**', component 2 as '**Spatial Disparity of Services**', and Component 3 as '**Solid Waste Collection and disposal Service**'. For the purpose of convenience, however, solid waste collection service and spatial disparity of services are taken as component 2 and component 3, respectively, and discussed in that sequence. The constituent variable of each of these three components is listed in the Rotated Component Matrix (Table 9-E).

Component Transformation Matrix (Table 9-F) provides information about the extent how strong or weak correlation there is among the components extracted. This information could help the researcher to decide which rotation technique (Varimax or Oblimin) is suitable for this particular data set. It is known that both techniques vary basically on the assumption they are based on; Varimax orthogonal technique assumes uncorrelated components whereas, Oblimin oblique technique considers the reverse (correlated). When the rotation technique (Varimax) employed for this data set is examined in terms of the correlation value among the three components, the researcher could declare that he has used appropriate technique. This is because the correlation coefficients, as shown in the **Component Transformation Matrix** table, among all components are below .5 (that is between component 1 and 2 and 1 and 3=.319, between component 2 and 1=.356, and component 2 and 3=-.065, between component 3 and 1= -.276, and component 3 and 2= -.171).

4.2.2. Liquid Waste Management: Component I

It is to be recalled that the analysis of the principal component comes to an end with the extraction of three-component solution. One of the components (component 1) is defined as liquid waste management. For more clarity and specificity purpose, liquid waste management (Component-1) has been classified into two main sub components: liquid waste collection and disposal services, and public toilet services.

Primarily, the researcher has tried to assess the nature and the magnitude of the problem. To this effect, he mainly depends on questionnaire survey (quantitative data). Similarly, the researcher employed qualitative data collected from key informants through interview mainly to analyse the extent to which waste (both liquid waste and solid waste) management has received policy responses.

4.2.2.1. Main Causes of the Liquid Waste Management Problems

Urban areas receive varied types of public services among which water supply, sanitation and/or liquid and solid waste collection and disposal services are so vital. The liquid waste collection and disposal service is particularly crucial as it has serious implication on human health and environment. Liquid waste contains many contaminants that may pose a threat to human health and the environment if it is not properly managed. Improved sanitation and liquid waste management is crucial to directly maintain water quality and safety. It can bring significant benefits to poor communities, particularly women, and maintain the health of eco-systems and local population (Un-habitat, 2010). Liquid waste of urban areas may be classified in different ways but the classification based on their sources as domestic, industrial and storm water go well with the purpose of this research. Since the municipality is primarily responsible to provide the domestic liquid waste collection and disposal service to the residents, the researcher's focus has been on such types of liquid waste and the storm water as well.

As it is explained above, waste management is one of the crucial public services that the local administrative bodies should ensure to the residents. Liquid waste management is a comprehensive concept which may refer to varied aspects such as waste collection (primary and secondary collections), disposal, treatment/recycling and reuse, public toilet, etc. Above all, based on the residents' perception, the researcher has estimated that the extent how liquid waste management problem is severe and identified the main aspects of the problem. The perception of residents collected through questionnaire has been analysed and presented in the Table 10. The result shows that only 4% of the respondents have rated the extent of the problem related to liquid waste management of their town as low, whereas, more than 80% of the residents have said that their town is faced with a

serious problem of liquid waste management. This revealed that most of the residents are suffering from poor liquid waste management.

Table 10: The Extent of Liquid waste Management Problems in the Study Areas

Alternatives	Frequency	Percent
Very low	1	.2
Low	17	3.8
Medium	66	14.7
High	241	53.6
Very high	125	27.8
Total	450	100.0

Source: Questionnaire Survey, 2015/16

The next question forwarded to residents was to differentiate the way how the problem is manifested: Which aspects of liquid waste management have been serious problem of the town you live in? These aspects of liquid waste management are taken in this research as basic indicators of the poor liquid waste management in study areas. By so doing, it would be possible to make the research project more informative to the liquid waste managers to focus on the main aspect(s) of liquid waste management system that is deemed to be serious problem(s) of the town by the residents; whereby intervention areas could be readily identified by the managers.

Based on varied literature sources the researcher has tried to enumerate the basic liquid waste management aspects as those related to the presence or absence of sewerage line, access to private latrine (prevalence rate) and practices of open toilet (urinating and defecation in open areas), misuse of storm water canals, prevalence rate and status of public toilets (which would be discussed in detail in the next topic), access to and related problems of septic suction trucks, and mishandling of commercial, institutional and communal house's liquid waste. Thus, relevant question items were purposely designed and included in the questionnaire thinking that respondents would appraise these aspects (elements) of liquid waste management in terms of the pressure they have exerted on their

socio-economic and environmental conditions. The outputs of the analysis have been discussed separately in the pages to come.

Primarily, it should be remembered that the liquid waste management system used in the urban areas of the region is the septic tank system. Even in the regional capital, Mekelle City, the liquid waste management system is septic tank (on-site liquid waste management) system wherein liquid waste and wastewater from all possible sources within a house unit is collected into a private (in rare cases into communal) septic tanks.

The liquid waste management system could be examined (researched) from diverse angles. But the focus of this research is only on the assessment of the on-site liquid waste management and disposal systems in the study areas because it is apparent that the liquid waste management system of both study areas is basically on-site liquid waste management system (septic tank and pit system). It is obvious that there are no sewerages in the urban areas of the region.

However, the researcher poses questions to residents whether they know that their home town lacks sewer line. This question has been included in the questionnaire particularly to partly understand the reason why residents are misusing the storm water canals. There might be confusion in the people of the towns as to the function of the storm water drainage canals; people may think the canals to have both functions; that is, canal meant for storm water and sewage drainage all together.

But very surprisingly, because they are unable to differentiate between sewer lines and storm water drainage pipes or channels, a significant number of residents have responded 'yes there is' when they were asked whether there were sewer lines in their town or not. As it is shown in Table 11, 88.2% of the respondents of both urban areas recognize the non-existence of a system of sewers in their towns. But a significant number of the urban communities (nearly 3.6%) are not able to differentiate between storm water tubes and sewerage lines. Hence, the researcher argues that it could be partly because of this confusion (unable to differentiate between storm water channels and sewer lines) that misuse of storm water canals are widely observed in the towns. It is therefore, necessary to notice that lack of awareness is part of the problem.

Table 11: People’s Perception as regards the Availability of Sewer Systems in the Study areas

Sewer Line Available	Frequency	Percent
Yes	16	3.6
No	397	88.2
I don't know	37	8.2
Total	450	100.0

Source: Questionnaire Survey, 2015/16

When the number and pattern of habitation of residents and the expansion and complexity of the business and industrial establishments is taken into consideration, septic tank type of liquid waste management system may not measure up with the status and demand of the urban centres, particularly of Mekelle City. According to the responses of the residents the poor waste water management system is mainly attributed to the nonexistence of sewer system in their town. The questionnaire survey shows that nearly 85% of the respondents (Table 12) believe that the poor liquid waste management in their town is mainly due to lack of sewer line.

Table 12: Causes of High Liquid Waste Management Problem

Lack Sewer line	Frequency	Percent
disagree	13	2.9
neutral	55	12.2
agree	307	68.2
strongly agree	75	16.7
Total	450	100.0

Source: Questionnaire Survey, 2015/16

Access to (or prevalence rate of) private toilet is also another major issue which reflects the level of liquid waste management endeavours. Previously, we have seen that most of the residents have said liquid waste management problem is a serious issue in their town. This problem could be reflected partly in terms of access problem to (prevalence rate of) private toilets and, as a direct consequence, in terms of the magnitude of open toilet users. To assess whether the poor liquid waste management of the study areas is related to the poor access and associated problems of the private toilet, the researcher has collected

information from the respondents through a questionnaire survey. The responses of the participants of this research, specifically the respondents of the questionnaire, have clearly shown that the poor liquid waste management of the urban areas is highly linked with access to private toilets and open toilet practices which would be discussed in next topic of this chapter. About 83.4% of the respondents that participated in the questionnaire survey have agreed that the liquid waste management problem is partly related to private toilet issues. In one way or the other, the researcher also acknowledges the problem of open toilets which largely is linked with access to private toilets (For detailed discussion, see the sub-heading 5.3.2).

The other two issues on which respondents have reflected their opinions are suction truck and public toilet services. In a similar way, the respondents were also asked whether the liquid waste management problem of the study areas is linked to issues pertaining to suction truck and public toilet services. As shown in Table 13, the number of respondents who agreed that the problem of liquid waste management is linked to suction trucks and public toilet services are 59.1% and 81.3%, respectively. The proportion of respondents who are unable to agree or disagree on the effects of the suction truck service problem on the liquid waste management is exceptionally larger. Very surprisingly, very significant numbers of respondents (37.1%) have taken neutral position with respect to the effect of suction trucks on complicating liquid waste management system in the study areas. This might imply that either most of the residents have not yet used suction trucks and hence have no information about it or have not clearly noticed the practices of the suction truck service providers (discussed in detail in 5.2.2.3).

When the design of the septic tanks constructed in the study areas is taken into consideration, it might not be surprising to come across with such a huge number of respondents who neither agreed nor disagreed. Because most of the septic tanks constructed are permeable (not watertight) and thus, most of their contents (particularly the watery part) readily escape from their confinements or containers (The issue of septic tank is addressed more in sub-chapter 5.3.2).

Table 13: The Main Causes of Liquid Waste Management Problem in the Study Areas

Alternatives	The Liquid Waste Management Problems related to													
	Private toilets and open toilets		Public toilets		Septic suction trucks		Commercial liquid waste		Institutional liquid waste		Communal house liquid waste		Storm water drainage	
	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%
strongly disagree			1	.2	1	.2			1	.2	1	.2		
disagree	4	.9	16	3.6	16	3.6	6	1.3	10	2.2	8	1.8	13	2.9
neutral	80	17.8	167	37.1	167	37.1	83	18.4	184	40.9	100	22.2	131	29.1
agree	301	66.9	242	53.8	242	53.8	249	55.3	227	50.4	258	57.3	236	52.4
strongly agree	65	14.4	24	5.3	24	5.3	112	24.9	28	6.2	83	18.4	70	15.6
Total	450	100	450	100	450	100	450	100	450	100	450	100	450	100

Source: Questionnaire Survey, 2015/16

The researcher has also tried to examine the liquid waste management problem of the study areas in relation to waste streams. Liquid waste could be classified in terms of source points as residential, institutional, commercial, and industrial. Because of various reasons, the effects of each of these types of liquid waste on complicating the sanitation and liquid waste management system in a particular area may considerably vary. In the assumption that it would make possible for any forms of intervention (at managerial, policy and strategy, planning or implementation level), the researcher has tried to collect and analyze information related to each type of liquid waste stream in the study areas.

Because of the fact that the issue of municipal liquid waste management is a multi-dimensional such as service delivery, implementation of rules and regulation, involvement of stakeholders, etc., the researcher has given focus only on a few aspects of liquid waste management. The duties and responsibilities of the local administration regarding industrial waste is very limited; it is not more than regulatory works; that is, to ensure whether or not the manufacturing establishments are handling their wastes as per the requirements described in environmental rules and regulations of the country, the region and the local administration (if any). This includes regular supervising, regulating and monitoring and evaluation of the waste management. But in the case of the municipal wastes, the local administration has dual responsibility: regulatory and operation.

Therefore, the researcher has tried to review the municipal waste streams in view of the sanitation problems and complications they have created in the study areas. Accordingly, the extent of the problem of municipal liquid waste management in general has been examined sufficiently by focusing on the different aspects of liquid waste management such as septic tank handling (primary collection), access to private and public toilets and septic suction trucks, and open toilet practices. Moreover, the researcher has tried to appraise the extent commercial and institutional liquid wastes have been properly handled and have not been a major problem. For this purpose, the researcher has employed the information collected mainly through questionnaire and observation.

Indeed, to evaluate the status of liquid waste management by source it requires the respondents to observe and identify clearly where the liquid waste that creates any problem comes from. But, it is believed that because of the mixed and unplanned land use system prevailing in the developing countries' urban areas, including Tigray Regional State, Ethiopia, it would not be an easy and straightforward task to the respondents to differentiate the waste stream that is creating them problems. Therefore, to overcome this challenge, the researcher, while rephrasing the questions in the questionnaire, has linked the types of liquid waste problems occurring in a particular area to the predominantly found land use in those areas. Therefore, any liquid waste management problem appearing especially in commercial activities concentrated areas is associated to commercial liquid waste management problem. The same is true for other liquid waste streams.

The outputs of the analysis of the data collected through questionnaire (Table 13) has shown that commercial and institutional liquid waste are mismanaged and have caused a problem on the overall liquid waste management of the study areas. Many of the respondents believed that the poor liquid waste management prevailing in the study areas is partly due to the maltreatment of the commercial and institutional liquid wastes by both the generators and the responsible body to provide services. The proportion of respondents who agreed on the wider prevalence of mishandling of commercial and institutional liquid waste was 80.2% and 56.6%, respectively. This implies that the liquid waste management problem of the study areas is largely linked with the mishandling of the

commercial liquid waste. The effect of the institutional liquid waste mishandling when compared with the commercial origin liquid waste is lower. But when it is viewed in terms of the proportion of residents affected by institutional liquid waste, it is more than half of the respondents who complained about mishandling of institutional liquid waste. Therefore, by the same logic, it could be argued that more than 80% and nearly 57% of residents in the study areas have been affected by the sanitation problems created by commercial and institutional liquid waste, respectively.

Lastly, because he has personally observed appalling situation in the communal houses, the researcher has also included questions in the questionnaire pertaining to communal house liquid waste problems. This aspect was mainly included to assess the extent of the problem when evaluated from the community's viewpoint. The extent of the problem created by the liquid waste generated from communal houses, as confirmed by about 75.7% of the respondents, is so high. So, the poor liquid waste management in the study areas is also partly attributed to the mishandling of the liquid waste generated in communal houses.

To sum up, bearing in mind the responses of the residents, the researcher has realized that there are strong liquid waste management problems in the study areas. The main causes of the poor liquid waste management have been identified and ranked according to the proportion of respondents that expressed their agreement (as 'agree' and 'strongly agree'). In other words, aspects of liquid waste management supposed to play vital role in causing or complicating the liquid waste management problem in the study areas have been evaluated and ranked based on the proportion of the respondents accepted it as problem or cause of problem.

The general assumption is that the cause of liquid waste management problem, that ranked first based on the proportion of respondents that confirmed its existence, is considered to be the leading factor in its role as a cause for the complications observed in liquid waste management in the urban areas. Based on the same principle, the aspect of liquid waste management that was reported to be as a source of problem by the least

proportion of respondents has been taken as an issue that made lowest contribution to the complications and problems of liquid waste management prevailing in the study areas.

Hence, as shown below (Table 14), first and foremost, the poor liquid waste management prevailing in the study areas is directly linked to lack of sewerage in the study areas. In other words, most of people believe that the existing liquid waste collection system (which is septic tank system) does not match to the present level of urbanization and socio-economic circumstances of the study areas. Most respondents (84.9%) have expressed their agreement (by circling 'agree' or 'strongly agree' options) that the prevailing septic tank system is not a suitable option for their cities in question.

The liquid waste management aspects that ranked second and third most causes of the problem, according to the proportion of respondents that confirmed their importance as sources of problem, are those complications related to private and public toilets used by the people. Roughly 83% and 81% of the respondents have recognized the inadequacy of the existing private and public toilets in both cities respectively that contributed to the prevailing wide spread practice of open spaces as toilets.

Even though they have not been ranked high on the list of the causes of liquid waste management problems in the towns by the respondents, problems pertaining to commercial and communal house liquid wastes have also been recognized by a significant number of respondents as major factors behind the poor sanitary conditions of their residential neighbourhoods.

Table 14: The Main Causes of Liquid Waste Management Problem and their Status

No	Liquid waste management problems caused by:	Responses		Status of the problem
		Freq.	%	
1	Lack of sewerage line	382	84.9	1 st
2	Private toilet and open toilet practices	375	83.4	2 nd
3	Public toilet services	366	81.3	3 rd
4	Septic suction truck services	266	59.1	7 th
5	Commercial liquid waste	361	80.2	4 th
6	Institutional liquid waste	255	56.6	8 th
7	Communal houses' liquid waste (septic tanks)	341	75.7	5 th
8	Misused storm water drainage canals	306	68	6 th

The proportion of the respondents who recognized the problem linked with commercial and communal houses' (condominium houses) liquid waste management, as the main causes of liquid waste management problem in their city or town, is also large even though such problems are ranked as the 4th and the 5th most important factors. Therefore, the research needs to address such issues adequately.

Moreover, despite the fact that they ranked in last positions (6th to 8th), over 59% to nearly 76% of the respondents believed that misused storm water canals, poor service and inadequacy of septic suction trucks and mishandled institutional liquid wastes are creating serious problems in the city or town they live.

In short, as the output of the questionnaire data analysis indicates, the poor liquid waste management in the study areas (Mekelle City and Adigrat Town) is attributed to the problems related to several aspects of the liquid waste management system. These problems include total absence of sewerage lines, and problems related to lack of access to any lavatory, be it private, communal or public toilets, as a result of which people resort to using open spaces within and around residential neighbourhoods as latrines. What is more, even when communal or public facilities are available, problems surrounding their sheer inadequacy, poor upkeep, and woeful abuse of especially public toilets, septic suction truck services, storm water drainage channels as well as liquid waste

discharged by commercial or communal facilities are quite common. But when evaluated in terms of the proportion of respondents, liquid waste management system (specifically lack of sewerage line), access to standard private toilets and wider use of open spaces as toilets, lack of access to standard public toilets and mishandling of commercial liquid waste and communal house liquid waste are the main causes of the liquid waste management problems prevailing in the study areas. A detailed analysis and discussion of these critical aspects of liquid waste management problems and related issues is carried out in the following contents and sub-contents.

4.2.2.2. Liquid Waste Collection Systems

As it has been stated before, the liquid waste management system existing in both study areas (which is also true in the whole urban areas of the Regional State of Tigray) basically relies on the availability of on-site liquid waste management facility, which is commonly known as the septic tank. The urban residents as well as the public and private institutions reliance exclusively on this type of facility is widely recognized to be one of the key factors behind the poor liquid waste management problems that are prevalent in the study areas. However, though it has been recognized as a problem in both study areas, the severity of the problem is not exactly the same for the two urban centres under study because both towns generate different volumes of liquid waste and have different environmental conditions and socio-economic situations.

Mekelle City, which is the second most populous city in Ethiopia (next to Addis Ababa), houses a large population and a number of economic activities. Besides, large size of population are permanently residing in the city; a significant number of people visits Mekelle for different purposes and time length such as for business, academic, administrative issues, etc. Moreover, Mekelle city hosts a number of big academic institutions like Mekelle University (which provides dormitory services), Sheba University College, Millennium College, and Rift Valley College, health institutions including Ayder Regional Referral Hospital, Shopping Centres (for example, Kedamay Woyyane Shopping Mall); Starred hotels (like Axum Hotel and Planet Hotel), high rising communal residential

houses (condominiums), manufacturing industries, and other big business establishments which do have a capacity to generate huge volumes of liquid waste.

Though it is much smaller than Mekelle, Adigrat is the second most populous urban centre of the Tigray National Regional State. In this town as well, there are different institutions and establishments which could generate high volume of liquid wastes like Adigrat University, Adigrat Addis Medicine Factory, Adigrat Zonal Hospital, communal houses like condominiums, numerous hotels, restaurants, beauty salons, etc.

When one imagines the volume of liquid waste which could be generated from such very large and complex residential houses, business establishments, institutions and manufacturing establishments, it would be reasonable to examine the extent to which septic tank system could comply with the demand of the urban areas under consideration.

Furthermore, to elucidate the inappropriateness of the liquid waste collection system existing specifically in the study areas, the researcher would like to explore some more indicators to be evaluated in terms the residents' opinion and relevant visible facts. In fact, the inappropriateness of the liquid waste management system and more specifically the shortcoming of the septic tank system could be reflected in different ways. To this effect, however, the researcher has employed only two indicators such as the incidences of spill over and seepage of liquid waste from septic-tanks and the adequacy and quality of septic suction truck services. The spilling over of septic tanks prevailing in the study areas are among the basic indicators of the inappropriateness and insufficiency of the septic tank system to serve the purpose.

Before discussing the existing facts related with septic tanks, the researcher has tried to clarify what septic tank is and how it (and pit latrine) is locally understood. The septic tank is defined as a large container that could be made up of concrete, fibreglass, polyethylene or other approved material that receives liquid waste from the plumbing drains of homes (residential), commercial or industrial houses. Whereas, pit refers to a hole dug in the ground of different sizes covered usually by wood (and rarely by concrete). Depending on the purpose (short-term or long-term), the size and construction design and construction

materials used to build pit latrines varies from one to another. The surfaces of pit wall and the bottom are made in such a way that they could readily absorb water and distribute water through to the subsurface. Even when it is needed to reinforce the pit wall for stability purpose, it is filled with stone rubble of graded size to help water escape through. The top of the pit is covered with wood and sometimes by concrete.

On the other hand, septic tank is both liquid waste collection and treatment system. Except in the traditional and old settlements and houses (which are locally identified as *nebbar tihzto*), all houses, be it residential or commercial are required to build septic tank that are proportional to the number of beneficiaries within their premises. Though family size of the residents varies from one to another, average size of septic tank is fixed as per the average household size and types of business that one runs. While residents are applying for approval of the plan of their new houses and for construction work permit, a standard design of a septic tank should be included in the blue print. Moreover, it is the responsibility of the officials to certify the house plan and to issue work permit.

The spilling over of liquid waste from the septic tanks may be attributed to one or all of the following three conditions: mishandling of the liquid waste at source by generators, unreasonably quickly filling up of the septic tanks, and lack of access to septic suction trucks' service. The first one has partly been discussed in relation to residents' (generators) handling status in the next sub-headings. Whichever the reason could be, the researcher would like, firstly, to show the extent to which the problem of spilling over of liquid waste from septic tanks in the study areas is serious. To this effect, the researcher has used data collected from the respondents through questionnaire and personal observation supported by photographs.

Both sources of data showed that spilling over of septic tanks is a common phenomenon in the study areas. Large number of respondents (more than 68%) has agreed (either 'agree' or 'strongly agree') that there is high problem of spilling over of septic tanks.

Table 15: The Problem of Spilling Over of Septic Tanks or Toilets

High problem	Frequency	Percent
disagree	35	7.8
neutral	105	23.3
agree	275	61.1
strongly agree	35	7.8
Total	450	100.0

Source: Questionnaire Survey, 2015/16

During his field visit, the researcher has come across with so many cases of spilling over of septic tanks and has captured some of these events by his camera at different times. Many of these spilling over cases are still going on either sporadically or persistently. To mention some, the Mekelle University (mainly in both Addi Haqi and Ayder Campuses), Regional Prison, the condominiums near Regional Administration Office and *Kebeles 17 (Edaga Bieray)*, TPLF's (Tigray People Liberation Front) demobilized army fighters' communal residence in *Kebeles 18*, and *Jubruk* neighbourhood are among the most common cases in Mekelle.

According to the explanation of the Sanitation and Beautification Office, and personal field observation, it has been apparent that one of the key reasons for such problem is the imbalance between the septic tank size (effluent holding capacity) and the number of beneficiaries dependent on the respective sanitation facility. Many of the institutions, establishments and residential houses (mentioned above and others) have huge beneficiaries and thus huge discharges which have been beyond the holding capacity of the septic tanks that the beneficiaries built up within their premises. For instance, the two campuses of the Mekelle University have not made efforts to expand the existing septic tanks either in their number or volume parallel to the increasing student intake capacity of the institutions. Instead, they strive to involve as many septic suction trucks as possible to empty the sewage from the septic tanks before they spill over. Fortunately, recently Mekelle University has been trying to prepare a small scale treatment project established nearly 2kms north-west of the Ayder Referral Hospital. Yet, it has not been able to control the problem; the liquid waste of Addi haki Campus drains out in both eastern and southern directions heading to the *Enda Abune Aregawi* settlement areas and to the Millennium

Parks, respectively. And it is creating serious environmental and sanitation problems mainly to the settlements found around the generation point and alongside the draining courses. Besides, this liquid waste, after few hundred meters travel, joins big natural water courses such as the *Serawat-endagebriel* and *Midregenet-Adihaqi Edaga* watercourses. Similarly, the liquid waste generated from the Ayder campus has been affecting the settlements situated north and north-east of the campus in many ways.

The liquid waste generated from the communal houses is also one of the sources of severe problem of sanitation in the town. The condominiums like those found near the Regional State Administration and the *Edaga Bieray (Kebeles 17)* have been spilling over and flowing over a longer distance. They have seriously affected not only the whole residents of the condominium houses and surrounding areas but also the environment and sanitation condition of many areas through which the effluents are crossing.



Figure 6: Liquid waste exploding from the septic tank in condominium houses, near Regional Administration Office, Mekelle city

Source: Personal photos captured during field observation, 2015/16

Besides, the liquid waste generated from the TPLF's demobilized militants' communal houses, found in *Kebeles 18*, has been a problem for so long a time. Though different efforts have been made at different time by different bodies to alleviate the problem, none

of them has been effective to stop the spilling over of liquid waste. The liquid waste generated from such communal houses usually creates ponds and joins one of the city's biggest natural watercourses within a short distance.



Figure 7: Spill over of septic tank in Kebeles 18, Mekelle City

Source: Personal photos captured during field observation, 2015/16

The issue of the Regional Prison's liquid waste problem is not different from what has been discussed above. The only difference which needs to be considered is that of its location. Almost all the cases mentioned above are located in the heart of the city, but the Regional Prison is situated at the edge of the city about 12 kms from the centre towards north. Nevertheless, what is specific to the Regional Prison's liquid waste is that it is overflowing to communities' grazing land (situated on the side of the prisoner house's fence) and shortly ends up at the river named Romanat. Romanat River is one of the largest rivers crossing the city and economically vital mainly to the people living in Romanat village and downstream. As the photo in Figure 8 shows, the liquid waste has formed a swamp area. The state of affairs of the grazing land is not only unpleasant but also annoying. However, cattle herders are playing on the ground and the animals are grazing on.



Figure 8: Sewage draining into a grazing land of a community

Source: Personal photos captured during field observation, 2015/16

Obviously, many similar eye-catching cases are plainly found in different areas in Mekelle city. Besides, sufficient cases that could reveal the inadequacy and inappropriateness of septic tanks, and liquid waste collection and disposal system are also available in Adigrat Town. But there are also other cases which are more informative about liquid waste collection and disposal system problem of the town. One of them is the illegal act of connecting septic tanks or toilets to storm water drainages, which are widely practiced. Many have been detected recently while the Mekelle-Adigrat-Zelanbesa highway was being constructed. It was only those residents living within few meters distance from the road under constructed road who have been discovered red-handed. But it is of great conviction of the researcher and residents as well as the relevant officers that there can be more cases in other parts of the town. Indeed, this is not limited to Adigrat; it is also common in Mekelle City (discussed in detail in 5.3.2).

4.2.2.3. Septic Tank Suction Trucks Services

As the only option of liquid waste collection and disposal services available to residents of both study areas, it is necessary to examine the status and quality of septic suction truck services provided to the community. In view of that, respondents were further asked to express their opinion through questionnaire pertaining to accessing septic suction truck services, fairness of the service charges paid to and the trustworthiness of service providers.

The first question raised to respondents was about the adequacy of septic suction truck service in their town. When the septic suction truck service is examined in terms of adequacy in mere quantity existing in both study areas, it would have been necessary to compare the number of septic suction trucks currently on duty and the standard per beneficiary or per the size of a town. However, the researcher could not access such standard from literature nor from the relevant offices. Moreover, the researcher argues that the ratio of septic suction truck to beneficiary standard could not be a mere solution to justify adequacy and appropriateness of septic suction truck collection and disposal system of any urban area. Because any effort to supply as many septic suction trucks as the size of the city or town could result in unnecessarily massive crowd of trucks (traffic congestion), which would not only create disagreeable condition on the environment but also on the day-to-day life of the society of the urban areas. Therefore, the intention of the researcher while assessing the adequacy of septic suction truck service is not to determine the number of septic suction trucks required to the specific city or town. Rather the researcher would like to show whether these urban areas need other options of liquid waste collection and disposal system.

As the output of the analysis of the questionnaire is shown in Table 16, it is only about 10% of the respondents who assert disagreement to the idea that lack of access to septic suction truck service is a large problem to the residents of Mekelle city and Adigrat town. In fact, a considerable number of respondents, about 22.9% of the total, were unable either to agree or disagree with the idea that lack of access to septic suction trucks was a problem in their city or town. Nevertheless, a very large number of respondents (68.9%)

have confirmed that there is a high problem of septic suction truck service, particularly with respect to access in their dwelling areas.

Table 16: The Types of Problems Associated with Septic Suction Trucks in the Study Areas

	Shortage of Septic suction trucks		High service charge of Septic suction trucks		Dishonest Septic suction truck service providers	
	Frq.	%	Frq.	%	Frq.	%
strongly disagree	1	.2	4	.9	1	.2
disagree	36	8.0	51	11.3	48	10.7
neutral	103	22.9	136	30.2	96	21.3
agree	251	55.8	229	50.9	299	66.4
strongly agree	59	13.1	30	6.7	6	1.3
Total	450	100.0	450	100.0	450	100.0

Source: Questionnaire Survey, 2015/16

As regards to the second and third issues, many residents have expressed their complaints on the service charge paid to septic suction truck owners and the honesty of the service providers. They argue that, for one thing, the service fee they pay to get service from the private trucks is not fair; it is unnecessarily expensive, especially when compared to what they were paying earlier for the services provided by the septic suction trucks owned by the local (municipal) governments. In fact, the grievances on such issues have been raised to the extent that the society as a whole has directly or indirectly been requesting the local governments to intervene (at least to control and to participate in the task of fixing average service fee together with the owners). Secondly, the issue that seems even more disappointing to the people is the widely observed acts of cheating made by the service providers and thus paying exorbitant service fees. This is mainly because the service providers asked them to make full payment for septic suction trucks that were not fully loaded. Therefore, the respondents were seriously disappointed not only because they were paying unnecessarily higher service fees but also because they were cheated by the service providers.

The respondents reported that the service providers are cheating them by manipulating the gauge which measures the contents of the septic suction trucks. They did it either by

simply removing the gauges or by making them dysfunctional and then distorting the readings. They strongly allege that even though the gauge's reading showed that the suction truck is fully loaded, it usually is a false reading. They were doing such mischief simply to inflate the number of trips (the counts of trips) and hence payments which normally are conducted as per trip. The proportion of the respondents who believed that the community is suffering from the unfair service fee and dishonesty of service providers were 57.6% and 67.7%, respectively.

The researcher has also explored the qualitative data collected from key informants mainly for the purpose of triangulating with the questionnaire data collected from residents. It is to be recalled that the researcher has posed similar questions to each of the five personnel of the Beautification and Sanitation Department selected from Mekelle and Adigrat (two each) and the Regional Office. The qualitative data have been analysed using a soft ware called Atlas ti version 7 and the outputs or reports of analysis have been presented in Box 1 to Box 10.

The outputs or reports of this software have been organized in terms of quotations, codes and themes and presented in boxes. The themes are by and large pertinent to liquid waste management endeavours, solid waste management systems (principal component two) and on-site (community) waste handling practices and policy responses to waste management and are discussed successively.

The first theme analysed is 'liquid waste collection services'. The output of the analysis has been presented in the next pages (Box1). The liquid waste collection service has been examined mainly in relation to access and coverage of service, and the quality of service delivery in the study areas. From the outset, though the duties and responsibilities of liquid waste management was handed over to the Sanitation and Beautification sector organized at all level of administration (Regional, city or town, sub-city, *Kebeles* levels) in 2009/10, liquid waste management system of the urban areas has been nominal because there is no organizational structure set up, no man-power recruited, no material and financial budgets specifically allocated to liquid waste management endeavours, etc. In the same way, informants from both study areas have confirmed that there is no formal and city-

wide or town-wide liquid waste management system in general and collection and disposal services in particular in their city or town. Septic suction trucks are the only options of liquid waste collection and disposal system, wherein currently collection activities are predominantly carried out by private septic suction trucks. The informants said that they do not know who is accountable for managing and administering the septic suction trucks and their activities. The Offices of the Sanitation and Beautification of the respective urban centre, which are thought to be sole accountable bodies, openly state that they hardly manage liquid waste of their respective towns; even they have not information about the number of septic suction trucks working in their towns. In other words, the respondents have hardly explained about the details of liquid waste collection service delivery including the operation of septic suction trucks' services. It has been clear that the septic suction trucks are not administered by the responsible office; hence, obviously the quality of the service they provide would be questionable. The key informants revealed that the liquid waste collection services, specifically the septic suction truck services, are characterized by a numerous, serious shortcomings. Some of the key shortcomings are linked to the quality and status of the septic suction trucks including their hygiene and sanitation, the ethical condition of the service providers, service or working hours, dumping situation, etc.

The informants have argued that the septic suction trucks which are currently in duty are not of standard, most of them are second hand and substandard; for instance, they do not have gauges, and their capacity is not known. There is no a clear legislation and a system of controlling the septic suction trucks whether they are imported as per specification. The informants have also expressed their own observation that the service providers lack working ethics. For example, dumping in illegal areas (in and in the outskirts of the city or town), haulage below the gauge (not full gauge) but receiving full payment from customers (dishonesty), leaving open the exit valve of their container and dropping of effluents or litters and emitting bad smells along their routes, etc, are common practices of the liquid waste collecting septic suction trucks.

To put it briefly, the septic suction trucks owners breach more often the legislation that bans suction and emptying liquid waste during the daytime (from 7:00am to 05pm). They are also breaching the rules that demand the septic suction trucks to take precautions

while transporting the liquid waste and the overall trafficking situation of the septic suction trucks. The septic suction trucks create unpleasant environmental conditions (emit bad odour) and disturb the overall socio-economic condition of the city and town including traffic obstructions. Besides, the trucks leave open their exit valves while they are coming back from the disposal site and thus drop effluent on to the road. The waste collection trucks (of both liquid and solid) have no properly defined routes to be used while they are moving to and from the dumping sites. What is more, they are not washed and cleaned properly. Owing to such problems, the suction trucks emit bad smells and create discomfort to the community living, working or moving in the areas along the routes where the trucks are moving.

Most of the problems identified above, by the research participants, display explicitly the poor status of liquid waste collection and disposal system in the study areas. First and foremost, as it is true everywhere in the region, the liquid waste collection and disposal system of the study area is septic tank system (on-site system). Sewer line systems have not yet been introduced in the region.

The shortcomings of the septic suction truck service also include the convenience of service hours. The service hours determined by the responsible bodies are not obeyed by the collection service providers (septic suction trucks). There is a general principle that septic tanks or pit latrines should be emptied during early morning hours and late afternoons till 11pm in the night. But these rules have been practically violated. The respondents argued that most of the problems related to liquid waste collection services and septic suction trucks took place mainly because there is no Institution or office which is in charge of administering the septic suction trucks' services.

Box 1. Output: Liquid waste Collection Services

Liquid waste Collection Service

Contents

Liquid waste collection Services	196
Code:wwaccess {4-0}	197
Code: wwdelivery {4-0}	199

Code: wwaccess {4-0}

P 1: I-SB1-UC1.rtf - 1:7 [Interviewee_1: It is well known..] (18:18) (Super)

Codes:[wwaccess - Family: WW: Collection service]

No memos

Researcher: Could it be said that there is a formal and adequate liquid waste management in Mekelle? What types of liquid waste management system is in place? Is it on-site (septic tank) or off-site (sewerage system) liquid waste management system? Moreover, could we say that all septic tanks are prepared on standard bases?

Interviewee_1: It is well known that till now there is no separate office or a legally accountable and responsible body to administer and manage the overall liquid waste produced in the city. Many tasks linked with liquid waste management are added to Sanitation and Beautification section. But observing the growing difficulties of managing liquid waste and lack of manpower specialized in that area, the House of Representatives of the Regional State of Tigray has passed a resolution a year before (in 2008 EC or 2015/16) that requires the establishment of a separate department alleged to be solely engaged in liquid waste management activities in the respective cities and towns in the Region. It is also decided that the department shall be organized under the Water Supply and Sewerage Office.

P 3: I-SB3-UC2.rtf - 3:11 [Researcher: Is there formal, p..] (14:15) (Super)

Codes:[wwaccess - Family: WW: Collection service]

No memos

Researcher: Is there formal, proper and adequate liquid waste management system in Adigrat? How do you evaluate the availability (prevalence rate) and standards/ quality of septic tanks and pit latrines found in Adigrat?

Interviewee_3: Liquid waste management is really a critical problem of Adigrat town. I can hardly say that there is liquid waste management system in the town. Except few activities related with liquid waste management, the Sanitation & Beautification (SB) Department is not accomplishing the liquid waste management tasks in the town. Managing public toilets (though it is outsourced), recording the needy residents and communicate the septic suction truck owners, and controlling and inspecting business houses that mishandled their liquid

wastes are, among others, the most common tasks related to liquid waste management of the Department of Sanitation and Beautification Department of the town.

P 4: I-SB4-UC2.rtf - 4:11 [Researcher: Is there formal, p..] (26:27) (Super)

Codes: [wwaccess - Family: WW: Collection service]

No memos

Researcher: Is there formal, proper and adequate liquid waste management system in Adigrat?

How do you evaluate the availability (prevalence rate) and standards/ quality of septic tanks and pit latrines found in Adigrat?

Interviewee_4: With regards to liquid waste, there is no full document that clearly states how liquid waste should be managed; but conventionally, the duties of managing liquid waste has been given to SB offices of the urban centres throughout the Region. Even though this is the case, in reality, when viewed in terms of the aspects of liquid waste management so far implemented, one can hardly say that there is liquid waste management system in Adigrat town. When viewed in relation to the major liquid waste management activities such as collection and disposal, public toilet service delivery, controlling and regulating of illegal acts like open toilet use, dumping in open areas and drains, etc, I can hardly believe that liquid waste management system is in place in Adigrat.

P 5: I-SB5-RC1.rtf - 5:4 [Researcher: Is there formal, p..] (17:20) (Super)

Codes: [wwaccess - Family: WW: Collection service]

No memos

Researcher: Is there formal, proper and adequate liquid waste management system in the urban areas of Tigray in general and Mekelle and Adigrat in particular? How do you evaluate the availability (prevalence rate) and standards/ quality of septic tanks and pit latrines found in Mekelle and Adigrat?

Interviewee_5: According to the legislation adopted in 2009/10 and 2011/12 (2002 E.C. and 2004 E.C.) liquid waste management has been merged with solid waste management (Sanitation and Beautification Office). However, there was no a new structure and manpower recruited for that particular section. Neither at the top (regional level) nor at city and town levels and their lower administration units, there is no a single employee specialized in liquid waste management. The overarching cause of the problem of sanitation and beautification activities related to shortage of manpower, and financial and material

shortage is the dismantling of the Municipality system and its structures in 2010 (2002 E.C.). Every activity that has direct financial implications has been paralyzed due to the pool system introduced together with the BPR system and subsequently the dismantling of municipal systems.

According to the BPR structure of 2012-2014(2004-2006 E.C.), there was one vacancy entitled 'customer care' whose duty is merely to register the needy customers and present their list to the private septic suction truck owners (in short, it connects the service recipients and providers). Certain towns had recruited, but it was totally cancelled in the new structure introduced in 2015 (2007 E.C.).

In principle the Sanitation and Beautification office has to carry out all activities related to waste management. But, because of deficiency in capacity which is mainly attributed to lack of manpower of relevant qualification and budget, the tasks of SB has been limited only to certain aspects of the liquid waste management. In fact, there is a wide variation among towns with respect to the extent the local administration (Sanitation and Beautification Departments) are involved in liquid waste management. In most of the towns including Mekelle city and Adigrat town, SB departments are involved in inspecting and controlling of mishandling of liquid waste at sources and improper management of public toilets activities, misusing of storm water canals. Particularly in Mekelle, cleaning of the storm water canals, controlling the septic suction trucks illegal dumping and managing the liquid waste disposal site are specifically the key tasks of Sanitation and Beautification Department of Mekelle.

Code: wwdelivery {4-0}

P 1: I-SB1-UC1.rtf - 1:9 [Septic tank (on-site wastewater..] (19:20) (Super)

Codes:[wwdelivery - Family: WW: Collection service]

No memos

Researcher: What challenges and opportunities are there in your city/town related with liquid waste collection and transportation?

Interviewee_1: Septic tank (on-site liquid waste management) system is usually associated with septic suction truck system. Therefore, septic suction trucks are the key means of liquid waste collection and transportation in Mekelle. But, the SB Department (be it the regional, city or sub-city level) does not know how they are managed, which sector or office is issuing them work permits and is managing them. I know almost all the septic suction trucks

working in the city are second hand products which do not meet the standard. They do not have gauges which have led them to unethical acts or to dishonesty. Their capacity is also not known. Moreover, working hours and driving routes are not defined or fixed and controlled; and the septic suction trucks are emptying their loads outside of the drying bed. Usually, they did it at night or safe time (out of sight). The septic suction truck owners do not keep the hygiene and sanitation of their septic suction trucks, so they emit out bad smells everywhere. The septic suction trucks do not pay any service charge when they use the drying bed though they collect more than 500 Eth birr for every single trip from beneficiaries. There is information received from the community that septic suction trucks are dumping their sludge in illegal areas (including in farm lands).

And some of them have been caught red handed while they were illegally dumping liquid waste in open areas in the city (mostly in Ayder sub-city around *Mayduba* areas and *kelkel debri* areas). The septic suction trucks empty their loads unsightly in many open spaces, in and out of the city, and sometimes in farmlands based on requests (usually in cash) of the farmers.

P 2: I-SB2-UC1.rtf - 2:2 [Regarding to liquid waste manage..] (3:3) (Super)

Codes:[wwdelivery - Family: WW: Collection service]

No memos

Interviewee 2: Regarding liquid waste management, it is difficult to deem that it is fully handled by the Department of SB in Mekelle. There is a strong understanding that liquid waste management is not among the duties and responsibilities of the department. In fact, the department does not have any employee specialized in liquid waste management. Likewise, it is involved only in very limited aspects of liquid waste management. Regulating liquid waste discharges, especially those occurring out of the premises of the generators and affects someone else, is one of the key tasks of SB. Similarly, the management of the liquid waste dumping facility, i.e. the drying bed or lagoon, and the public toilets (though they are outsourced) is among the tasks executed by the SB Department. Nevertheless, almost the whole liquid waste collection works is carried out by private septic suction trucks which have no links with our office.

P 2: I-SB2-UC1.rtf - 2:13 [The other problem related with..] (41:42) (Super)

Codes:[wwdelivery - Family: WW: Collection service]

No memos

Interviewee 3: The other problem related with liquid waste management is the management of septic suction trucks. It is suction trucks are administered by the Office of Transportation. The Transport Office may have certain duties and responsibilities in relation to the septic suction trucks but the management of the tasks of the septic suction trucks is overlooked. The SB Department of Mekelle is involved only in controlling illegal dumping and sometimes the time when they had to empty septic tanks in the city and dumping into the drying bed.

Sometimes, the septic suction trucks dump liquid waste clandestinely in nearer areas particularly onto the farmlands within the jurisdiction of the city administration. Though there is no system and procedure to control the dumping, most of the septic suction truck owners are suspected of dishonesty. To raise the number of trips and thus payment, the drivers stop sucking before the septic suction trucks are full of load. This type of dishonesty is one of the consequences of lack of accountability. The time when septic tanks are emptied needs to be fixed due to the environmental and social effects created during the process of suction.

P 4: I-SB4-UC2.rtf - 4:12 [Primary liquid waste collection ..] (28:28) (Super)

Codes: [wwdelivery - Family: WW: Collection service]

No memos

Interviewee 4: In Adigrat, primary liquid waste collection from septic tanks and pit latrines is carried out by individuals who either privately owned or rented septic suction trucks. There are totally three septic suction trucks owned privately and one owned by the municipality, but rented to individuals. The main problem related to the septic suction trucks is their management. It is not clear which office is accountable to the management of the septic suction trucks; they are not managed by the SB section. As a result, dishonesty and dumping of the liquid waste illegally in any rural area (in open areas, peasant farms, drains, etc) have been serious problems in Adigrat town. The town has no fixed or restricted liquid waste dumping area. It is dumped anywhere usually at the edge of the town. Moreover, the septic suction trucks empty septic tanks or pit latrine particularly in the main market centre or other public areas during the day time when massive mobility of people is taking place. The septic suction trucks drop effluents or litters along the streets while they are

transporting it to dumping areas and coming back with open exit valve. They are also unhygienic and substandard. In fact, some peasants are dealing with the septic suction truck drivers to empty the sludge on their farmland. There is no anyone who controls and there is no any means to control whether or not the septic suction trucks are transporting full tankers. This type of dishonesty has been raised by the community through different mechanisms.

4.2.2.4. Liquid Waste Disposal

Disposal service as one of the key public services needs to be provided by the local government. Disposal is the ultimate fate and inevitable phase of any waste substance including liquid waste. But the crux of the matter is whether or not the liquid waste is safely and appropriately disposed off. With respect to disposal services, Mekelle and Adigrat have dissimilar settings. In the case of Mekelle, one liquid waste disposal site is found at a village named as Romanat which is 12 kms north of the city centre. It is located almost at the outer edge of the city and topographically it is situated at lower catchment of the city. The disposal system is called 'drying bed' or 'lagoon'. Basically, the assumption for using this type of waste disposal and treatment system is that the liquid waste collected from septic tanks (where primary collection and partial treatment is undertaken) is collected and transported to this drying bed by septic suction trucks; then, through time, the liquid part will be lost by evaporation and the solid part (residue) will dry up and used as a fertilizer. The dried up residues (fertilizer) are collected and transported to beneficiaries. Finally, the empty beds are refilled with liquid waste and the same process continues. There are eight beds thought to be used one after the other.



Figure 9: Sludge drying up to be converted to fertilizer in the drying bed

Source: Personal photos captured during field observation, 2015/16

This was the logic for using drying bed; yet, the practice is different and it has been a source of various socio-economic and environmental problems. The problems connected with liquid waste disposal system are actually so diverse which could be grouped into three aspects such as improper site selection, poor managerial activities, and illegal acts. The liquid waste disposal site management system is the contractual obligation of the local administrative body (municipality). In fact, the problems related with disposal site are very diverse.

When viewed from diverse angle, the field observation of the researcher reveals that the disposal site of Mekelle is improperly selected. The disposal site is totally situated amid of agricultural farms and on a few meters distant from the Romanat River, which drains almost the whole part of the city in a southeast- northwest direction. The site selection problem has been aggravated by the poor management system of the dumping site.



Figure 10: Discharge flowing out from the drying bed towards the Romanat River crossing the farmlands

Source: Photos captured during field observation, 2015/16

Moreover, mainly because of poor management condition, the septic suction trucks usually fill their contents into the beds beyond the maximum holding capacity of the beds and then effluents overflow down slope to the nearby farming areas and the river. The problem of overflowing of effluents becomes so severe during the rainy seasons. Likewise, every constituent of the liquid waste from all waste streams are collected indiscriminately and emptied into the bed without filtration process. In fact, there is an attempt to filter out certain unnecessary big items using certain structures like mesh made up of wire but it is not effective, it could not serve the purpose.

Concerning the disposal system of Adigrat, the situation is very much worse; where there is no even formally defined or selected liquid waste dumping site. Liquid waste is collected and transported and disposed off anywhere outside the town, usually in permanently or temporarily vacant areas. But, incidents of emptying illegally sewage onto farmlands of farmers is widely observed in Adigrat. As pointed out by the key informants, it

is not unusual to encounter septic suction trucks drivers dealing informally with farmers to empty sewage onto the farmlands in both Mekelle and Adigrat.

To examine the disposal system, a few questions were also forwarded to the key informants. It is to be recalled that an in-depth interview has been conducted with key informants pertaining to liquid waste disposal system. The data related to this aspect has been analyzed using software and the output (report) has been presented in Box 2.

The report discloses a number of facts pertaining to the status and system of disposal in both study areas. A key issue unpacked by the informants is that disposal sites are either not properly selected or are totally absent. Mekelle's disposal site has been selected taking only the distance from the city and the drainage pattern of the city into consideration. These were the only criteria considered in the process of selection of the site.

Another issue raised to the informants was about management status of the disposal site. How far the site is properly managed? The response of the informants to this question was straightforward that, when viewed from any angle, the disposal site management condition is very poor. It is not only that the dumping site (drying bed) is inappropriately located but also it is poorly managed. The liquid wastes emptied into the drying bed are freely flowing down catchments particularly during rainy seasons crossing the farmlands surrounding the site (figure 10).

The liquid waste management situation in Adigrat is very shocking when particularly the disposal system is considered. The field observation and the reports of the analysis of the interview of key informants reveal that there is no even a slight attempt to manage liquid waste disposal. Very surprisingly, Adigrat town has no predefined liquid waste dumping site. The septic suction trucks empty the sludge illegally anywhere in and outside the town haphazardly. Usually, they pour sludge onto farmlands based on the request of the peasants. In fact, such types of illegal acts are not also unusual in Mekelle, though the magnitude of the problem is less severe than it is in Adigrat.

Box 2. Output: Liquid waste Dumping

Liquid waste Dumping

Contents

Liquid waste Dumping	206
Code: wwdsite {4-0}	207
Code: wwdstatus (2-0)	208

Code: wwdsite {4-0}

P 1: I-SB1-UC1.rtf - 1:10 [Interviewee_1: Yes there is an..] (22:22) (Super)

Codes:[wwdsite - Family: WW: Dumping]

No memos

Researcher: Is there a liquid waste dumping area in Mekelle? If there is, how do you evaluate its site and management situation or status?

Interviewee-1: Yes there is and it is a drying bed or lagoon located in the northern edge of Mekelle. The site of the drying bed is inappropriate due to different reasons.

P2: I-SB2-UC1.rtf - 2:14 [Researcher: Is there a wastewa..] (43:45) (Super)

Codes:[wwdsite - Family: WW: Dumping]

No memos

Interviewee-2: Yes there is a liquid waste dumping area called drying bed or lagoon. It is located within the Ayder sub-city administrative boundary. While the site was being selected, the main issue that was considered was only the distance from the city. Its effect on the settlement around it, down catchment activities and natural drains and rivers was not thoroughly considered. By then these issues were overlooked.

But later, there have been complaints from the people around it, and down catchments to Ayder Sub-city Administration and to SB Department at Centre.

P3: I-SB3-UC2.rtf - 3:13 [Researcher: Is there a wastewa..] (17:18) (Super)

Codes:[wwdsite - Family: WW: Dumping]

No memos

Researcher: Is there a liquid waste dumping area in Adigrat? If there is, how do you evaluate its site and management situation or status?

Interviewee_3: What is very surprising and shameful to Adigrat town administration is that it has not yet fixed liquid waste dumping site. The septic suction trucks are dumping the slugs anywhere in the edge of the town and rural settlements found around the town. Sometimes, the septic suction trucks dump their liquid waste on peasants' farmlands as per their request

to the septic suction truck owners privately. In fact, some other peasants are also complaining that they are facing social and environmental problems due to the waste dumped around their settlements and farmlands.

P 4: I-SB4-UC2.rtf - 4:15 [Researcher: Is there a wastewa..] (32:33) (Super)

Codes: [wwdbsite - Family: WW: Dumping]

No memos

Interviewee-4: The core problem of liquid waste management in Adigrat town is the absence of an officially known, fixed disposal site of liquid waste. Septic suction trucks are emptying their load anywhere, in open areas, bush areas, draining areas, etc. No official has yet recognized the problem of lack of dumping site. No effort has been made to control or regulate the septic suction trucks that empty liquid waste even in environmentally and socially sensitive areas.

Code: wwdstatus {2-0}

P 1: I-SB1-UC1.rtf - 1:11 [Moreover the management condit..] (22:22) (Super)

Codes: [wwdstatus - Family: WW: Dumping]

No memos

Not only the location of the dumping site or the drying bed is inappropriate but also the management condition the liquid waste dumping site of Mekelle is very poor. Sometimes, the beds become full and liquid waste overflows to down catchments crossing large farmland, and then after some 100 meters flow, it joins the main river that drains almost the whole city and vast areas surrounding the city. The problem becomes worse during summer (rainy season). Of course, peasants around the drying bed have frequently appealed to different administration bodies working at different levels. I know liquid waste is escaping from the confinement and flows through their agricultural farm and flows into the nearby river called Romanat. The liquid waste confinement (the drying beds) are constructed in such a way that they could only hold up to certain level, but when it comes beyond it, there is an exit to flow out through an open ditch to the surface. It is true that there is a problem in the management of the drying bed. The problem becomes intense during the rainy seasons. Moreover, I strongly believe that it needs an improvement in its design. It also needs site managers of its own in adequate number with necessary qualifications. The management

system should comply with the type and magnitude of the problem.

P 2: I-SB2-UC1.rtf - 2:15 [Not only the liquid waste emptie..] (45:45) (Super)

Codes: [wwdstatus - Family: WW: Dumping]

No memos

Not only the liquid waste emptied into the drying bed is creating problem to the community living in that area but also many septic suction trucks were dumping out of the drying bed, mainly before the main road to the site was converted to asphalt road. Some farmers are trying to use the liquid waste for their farm as fertilizer either that which directly flows from the drying bed or that which was directly dumped on their farm by the septic suction trucks.

4.2.2.5. Public Toilet Services

The need for public toilet services arises primarily to fill the private toilet accessibility gap in slum areas, lower status residential areas, areas where local drinks are common, etc.). Besides, public toilet services are necessary in areas where for some reason public gatherings take place occasionally or regularly like market areas or shopping areas, entertainment areas, sport areas (for example, stadiums), cultural institutional areas, and so on. In the areas mentioned above, public toilets are among the key services needed for the residents.

Lack of toilet facilities at the right time in the right place contributes to the creation of dirty streets that are unsanitary, unpleasant and can spread infection. Inappropriately located public toilet facilities and improper timing of service during the day and night encourages street fouling, seriously impairing of the quality of environment and quality of life of local people (Oyinloye and Oluwadare, 2015).

Indeed, there have been practices for a long time to provide public toilet services in the study areas and in many other urban areas of the region. These days, most of the public toilets are owned and managed directly by local governments, but a significant number of public toilets, especially in the larger towns, are outsourced to micro and small enterprises

(MSEs). Public toilet services could be examined from different dimensions. But due to scarcity of data, the researcher has focused on limited issues pertaining to public toilet services. Because of largely lack of awareness and of course for some trivial reasons, many service providers, especially the groups to whom the local government has outsourced, are reluctant to give information and to allow visit and make critical observation on the public toilets. The service provider does not allow even to take photos of the public toilets.

For this reason, the researcher has relied more on questionnaire survey and key informants for data generation to unpack the key features, adequacy and quality of services of the public toilets. The outputs of the questionnaire data analysis have been presented in Table 16 (on page 192).

The research has tried to examine the issues related to the importance, adequacy, distribution or access, and quality of the public toilet services. Initially, respondents were asked about the importance of public toilets in maintaining sanitation of their city and town. More specifically, a question was posed to the respondents mainly to explore whether or not the people well recognizes the benefit of the public toilets and have demand for the expansion of public toilet services.

As it is indicated in Table 17 below, most of the respondents (87.5%) acknowledged that public toilet services are necessary in their town despite the fact that respondents need public toilets for different reasons.

Table 17: The Necessity of the Public Toilet Services in the Study Areas

Very necessary	Frequency	Percent
Strongly disagree	3	.7
Disagree	8	1.8
Neutral	45	10.0
Agree	285	63.3
Strongly agree	109	24.2
Total	450	100.0

Source: Questionnaire Survey, 2015/16

The persons in need of such types of service could be broadly categorized into two. The first categories are the people who are transient or are out of their home for some time. This includes public places such as bus station, railway station, market places, sport fields, etc. Beneficiary of these types of toilets are not necessarily found in the vicinity of the toilets.

The second categories of public toilet beneficiaries are those found in overcrowded and slum areas where residents are not able to own private toilets due to some reasons. So, the beneficiaries are the nearby settlements and, from the outset, they are in place to serve primarily the community in vicinity. But sometimes, there could a toilet which might be supposed to serve only a specific community or neighbourhood. These types of toilets commonly referred to as community toilets or shared toilets. But the researcher is interested only in the types of toilets of which the ownership, administration and sometimes operation task rests primarily on the local government/municipality and are commonly known as public toilets.

The next questions indicated in the questionnaire were related to the adequacy, and quality of the services provided by toilets. Adequacy may imply the ratio of the number of public toilet facilities to the number of the persons in need of the service or in terms of accessibility to the needy areas and persons.

The outputs of the analysis made using SPSS program have been presented in the Table 18. As shown in the Table, more than 78% of the respondents believe that there are inadequate public toilet facilities. This implies that there are public places as well as in residential areas in need of public toilets.

The other issue which is more related to the issue of adequacy is distribution or location of the existing public toilets. In few of this issue, the researcher wants to reveal whether or not the sites of public toilets are selected and prioritized in the respective urban areas based on relevant data and thorough study. It has been essential to explore whether there is a system of conducting need assessment and prioritization of sites of public toilets. To this effect, the researcher has interviewed the responsible bodies in the respective

administrative units and their responses have been analyzed and presented the report in Box3. As well, the researcher has tried to collect the opinion of the residents through questionnaire. The responses revealed that most of the residents have discontent on the issue of public toilet distribution or location. 56% of the respondents reported that they believe that the locations of the public toilets are improper.

Table 18: Basic Features of the Public Toilets in the Study Areas

	Basic features of Public toilets													
	Shortage		Improper Location		Unhygienic & Mishandled		Physically Poor		Shortage of Water of		Irregular Service		Lack of Adequate Customers	
	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%
Strongly disagree	6	1.3	1	.2	1	.2	1	.2	3	.7	4	.9	5	1.1
Disagree	19	4.2	36	8.0	26	5.8	35	7.8	6	1.3	33	7.3	34	7.6
Neutral	73	16.2	161	35.8	136	30.2	110	24.4	185	41.1	156	34.7	186	41.3
Agree	227	50.4	192	42.7	231	51.3	229	50.9	238	52.9	216	48.0	203	45.1
Strongly agree	125	27.8	60	13.3	56	12.4	75	16.7	18	4.0	41	9.1	22	4.9
Total	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0

Source: Questionnaire survey, 2015/16

The other basic issues addressed in the questionnaire were the hygiene or cleanliness, the basic facilities and the quality of services of the public toilets. These are generally management issues. Indeed, the public toilet management may cover several issues beyond what have been addressed here. But these are key constituents of the management activities. The management activity should primarily focus on maintaining the hygiene and sanitation of the public toilets. Cleanliness and sanitation is the most important thing to attract customers and close up other options like open toilet. Hence, the management issues of the public toilets, as key means to ensure public service, need serious attention from the service providers.

When referred to the reports (See Table 18), 63.7% of the respondents agreed that public toilets are improperly handled, that is, they are unhygienic. Moreover, a significant proportion of residents (67.6%) believed that most of the public toilets are physically poor. This implies that the public toilets which exist in the study areas are of poor quality due to

either low standard (or defected) construction works or because of lack of care and maintenance.

The other problem of the public toilets which might be linked with their unhygienic and insanitation condition is shortage of water which is one of the key facilities needed for toilets in general. With regards to this issue, it is only 2% of the respondents that plainly declined to agree on the idea that public toilets have the problem of water shortage. Except those who prefer to be neutral (which accounts for 41.1%), the rest (56.7%) agreed that public toilets found in their city or town are suffering from water shortage.

The last management issue revealed through the questionnaire survey was irregularity of service. As indicated by the workers of the public toilets in both urban centres, the public toilets are supposed to give service for about 13 hours a day (6:00 AM to 7:00 PM). But they argue that bearing in mind the high mobility of the people, time fixed for service (13 hours) is insufficient; public toilet services had rather to begin a bit early in the morning (5:00 AM) and stay till late evening (3:00 PM).

To the worst of it, the public toilets are not providing full services hours as deemed by the institution. Many public toilet service recipients are complaining that they are not receiving service as per the schedule. Because of different reasons, which are partly personal problems of the workers and lack of infrastructure like water supply and electric light, lack of maintenance, etc. the services provided by public toilets is incomplete and irregular. It is not only that public toilet services are interrupted for hours within a day; even at times they are closed for several days. The information collected through questionnaire survey strengthens the idea that services provided by public toilets are very limited. More than 57% of the respondents believe that public toilets are not providing service to the needy regularly; they are not consistently opened and closed on time. This implies that beneficiaries could not access the public toilets service when they necessitate.

Besides, public toilets have been characterized by varied challenges. Most of these challenges have directly or indirectly a diminishing effect on the quality of services and then limiting the number of beneficiaries. The challenges are mainly associated to

inappropriate location, insanitary and unhygienic condition, inadequacy of infrastructure facilities, and poor physical condition (quality of designs, buildings, etc). To reveal the extent to which those problems have affected the public toilet services, the researcher needs to ask the respondents about the size of beneficiaries of the public toilets services. To this effect a few questions are included in the questionnaire to know whether the public toilets are short of customers. Accordingly, half of the respondents reported that the public toilets have suffered from customer deficiency. It has also been confirmed during the field observation that many of the public toilets were situated in improper sites and have poor hygiene and infrastructure like water and electric city.

While analysing the responses of the respondents in the questionnaire, the researcher has come across with an exceptionally large number of residents who have been 'neutral' to most of the question items pertaining to public toilet services. For instance, the proportion of respondents who neither agree nor disagree to the questions pertaining to location, hygiene, physical quality, water supply, regularity of service and adequacy of beneficiaries is 36.8%(161), 30.2%(136), 24.4%(110),41.1%(185), 34.7%(156), and 41.3%(186), respectively. It seems amazing and even shocking to have such cases, but the key reason is apparent that many of the residents in general and the respondents in particular are either totally none or rarely visitors of the public toilets who could hardly notice the conditions of the public toilets.

As it has been clear from the discussion above, therefore, liquid waste management elements should include not only the collection and transportation of liquid waste from septic tanks and pit latrines to dumping sites and septic suction truck services, but also the public toilet services. Public toilet services are believed to be very crucial facilities primarily because there are a significantly large number of people who are in need of such types of services. Secondly, a public toilet service helps to ensure the cleanliness and beauty (attractiveness) of an urban area.

To further unpack the accessibility problems and status of the public toilets, data were collected from key informants and analyzed using software. Fortunately, the response of the respondents (households) agrees with that of the key informants (interviewees). Both

the key informants and the household heads believe that public toilets, if well managed, are very crucial to maintain the sanitation condition of the urban areas to significantly reduce the incidences of open toilet; yet, most of them are constrained by a range of factors. As the report of the qualitative data analysis prepared by the software shows (refer to Box3), the interviewees plainly understand the paramount importance of the public toilets in their city and town particularly in public areas (such as shopping areas, bus stations, open market areas, religious institutions, sport fields, etc) and settlements (traditional housing areas like *nebbar tihzto*, local drinks selling houses like *tela* houses, *tej* houses, etc) where standard private toilets are deficient. But regarding their distribution, the key informants strongly believe that there are many residential, commercial and public places that need public toilet services. Adigrat is particularly very much deficient in public toilet services.

Box 3. Output: Public Toilets

Public Toilets

Contents

Public Toilets	216
Code: ptaccess {5-0}	217
Code: ptstatus {5-0}	219

Code: ptaccess {5-0}

P 1: I-SB1-UC1.rtf - 1:13 [Researcher: What criteria do y..] (26:27) (Super)

Codes:[ptaccess - Family: Public Toilets]

No memos

Researcher: Are there public toilet services in your town? How important role are they playing to ensure the sanitation and beautification of the town? What criteria do you use to site the Green Toilets?

Interviewee-1: We tried to consider different criteria to ensure access or centrality to potential beneficiaries which are mainly public places like bus station, market areas, etc. But the availability of space has been the dictating factor for siting, and even in certain areas the resistance of residents not to site toilet near to their home area has been among the most challenges. The poor status and of bad practices of the community like dumping garbage alongside the toilet houses particularly in the old ones has created prejudice on the community's attitude towards public toilets. To many people, public toilets are dirty and garbage collecting sites. Therefore, residents prefer public toilets to be sited as far away from their house as possible.

P 2: I-SB2-UC1.rtf - 2:17 [While selecting the site of pu..] (48:48) (Super)

Codes:[ptaccess - Family: Public Toilets]

No memos

Interviewee_-2: While selecting the site of public toilets, we make efforts to consider as many criteria as possible, but the availability of beneficiaries and adequate space are the two overarching criteria.

P 3: I-SB3-UC2.rtf - 3:14 [Researcher: Are there public t..] (19:20) (Super)

Codes:[ptaccess - Family: Public Toilets]

No memos

Interviewee_3: In Adigrat town, there are 14 public toilets of which 11 are functional. The upgrading of 2 public toilets and construction of one new (around the area of *mitsae worki*)

is being undertaken.

P 4: I-SB4-UC2.rtf - 4:16 [Researcher: Are there public t..] (34:36) (Super)

Codes: [ptaccess - Family: Public Toilets]

No memos

Interviewee_4: Public toilets are thought to be one of the solutions to the problem of inaccessibility to private toilets in Adigrat. It is overtly estimated that a significant number of residents of the town have no toilets altogether or have sub-standard ones. So, such residents need public toilets in the nearby. Moreover, public toilets are very necessary in public places such as market areas like in near *Edaga* areas, religious areas like in *Endacherckos* and *Medhanialem* churches, and bus terminals, the neighbourhoods where traditional drinks houses are widely found (06, 02, and 03 *Kebeles*) and in the congested, sub-standard settlement areas in *Jelbasefer*, 01*Kebeles Mesgid aslam*, *Adiametekirstos*, *Adilikekahnat*, etc neighbourhood. Nevertheless, Adigrat town is very deficient in public toilet services.

P 5: I-SB5-RC1.rtf - 5:7 [Researcher: Are there public t..] (21:22) (Super)

Codes: [ptaccess - Family: Public Toilets]

No memos

Researcher: Are there public toilet services in Mekelle and Adigrat towns and in the region as a whole? How important role are they playing to ensure the sanitation and beautification of the towns? What challenges are there with respect to public toilet services and what measures have been taken?

Interviewee_5: The provision of standard and sufficient public toilet services to the needy is one of the key tasks of SB. Since recent times, the government has tried to give attention to the liquid waste management problems in general and public toilet service problems in particular. Since 2016, the very modern and multi functional toilets named as Green Public Toilets have been constructed and are being used in Mekelle city. This exemplifies the attention given to this sector by the decision makers. Moreover, in 2016, the Council of Representatives of Tigray Regional State decided that the liquid waste management duties and responsibilities shall be transferred from the SB Department where it has been for long

time to the respective City's and Town's Water Supply Office though it has not yet been realized.

Code: ptstatus {5-0}

P 1: I-SB1-UC1.rtf - 1:12 [Researcher: Are there public t..] (23:25) (Super)

Codes: [ptstatus - Family: Public Toilets]

No memos

Researcher: How do you evaluate the quality of services they provide and physical and social status of the public toilets in your city or town? What challenges are there with respect to public toilet services and what measures have been taken?

Interviewee_1: We can evaluate the public toilets by classifying them into three phases: those that were established before 2004, in 2004-2008 and those established after 2008. The public toilets established before 2004 are predominantly dry pit. The quality of their septic tanks and buildings, the facilities they have and the way they provide services is very poor; and their sites are not clean and safe and are not comfortable to all social classes of people. After 2004, there was an effort to improve the number and quality of the public toilets. For instance, those found on the Nations and Nationalities Square, and near to the City Public Library are among those classified as modern public toilets with public showers established during this period. Generally, during this time, there was more interest to establish new public toilets that consists of both latrine and shower services built in a wider space size of better standard than before. Those established in 2008 and after are specially designed and have multipurpose. They are very unique from the previous ones in many ways. They are usually called as Green Public Toilets. Besides to the toilet and shower services they provide, they are designed in such a way that they have green area which could serve as park area, and certain additional services which are attendant to the main services such as coffeehouse services, open space reading services, and shoe shining services. Moreover, the green toilets are different from previous toilets in that they lay on wider space. The area size of the compound of each of the Green toilet ranges between 300 and 1000 sq. meters except the two found in Hadnet sub-city.

Currently, there are 11 Green toilets which have already started functioning and there will

be four additional toilets in the coming years. Almost all the sub-cities do have at least one Green public toilet. As much as possible, efforts are made to ensure fair distribution of public toilets throughout the city, but more emphasis are and will be given to public places where large number of people are attracted to. One of the challenges we are facing is availability of adequate space to establish new public toilets in the needy areas.

P 2: I-SB2-UC1.rtf - 2:16 [Researcher: Are there public t..] (46:47) (Super)

Codes:[ptstatus - Family: Public Toilets]

No memos

Interviewee_2: The task of Mekelle municipality-SB Department embraces public toilet management. All public toilets are outsourced to groups mainly to females through contract system. Most of them are old and have not got maintenance. As a result, many of them are not functional. Some of the problems are linked with the building and sewer system, the septic tank, and facilities like water and electricity. Partly due to their poor quality (unhygienic and physically poor quality) and inappropriate site, some of the public toilets are deserted of beneficiaries. To share the operators' costs, the SB Department-Municipality of Mekelle provides free septic suction truck service to the public toilet operators. Previously there was a tendency to give priority to MSEs while the public toilets were outsourced. But because of the disagreements created among the member of the MSEs, the public toilets were often exposed to closure. Subsequently, it was decided to outsource the public toilets to individuals rather than to groups; as a result, the incidences of closure have been significantly minimized.

P 3: I-SB3-UC2.rtf - 3:15 [Previously because of various ..] (21:21) (Super)

Codes:[ptstatus - Family: Public Toilets]

No memos

Interviewee_3: Previously, because of various reasons (related to hygiene, location, service charge, etc of the toilets), the number of beneficiaries of public toilets was very low. But today, the number of public toilet users is increasing from time to time. The SB unit is also making an effort to improve the hygiene and standards of the public toilets. Moreover, there is an effort to increase the number and the distribution of the public toilets to improve accessibility. Yet, the use of open toilets in general has not been reduced to negligible or an

acceptable level.

P 4: I-SB4-UC2.rtf - 4:17 [Nevertheless, Adigrat town is ..] (36:36) (Super)

Codes: [ptstatus - Family: Public Toilets]

No memos

Interviewee-4: Nevertheless, Adigrat town is very deficient in public toilet services and the existing ones are sub-standard, of poor physical structure and infrastructure, and unhygienic condition. The public toilets found in the market areas like in the *Meyda-agame* market area have relatively more beneficiaries, but the community is improperly using them.

P 5: I-SB5-RC1.rtf - 5:6 [Public toilets if flourished a..] (23:23) (Super)

Codes: [ptstatus - Family: Public Toilets]

No memos

Interview_5: If public toilets flourished and well managed, they can significantly reduce the incidences of open toilet. But most of them are constrained by a range of factors: their number is very low as compared to the size of the needy community and areas; their distribution is unfair and their sitting is inappropriate; they are unhygienic and substandard; etc. Most of the public toilets have also suffered from shortage of infrastructure like water and electricity (including those found in Mekelle and Adigrat), and lack of maintenance. Though they are outsourced to cooperatives or individuals, the public toilets are still not properly managed.

The key informants well recognize the efforts made to fulfil the demand for public toilet services in many parts of the urban areas. For instance, in Mekelle, about 11 modern toilets have been established and started functioning in 2016 and the construction of another eight modern public toilets was underway. In fact, in Adigrat, the focus of the responsible body was on upgrading the existing ones; upgrading of two toilets and construction of one new toilet was ongoing in 2016. However, the report of the qualitative data analysis (Box3) discloses that the attention given to public toilet services in general is still inadequate. In other words, public toilets have not received sufficient responses from the concerned bodies.

The informants of both urban areas do also agree that most of the public toilets are sub-standard and inappropriately sited. There are many criteria employed to select the sites of public toilets but availability of space and potential beneficiaries are the most dictating factors particularly in Mekelle city.

In view of the status (standard) of the public toilets, the key informants' evaluation, as shown in the analysis report (Box3), is straightforward. The key informants are aware of that access is important factor for public toilet service enhancement; but, unless coupled with the physical quality, mere access would not ensure or guarantee optimum service delivery on its own. In other words, the poor quality of the public toilets could not be offset by any other measures. The key informants invariably pointed out that the public toilets are of poor quality, except those constructed recently in Mekelle which often are called as 'green' public toilets. The researcher's personal observation has confirmed that many public toilets are poorly furnished with infrastructures like light and water. Such problems have an automatic repelling effect to customers. This implies that the toilets are not readily visited by beneficiaries.

In short, despite their key role to play in minimizing the problem of shortage of private toilets (access to private toilets) and to keep the sanitation and beauty of the urban centres, it is generally pointed out that most of the public toilet services are constrained by several factors. Among which limited number and distribution, inappropriate site, unhygienic, poor physical (the wall, roof, door, septic tanks, and sanitation facilities) condition partly due to lack of proper maintenance, and lack of infrastructure (mainly water and light) are common features almost to all public toilets in both urban areas. Owing to these constraints, most of the public toilets are sub-standard and their services are deficient.

4.2.3. Solid Waste Management: Component II

It is to be recalled that solid waste collection and disposal service was one of the three components extracted using PCA technique. It is also noted that rearrangement in the sequence of the components has been undertaken. Solid Waste Collection and Disposal Service were by default Component 3 and Spatial Disparity of service as Component 2.

But for convenience and to maintain logical flow of ideas (and question items), both Components (2 and 3) have been interchanged. Hence, hereafter, Solid Waste Collection and Disposal Service has been identified as Component 2. Similarly, Component 3 would be Spatial Disparity of Services.

The analysis of Component 2 (Solid Waste Collection and Disposal Service) has been carried out in three sub-headings or themes which could be considered as sub-components, such as Solid waste characteristics, Solid Waste Collection and Transportation, and Solid Waste Disposal system

4.2.3.1. Solid Waste Characteristics

Waste management system has six functional elements, among which, waste characteristic is an initial and essential element. All other waste management elements are heavily dependent upon this first element in many ways. For instance, the types of waste collection system, the frequency of waste collection, the types of waste treatment or recycling system, the disposal system, the types and size of equipment and facilities including vehicles is determined depending on the waste characteristics (mainly the nature, composition and rate of generation of waste) of the particular urban centre. Therefore, to determine the waste collection frequency, the feasibility of composting or recycling and disposal options, types of equipment (e.g. public containers), and types and number of transportation vehicles (e.g. compactors, skip loaders) and types and sizes of facilities (public containers, transfer stations, sewer lines, drying beds or lagoons, treatment plants, landfills, etc), it is necessary to have adequate and reliable information on the nature, composition and rate of generation of the solid waste generated in the urban centres in question.

Moreover, waste management policies and programs, and planning activities heavily depend on waste characteristics. In general, for proper waste management, precise, recent and clear information about the characteristics of the waste is a preliminary concern and requisite. Any assessment in the waste management by the researchers as well as practitioners should, therefore, be preceded by adequate and precise examination and knowledge of the waste characteristic of the particular area.

On the whole, waste characteristics refer mainly to the waste nature, type or composition, and generation rate which depends on several factors. The economic development, culture and way of life of the society, location etc, of the urban areas is among the most important factors of the characteristics of waste. In other words, the characteristic of the waste generated in a particular society is the direct outcomes of these factors.

As Ethiopia is one of the developing African countries, its all urban areas by and large share typical features of the developing countries' urban areas. At least economically, The urban areas of Tigray Regional State, one of the regional states of Ethiopia, are not significantly different from most urban areas of developing countries in general and African countries in particular. But because of socio-cultural, location, and physiographic reasons, the study areas may reveal distinct characteristics in environment and waste management.

Nature and composition of waste

The data collected from the responsible offices' documents and annual reports showed that the nature of the solid waste collected by municipality in both study areas is predominantly organic. These include food items, wood and plant leaves and ashes. The household questionnaire survey conducted in 2014 for the purpose of Structural Plan Revision of Mekelle City, for instance, indicates that wood and plant leaves and food remnants ranked as 1st and 2nd in volume, respectively. Likewise, the sources from the Department of Sanitation and Beautification of Adigrat indicated that organic wastes constitute the highest proportion of the municipal waste collected from the town. And this is a good opportunity to put in place better and more economic waste management systems in the respective urban areas. For the study areas where open dumping or landfill has been a predominant disposal option, a multi-functioning composting could be better option for these urban areas.

Some of the functions of composting include reduction in the quantity of waste that ultimately gets into landfill. Thereby, costs of collection and transportation will be reduced. Moreover, it could delay the time for closure of the landfills. In short, by preventing

significant quantity of organic waste from reaching the landfill, composting will extend the lifespan of the landfills. Nevertheless, despite the presence of a large proportion of the organic materials in the waste generated in the study areas, the experts in charge of waste management of the study area have elucidated that the magnitude of waste converted into compost in the study areas is virtually nil. For example, the 2015's annual performance report of Mekelle city showed that about 5832 households were involved in small scale composting activities. However, currently because of various reasons, the number of households involved in the work of compost production has been seriously diminished mainly due to lack of marketing. Moreover, the key informants of both towns believe that the proportion of nonorganic wastes is significantly increasing.

The composition of the wastes basically refers to the constituents of the wastes generated in the study areas. Although the responsible offices of the respective cities or towns are in charge of conducting an overall survey to identify the waste characteristics particularly the nature, composition and generation rate in particular of their city or town, many of them have hardly undertaken it. Usually, they replicate directly the rate or ratio of other urban centres deemed to have similar status. But environmental estimates and waste management assessments are needed to be contextualized. For that reason, most of the data employed for planning purposes and operational purposes are more likely to be defective; the relevant data are either missing or are incomplete and imprecise.

As municipal source of the study areas shows, municipal solid wastes are composed of diverse items. These include wood and plant leaves and straws, remnants of wood items, plastic materials, soils, ashes, metallic materials, and textile products and shoes of different proportion.

On the other hand, information regarding the characteristics of liquid waste generated in the study areas is hardly available in any way in the study areas. But the experts of the respective urban areas believe that detergent and solid substances mixed with slugs of the liquid wastes collected from the urban areas form considerably high proportion.

Waste Generation Rate

As explained before, estimates of waste generation are very crucial to the waste management endeavours in many ways. Per capita waste generation rate enables to estimate the total waste generated in a particular urban centre. Estimation of the total waste generated, which could be expressed either in terms of volume or weight, is a prerequisite to the efforts made to launch an effective and efficient waste management system in a particular urban area. To determine the waste collection equipments and vehicles, human power size and materials type, and landfill size needed, estimation of the magnitude of waste generation is a vital factor. A precise information or data of the nature, composition and magnitude of waste generated could also be essential inputs in developing the waste management policy. For theoretical and practical purposes, waste generation (rate and magnitude) demands thorough consideration in waste management research projects.

Estimates of waste generated by sources, if available, could have great benefits to the overall waste management endeavours. Wastes could be generated from different sources of varying quantities such as from residential houses (households), commercial or market areas, institutions, streets, industries and so on. However, it is difficult to obtain waste estimates by sources/ generation points in the study areas. The only estimates available in the municipal office is the per capita per day waste generation rate taken arbitrarily either from any survey conducted for academic purposes or from literature.

Different figures are claimed by different sectors with respect to the per capita waste generation rate in both urban areas. Both Mekelle and Adigrat municipalities were using the rate 0.25 k/person/day for all practical purposes till the past two years. However, as indicated in many literature sources, this was taken as the lowest rate which was characterizing most of the developing countries' urban areas so long before. But currently, because of the wide change in the socio-economic condition of the developing countries, including Ethiopia, this rate of generation is rarely applicable. Similarly, taking the socioeconomic changes undertaken in the country in general and the urban areas in particular into consideration, it would be more likely to have higher per capita generation rate than it was before. In short, the solid waste generation rate which has been used in the study areas does not measure up the existing socio-economic situation of most urban

areas of the region and the country as a whole. Mostly offices tend to use lower rate and this has negative impacts on the planning and performances of the respective offices. One of the big impacts of applying lesser generation rate is inflated collection coverage. As a result, high collection coverage (when computed in percentile) would be falsely recorded and then the actual performance of the respective offices would be concealed and would practically be inflated. It would have also an effect on the manpower, budget and material allocation. This is because when very low waste generation rate is applied, the total waste generated would be underestimated. Owing to lower generation rate, therefore, the actual waste management performance of the municipality would be concealed, and of course, their collection performance would be exaggerated. To correct such distrust, the researcher has therefore preferred to employ generation rates of different sources, where possible, even to review the performance of the municipalities.

In Mekelle, three different sources have indicated three different generation rates; these are Mekelle municipality (Sanitation Beautification Department), the Regional Science and Technology Bureau, which is accepted by the Bureau of Urban Development, Industry and Trade (BUDIT) - the Sanitation and Beautification Sector, and the Mekelle Structure Plan Revision Project document as 0.25 kg/person/day, 0.39kg/person/day, and 0.367kg/person/day, respectively. The rate employed by Mekelle Municipal Office is considerably lower than the rate referred by the other two sources.

The researcher has relied on the rate used by the Regional Sanitation and Beautification Office that is 0.39kg/person/day to make all waste related calculations in Mekelle city such as the total waste generated, waste collection coverage and other related matters, where necessary. Whereas for Adigrat town except the rate employed for long time by the responsible office (0.25kg/person/day), no other options are obtained. As a result, using these official rates, the researcher has tried to compute and estimate the magnitude of yearly solid waste generation, annual change of generation (in volume and rate) of the study areas (Table 19).

Table 19: Estimation of Solid Waste Generation in the Study Areas, 2004-2009 FYE

Year	Population*		Annual waste production (m3)		Annual Chang of Waste generation (m3)		Annual rate of Chang of Waste generation (m3)	
	Mekelle	Adigrat	Mekelle	Adigrat	Mekelle	Adigrat	Mekelle	Adigrat
2004	222724	59192	222724	59192	-	-	-	-
2005	251759	67149	251759	67149	12524.6	3432.4	13.04	13.44
2006	296035	81738	296035	81738	19099.1	6293.2	17.59	21.73
2007	332803	86094	332803	86094	15860.4	1879	12.42	5.33
2008	369570	90658	369570	90658	15859.9	1968.7	11.05	5.3
2009	406338	95358	406338	95358	15860.4	2027.4	9.949	5.18
Average change					15840.88	3120.14	12.8098	10.196

Sources: * CSA

As can be seen from the Table above, the waste generation is steadily increasing from year to year. In Mekelle, in the last five years waste generation has increased on the average by more than 15840 m³ annually. When expressed in rate, it was growing by more than 12% annually. Similarly, from the year 2004-2009, on the average 3120.14 m³ solid waste has been added annually to the total volume of waste generated in Adigrat town. In other words, waste generation has increased by more than 10% annually. Similar to the situation in many of the developing countries of the world, rapid population growth has been the main reason for the steadily moving up in the magnitude of waste generated in the study area.

As explained before, solid waste characteristic is one of the three themes developed from the topic solid waste management. Solid waste characteristic is assessed in terms of both composition and generation rate. The responses of the key informants clearly show that there has been a significant change in the characteristics of the waste generated from year to year owing to the overall change in the socio-economic condition of the society. Not only that economic condition is changing but also the life styles of the society particularly the urban community is changing. And this change has resulted in a change in the nature and composition of wastes and the generation rate of the urban community. The increasingly changing in the composition of waste is also clearly observed in the rural

community living in the near vicinity to the urban areas. For example, plastic wastes have invaded the urban environment and the country side as well.

In fact, it could be normal to imagine a changing situation in waste composition and generation rate due to the on-going change in the socio-economic and demographic condition and lifestyle of the society in the urban areas throughout the region. But, what is not normal is its being deprived of adequate responses from the responsible bodies. The responses of the key informants (See Box4) have confirmed that the quantity and composition of the waste produced in their urban centre is significantly changing wherein plastic materials are disproportionately increasing. Moreover, the nature of the waste is still predominantly organic. Yet, the proportion of inorganic materials is rapidly rising. The key informants also argue that there is no significant measure taken by the responsible bodies in response to the changing nature of the waste except the efforts made to increase the geographical coverage of collection services by inviting more micro and small enterprises to involve them in door to door collection activities.

Box 4. Output: Solid Waste Characteristics

Solid Waste Characteristics

Contents

Solid Waste Characteristics.....	230
Code: Composition {3-0}	231
Code: Generation {3-0}	232

Code: Composition {3-0}

P 1: I-SB1-UC1.rtf - 1:3 [However, because of various re..] (4:4) (Super)

Codes:[Composition - Families (2): SW:Characteristics, Waste Approach]

No memos

Researcher: Have you observed significant changes in the waste characteristics particularly in the nature and composition of waste in the last few years in your town? How did your office in particular and the policy in general respond to the change, if any?

Interviewee_1 Because of various reasons, we have not yet conducted a survey. In fact, it is clearly observed that the quantity and proportion of plastic materials is increasing. Moreover, the magnitude of inorganic materials produced in the city is growing significantly despite the fact that the proportion of the organic materials of the waste is still higher than inorganic ones. But so far, there is no significant work done by the Office in response to the changing nature and composition of the waste. Whereas in response to the growing quantity of waste generated (which occurs mainly because of the increasing number of population and peripheral expansion of settlements), additional collection groups have been organized and involved in a door to door collection activities.

P 2: I-SB2-UC1.rtf - 2:4 [What is particularly difficult..] (5:5) (Super)

Codes:[Composition - Families (2): SW:Characteristics, Waste Approach]

No memos

Interviewee_2: What is particularly difficult to estimate and express numerically is the relative proportion of each of the key constituents of the waste generated. It can be estimated that the organic wastes constitute predominantly higher proportion of the waste generated in Mekelle. Moreover, since recent time, the proportion of plastic materials is increasingly rising and has been creating environmental and social problems.

P 3: I-SB3-UC2.rtf - 3:2 [Likewise the composition, thou..] (2:2) (Super)

Codes:[Composition - Families (2): SW:Characteristics, Waste Approach]

No memos

Interviewee_3: The composition, though no measurement is conducted, of waste is changing.

Currently, the proportion of plastic materials, mainly the plastic bags and water packing plastic materials, is incredibly growing and has complicated the conventional waste management system of our town.

Code: Generation {3-0}

P 1: I-SB1-UC1.rtf - 1:2 [Researcher: Have you observed ..] (1:3) (Super)

Codes:[Generation - Families (2): SW:Characteristics, Waste Approach]

No memos

Researcher: Have you observed significant changes in the waste characteristics and particularly in the quantity of waste produced in the last few years in your town? How did your office in particular and the policy in general respond to the change, if any?

Interviewee_1: Yes, the quantity of waste generated has been increasing because of various reasons. The waste composition and rate of generation before 10 years and now has not been the same. As the city grows, waste composition and generation has been significantly changing. Indeed, waste characterization is one precondition for the strategic waste management system to which we are heading to (we are looking to reach at). Whereas in response to the growing quantity of waste generated mainly because of the increasing number of population and peripheral expansion of settlements, additional collection groups have been organized and involved in a door to door collection.

P 2: I-SB2-UC1.rtf - 2:3 [As far as I know the Office ha..] (4:4) (Super)

Codes:[Generation - Families (2): SW:Characteristics, Waste Approach]

No memos

Interview_2. As far as I know, the office has not yet conducted a survey to determine the waste composition and generation rate of the city, but I believe it had to do. Usually, the office employs figures taken either from other urban areas of similar level of urbanization or studies conducted by different organization or individuals for some purposes. Currently, to estimate the total generation of the city for planning purposes, the Department uses figures studied by Regional Science and Technology Office and accepted by the BUDIT, Sanitation and Beautification Department of the Region such as 0.39 kg per capita per day.

P 3: I-SB3-UC2.rtf - 3:1 [Researcher: Have you observed ..] (1:2) (Super)

Codes:[Generation - Families (2): SW:Characteristics, Waste Approach]

No memos

Researcher: Have you observed significant changes in the waste characteristics in the last few years in Adigrat? How did your office in particular and the policy in general respond to the change, if any?

Interviewee_3: Waste characteristics change is almost a universal phenomenon of all urban areas where there is rapid urbanization and change in life style of the community. Adigrat could not by any means be different from this fact. Mainly because of its population growth, the quantity of waste produced is increasing from year to year.

4.2.3.2. Solid Waste Collection and Transportation

Waste management (both solid and liquid) is more than just collection. Solid waste management particularly is a comprehensive concept which involves diverse activities integrated within a cycle. It is not mere collecting waste, but it includes activities like transporting, processing, recycling, disposing and monitoring of waste materials. To take on these different activities, it requires different types of facilities like secondary storage, transfer stations, landfill, treatment plants facilities, etc. The activities of waste management and associated facilities are affected by numerous factors wherein environmental, economic, technical, legislative, institutional and political issues are the most important.

Therefore, while examining the (solid) waste management, it would be necessary to think about all the waste management activities ranging from the work of generation to collection and to the ultimate disposal and monitoring together with their respective facilities. Moreover, the study on the waste management would be incomplete if the factors that affect the waste management are overlooked.

Primary Collection

Waste management is one of the basic environmental services given mainly to urban residents. Waste management as a key public service is very essential to urban areas. Urban residents may receive different types of public services among which solid waste collection is one of the basic ones. It would not be possible to create habitable and attractive city or town unless adequate and safe waste collection services are in place.

As explained above, the waste management system includes different elements such as generation, collection, storage and/or transfer station, transportation, treatment (processing and recycling), and disposal. Obviously, the collection service is not only the most necessary but also it is a costly element of the waste management. It is the (local) government's responsibility to ensure adequate and safe solid waste collection services either by directly participating in operation and monitoring and regulating activities or only on regulating tasks. As a direction of government of the region as well as the country, municipal authorities should engage themselves only on regulatory activities, whereas the operational tasks have to be outsourced to community based organizations, micro and small enterprises or private enterprises on a short or long-term contract bases. The primary collection service in the study areas is totally given to micro and small enterprises. And in most urban areas of the region, secondary collection has also been outsourced to MSEs.

Collection service could be provided in different ways such as door-to-door, kerbside, and container system. In the case of the study areas, the types of collection service used in residential houses, business houses, offices and institutions is (as stated by the responsible bodies) predominantly door-to door collection. But the types of service is more of kerbside where residents bring their waste container or receptacles to the collection truck standing at central place to households of one or more blocks. The collection crew announces their advent through a horn and then residents bring their waste and hand over to the collection crew standing on the truck. Unfortunately, the collection trucks and crew do not have well defined and regular collection routes and collection posts. They move around randomly in the service area and stand their trucks anywhere at random. But, in few institutions and business establishment, public containers are sited. The collection system installed in both Mekelle City and Adigrat Town is kerbside collection system. The

collection system in both Mekelle and Adigrat slightly varies. In Mekelle, the primary collection (kerbside collection system) is totally handled by MSEs. The primary duty of the primary collection crew is to collect wastes from collection points and transport into the nearby transfer stations. In the transfer stations, there are big public containers into which the collection trucks empty their content. Under normal condition, the transportation of the public containers from the transfer stations to the landfill (secondary collection) is the duty of the municipality. The municipality trucks (called skip loaders) pick the public containers with 30 minutes and empty them on to the landfill and return it back to the transfer station. But these days, most of the wastes are directly transported to the landfill by MSEs from every collection point. But, the involvement of the MSEs in secondary collection (transportation) is conditional; it is only upon damage or dysfunction of the skip loaders. The collection trucks in Mekelle city, when they are full, empty their content into public containers placed in well-defined places designated as transfer stations. This is the basic duty and responsibility of the MSEs but sometimes they directly transport the waste collected from door to door houses to the disposal site. The waste collected in public containers in the transfer stations are transported by skip loaders to the dumping site. Basically, the task of transporting the waste from the transfer stations to the dumping ground and landfill management is exclusively the responsibility of the municipality. But sometimes, in addition to their involvement in the kerbside collection, the MSEs are given the tasks of directly transporting the waste to the dumping ground. This can be illustrated through the pictures given below.



Figure 11: Collection trucks unloading wastes in Mekelle’s landfill

Source: Personal photos shot captured during field observation, 2015/16

The collection system in Adigrat is slightly different from that of Mekelle’s. In Adigrat, the kerbside collection of waste was conducted by the Municipality’s tractors and temporarily recruited collection crews till 2016. But since then both collection and transportation works have been outsourced to MSEs. The MSEs collect the waste from the collection points and transports it directly to the landfill using rented trucks. In other words, there is no such system of ‘transfer station’; what has been collected is directly transported to dumping site. Adigrat was using a dumping site situated almost in the centre of the town until 2015. In fact, unlike to that of Mekelle, the new dumping ground of Adigrat is not situated within the town’s jurisdiction proper though no one could be certain whether there have been any other options than locating outside the town’s effective administrative border line. The new landfill established by the local administration in collaboration with World Bank has been used since 2016 (landfill issues have been discussed in sub-chapter 5.2.3.3).

Therefore, when the researcher uses the term ‘waste collection’ he is referring to the activities of receiving waste from generators directly before it is transferred to the transfer station or transported to the dumping site. With this brief overview of the overall situation

of the collection system, the researcher has proceeded to analyze the data collected from the residents through questionnaire survey.

From the outset, the researcher has tried to estimate the waste collection coverage of the study areas so as to reveal the capacity of the municipal offices to ensure clean and safe environment to their residents. While computing the waste collection coverage of study areas, he has estimated the magnitude of waste left uncollected within the city or town dumped in open areas, river courses, streets, etc. In so doing, the researcher has been able to reveal whether the collection works, as one of the vital public services, has kept pace with the volume of waste generated and population growth of urban areas under discussion. Despite the scanty and less reliable information available in the municipal offices, the researcher has used data of five years annual collection to unveil the extent to which the public service (particularly the waste collection service) was able to cope with the population growth of the study areas. For this purpose, the researcher has used population data (projected from CSA, 2007 E.C) and annual waste collection from the respective towns' Sanitation and Beautification Departments. Whereas, the annual waste production and waste collection coverage has been calculated based on the per capita waste generation rate employed by the regional Waste Sanitation and Beautification Office (0.39kg per capita per day) and population size.

Accordingly, as shown in Table 20 below, large proportion of waste has been left uncollected every year in both areas. In Mekelle, for example, for the years before 2009 EFY, the waste collection coverage ranged between roughly 63% in 2007 EFY and 83% in 2004 EFY. Within five years (2004-2008 EFY), totally 172130.6 m³ waste has been left uncollected in Mekelle city. To remove this huge volume of waste left uncollected for several years in open areas, streets, natural water courses, storm water canals, etc the local administration arranged a sanitation campaign in several occasions, for example few days before and after to February 18, 2009 in the name of the anniversary of the armed struggle of the TPLF (Tigray People Liberation Front which is currently a ruling party in the Region) and May 28, 2009 the downfall of the military junta (Derg Regime) vast sanitation campaigns have been conducted in Mekelle. As a result, as per the municipality records, in 2009 EFY huge volume of wastes have been collected which were largely a backlog.

About 175279.4 m³ waste produced in the year 2009 EFY and 109832.6m³ were left uncollected in the previous years (from 2004 to 2008 EFY). Totally, 285112 m³ have been collected in 2009 EFY. But still within the past six years about 62298.01m³ more waste has been left uncollected somewhere in the city.

In the same way, in Adigrat, the waste collection coverage recorded in the municipal documents for the past six years (2004-2009 EFY) ranges between 70% in 2006 EFY and 85% in 2004 EFY. This implies that within the six years, about 44474.5m³ of municipal solid waste has remained uncollected in the town.

Table 20: Waste Collection Coverage in the Study Areas, 2004-2009 FYE

Year	Population*		Annual waste production (m ³)***		Annual Waste collection (m ³)**		Waste collection coverage (%)***		Annual Waste left uncollected (m ³)	
	Mekelle	Adigrat	Mekelle	Adigrat	Mekelle	Adigrat	Mekelle	Adigrat	Mekelle	Adigrat
2004	222724	59192	96075.03	25533.28	71379	21788	74.3	85.33	24696.03	3745.28
2005	251759	67149	108599.7	28965.64	90152	23423	83.01	80.86	18447.68	5542.64
2006	296035	81738	127698.7	35258.8	88178	24835	69.05	70.44	39520.73	10423.8
2007	332803	86094	143559.1	37137.82	90824	26416	63.27	71.13	52735.11	10721.8
2008	369570	90658	159419.1	39106.56	122688	32000	76.96	81.83	36731.06	7106.56
2009	406338	95358	175279.4	41133.97	285112	34200	162.7	83.14	-109833	6933.97

Sources: * CSA (2007)

**Sanitation and Beautification Department, Mekelle City

*** computed based on population data in the second column and waste generation rate (0.39 kg per capita per day)

Besides the data collected from records and annual reports of the municipality, the researcher has collected information pertaining to the waste collection service from the community through questionnaire survey. Some of the questions raised to residents were focusing on the extent to which waste collection services comply with the beneficiaries' need, and on the way how residents were served by the collection crew. To be more specific, information pertaining to collection program regularity, collection schedule

suitability, adequacy of notification of the advent of collection crew at collection points, collection crew's manners, etc are collected to evaluate the solid waste collection services. The information collected through questionnaire was analyzed as usual using SPSS program and the outputs are presented in Table 20.

In view of the services, residents were primarily asked about the regularity of the collection services they are receiving; 'how frequent the collection crews have cancelled collection programs?' Most of the residents (80.6%) have expressed their grievance that the collection program is frequently cancelled by the collection crew. Program cancellation may refer to either jumping service days accidentally or disappearing constantly for so many collection service days. In other words, the idea of 'program cancellation' does not only mean missing first day and coming the next day. But it does also refer to constantly missing or disappearing for so long time from duty such as for weeks, months and even for years. It is not unusual to cancel a program in both study areas, but the problem gets more attention when pursued by questions 'how frequent' and 'for how long' the service is interrupted. The response of the respondents to the first question is clear and short that the solid waste collection program is cancelled frequently. Indirectly, the responses to the question 'how frequent' are virtually often; the collection fleets break the collection program so many times. But, with regards to the second aspect of collection cancellation, that is 'for how long', the responses of the residents range from two weeks to six months. Most of the respondents do remember that they have been encountered with interruption of collection service in their neighbourhood in the last two years (before 2015/16), on the average, for a month constantly.

The second serious issue which has an effect on service delivery is the timing or scheduling of collection service. The timing of service has been designed taking primarily the social and environmental condition of residents into consideration. In principle, early morning (before 07 a.m.) and late afternoon or evening (after 06:00 p.m.) is thought to be the convenient time because many residents pass almost the whole (working) day out of their home. In view of this, the researcher has asked residents whether the time when the collection crew visits their neighbourhood is convenient. The response of the respondents to this question has disclosed the fact that the collection fleets visit the respondents'

neighbourhoods during inconvenient hours. Most of the residents spent most of their day time out of their home either in public or private works. By and large, many residents are not available during working hours and market days at home; yet, the waste collectors arrive at home during the time when beneficiaries are not at home.

The distance travelled by the respondents to get waste collection service and the system used to notify the advent of the collection crew to the beneficiaries is among the necessary conditions needed to ensure quality service delivery. Sometimes it might be misleading when the figures are considered in terms of only majority (or most) or minority. For instance, the data showed that the majority of the residents (nearly 53%) have no complaints about the distance they travelled to receive collection service. But there are intolerably significant numbers of residents who have been unfairly forced to travel long distances carrying their waste container to the collection posts. Put specifically, more than 42% of the respondents agreed (strongly or very strongly) that collection touring line (or collection post) is far from their houses. It is painful to see usually mothers carrying wastes for long distances to reach collection posts.

Table 21: The Basic Features of the Kerbside Collection Services Provision in the Study Areas

		Basic features of door to door collection service													
		Collection Program Cancellation		Collection Schedule Improper Timing		Far Collection Post (trucks' touring line)		Inadequate Notification		Unnecessarily rushing Collection Crew		Unethical Collection Crew		Dissatisfied Collection Crew	
		Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%
Valid	strongly disagree	3	.7	4	.9	28	6.2	19	4.2	13	2.9	7	1.6	8	1.8
	disagree	79	17.6	72	16.0	215	47.8	220	48.9	113	25.1	120	26.7	114	25.3
	neutral	5	1.1	5	1.1	16	3.6	2	.4	8	1.8	15	3.3	20	4.4
	agree	244	54.2	257	57.1	171	38.0	202	44.9	252	56.0	252	56.0	261	58.0
	strongly agree	119	26.4	112	24.9	20	4.4	7	1.6	64	14.2	56	12.4	47	10.4
	Total	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0

Source: Questionnaire Survey, 2015/16

Finally, residents were asked about the adequacy of notification made by the collection crew. Comparatively, the proportion of respondents who agreed on the adequacy of

notification is more than not. Nevertheless, significant number of residents is offended by the collection crews for the crews are not properly notifying their advent to the collection posts. This type of problem becomes more severe to residents when the waste collectors touring line is so distant from their home. Because of these reasons residents are forced to store wastes at home for unnecessarily more days. As result, residents would be exposed to variety of diseases due to insanitary and unhygienic conditions. When 'inadequate notification' coupled with 'distant collection post' is taking place repeatedly residents would be left off unserved. Numerically, nearly 47% and 42% of the households are estimated to be suffering from the problems associated with notification and collection posts' distance from beneficiaries, respectively. Therefore, the residents were not only unable to get alert message or notice from the collectors on time to empty their receptacles, but also they have to shoulder the burden to carry receptacles of waste for long distance to reach the collection post because the collection touring line is far from their houses.

Taking the long distance that beneficiaries are supposed to travel and the improper notification system in place into consideration, it would have been advisable to keep on some more time till beneficiaries travel such long distance and arrive at the collection post with their load. Put differently, when both situation (far collection posts and improper notification) occur simultaneously, beneficiaries need the collection crews to spend more time at each collection post. Nevertheless, even if the duration that collection fleets spent on each collection post is an important factor for decent service, what is practically happening is contradictory. Very large number of residents (about 72%) complains that the collection crews are unreasonably rushing not considering the large number of beneficiaries who would otherwise missed the service. They have no tolerance even for seconds to keep the beneficiaries to bring their receptacles. The researcher has personally observed when the collection crews get away, leaving behind beneficiaries running after them.

One of the big issues in service delivery is the work ethics of the service providers (particularly collection crews). The researcher has often observed personally when residents quarrelling and clashing with the collection crews. It is not unusual to see residents shouting at the crews and, if these incidents are occurring repeatedly, it is

believed that the quality of service would be damaged. So the researcher has included questions in the questionnaire to assess the extent how such bad practices are prevailing in the study areas and the possible reasons why beneficiaries are complaining at the collection crews. Some of these questions are related to behaviour or work ethics and satisfaction of the collection crew in their job. Ethicality is a requisite in any public service delivery and it is highly linked with the interest or job satisfaction of the service provider. Ethicality is one of the requirements of the MSEs (as service providers) and has clearly stated in the contract agreement made between them and the municipality.

Accordingly, the researcher has forwarded the issue to residents and most of them have confirmed that most of the collection crews display misconduct during waste collection time; they are disrespectful to the beneficiary. Generally, the way the collection crews interact with and entertain the beneficiaries is not good. The return from the community is also not different. The misconduct of the crews are manifested in many ways such as lack of willingness to return back the receptacles of the residents though it is their duty to do so, rushing leaving beneficiaries not served, and unwillingness to help beneficiaries lift their receptacles to the top of the vehicle are among the common behaviours reflected by most of the collection crews.

In general, it appears that the unethical behaviours are might be attributed to their dissatisfaction on their job. It is believed that lack of interest coupled with misconduct would heavily damage the service delivery endeavour. Hence the researcher has tried to examine the interest of the collection crew to participate in collection activities. To this effect, the researcher has asked the beneficiaries through questionnaire and the waste experts in the municipality and the MSEs (through informal interview). The responses of the experts have been analysed and presented in detail in Box5, but the residents' opinion has been analyzed and the output has been presented in Table 21 above. As it is indicated in the Table, the proportion of the residents who agreed (and strongly agreed) on the idea that 'the collection crews have problems of dissatisfaction in their job' is so large. The community has observed serious problems of dissatisfaction on the members of the collection crews. And because of some reasons, the researcher has also observed certain dissatisfaction on the collection groups and he believed that such condition would have

been the sole sources of their misconduct of the collection groups as reflected on their occupation. The ultimate result of all these problems is the poor quality of waste collection service provided to the community.

But it would be essential to raise the question 'why the collection crews are dissatisfied and behave badly?' One of the reasons for dissatisfaction is that most of the collection crews are recruited and they are underpaid and ill-treated by the owners of the collection fleets and this would inevitably damage the quality of services. Because dissatisfaction ends up at misconduct and bad practices, it would readily result in poor solid waste collection services.

As an extension of the service delivery, the responsible body has one task to do, which is to collect feedbacks. It is well known that solid waste collection service is one of the key public services provided in urban areas. Because of its paramount importance to improve the overall collection service delivery system and then enhance good governance, it is more likely that the responsible bodies would have to establish a very simple and effective complaint hearing systems. In principle, feedbacks are so vital to, among others, identify weaknesses and strengths and then correct weaknesses and enhance and maintain strengths. Failure in service delivery could be instantly detected and corrected if a smooth, simple and effective complaint hearing system is put in place. Therefore, bearing in mind the vital role it plays, the researcher has been interested to examine whether complaint hearing system is in place and, if any, the extent to which it has been used by the officers and residents. To this effect, the researcher has collected information from residents and the responsible office (Sanitation and Beautification Office of the city and town).

Primarily, the residents were asked whether complaint hearing system is readily available in their neighbourhood. If so, to what extent does it bring them a solution to their problem? The responses of the residents to these questions reveal that, unfortunately, more than two-third of the respondents have chosen either 'there is no' or 'I don't know' answer when they were asked whether complaint hearing system is in place in their city or town. This implies that 77.3% of the communities of the study areas do not have any regular means to report about their complaints to the responsible body.

Table 22: Availability of Complaint Hearing System

Alternatives	Frequency	Percent
Yes	102	22.7
No	279	62.0
I don't know	69	15.3
Total	450	100.0

Source: Questionnaire Survey, 2015/16

The presence of simple complaint hearing system could be one essential opportunity to improve solid waste collection service provided that it is accompanied by clear solution. Certainly, because of its sensitivity, residents would need immediate response to their problems. Nevertheless, more than half (nearly 51%) of the residents who noticed the presence of complaint hearing system in their area said that the complaint hearing system hardly brings them solution to their problem, whereas 39% replied that it occasionally brings them solution.

Transfer Station and Transportation

In principle, the kerbside collection service or door-to-door collection service refers to the system where residents bring their waste container themselves to the collection truck which stands on a collection post. The wastes collected from generators are taken either to a transfer station (temporary collection site) or directly to the ultimate disposal site called landfill. In this study, all activities subsequent to kerbside collection but prior to transportation and dumping activities are considered as phase one, known as Primary Collection. The end of Primary Collection phase is Transfer Station. Transfer Station is a building or processing site for the temporary deposition of waste. Transfer stations are often used as places where local waste collection (primary collection) vehicles deposit their waste cargo/container prior to loading it into larger vehicles. Waste transfer stations are facilities where municipal solid waste is unloaded from collection vehicles and briefly held while it is reloaded onto larger long-distance transport vehicles for transport to landfills or other treatment or disposal facilities (Zemanek, et al., 2011).

It is only Mekelle city which uses Transfer Stations. Despite their multi-purposes, in Mekelle, transfer stations are used only for single purpose, which is to collect waste using small trucks from generators using small trucks and to reload them in mass (large volume) onto heavy duty machinery (such as skip-loaders) which transport the waste to the landfill site. The main focuses of the research with respect to transfer station are mainly two: One is the rationale behind to establish transfer station in the study area. The second focus is the status of the transfer stations particularly their handling situation and socio-economic and environmental effects.

Right from the outset, transfer stations are needed when the dumping site is situated far from the city and thus heavy hauling trucks could be used to transport the waste from the transfer station to the landfill. This is because the primary rationale for using transfer station is to reduce the cost of transporting waste to disposal facilities (Zemanek, et al., 2011). If the disposal site is too far from the city, the time spent by the crew of the pickup truck in unproductive travel becomes excessive; as a result, it might be uneconomical to use collection trucks for travel to the disposal site. Transfer stations need, therefore, to be established at convenient locations where cost of transportation becomes minimal (Singh, et al., 2014). In so doing, the use of transfer station could speed up the primary (in this case kerbside) house to house collection.

The most important considerations in planning and designing a transfer station are location, type of station, access, and environmental effects. At the transfer station, partial or complete solid waste processing such as sorting, shredding, compacting, baling, or composting may be provided. The objective is to reduce the volume, alter the physical form, and recover usable materials. It is important that the transfer station be located as near as possible to the generation centre. Good road access as well as secondary or supplemental means of transportation are necessary. Also, the site must be environmentally acceptable (Singh, et al., 2014).

In view of these criteria, does Mekelle really need transfer stations? And why Adigrat does not have transfer station? Is it not rational to establish transfer station in Adigrat? One thing which should be clear is that it should not be for granted to introduce transfer station

system because it has huge cost and time implication. Moreover, the socioeconomic and environmental impacts of transfer stations on the nearby settlements are very high. That is why the research needs to examine the rationale for transfer stations in Mekelle city and not in Adigrat town.

When we examine Mekelle's case, there were five transfer stations in the city, one each in the five sub-cities: In Ayder (which also serves to Semen Sub-city), Hadnet sub-city, Hawelti sub-city, Keddamy Woyyane (which is located on the edge of Hawelti sub-city), and Quiha sub-city. Except the Transfer station found in Ayder sub-city, which is designated to serve both Ayder and Semen Sub-cities, and the Adi Haqi sub-city that has no transfer station, each of the five transfer stations serves one each sub-city where it is found.

However, the disposal site of Mekelle is located only 8kms far from the city to the west direction. When the distance of the landfill to each of the transfer stations is measured, except to Quiha transfer station, it is below the minimum recommended distance for Transfer station to establish. When it comes to the transfer stations, Hawelti's and Keddamay Weyyane's sites are much nearer to the landfill. Very surprisingly, most of the collection areas of Hawelti sub-city are nearer to the landfill than to the transfer station (found in Endagebriel area). For example, Adiha, Adishimdhun and Dae'ro are the largest neighbourhoods in Hawelti Sub-city situated closer to the landfill than to the transfer station located in Endagebriel area. Similarly, the waste collected from most of the neighbourhoods in Ayder and Hadnet sub-cities is transported to the transfer stations located almost eastern edge of the sub-cities. They simply increase distance and thus cost. The two transfer stations (in Ayder and Hadnet Sub-cities) are also a bit distant from the average distance between the landfill and the centre of the city (roughly 8 kms). Both the Ayder and Hadnet Transfer stations are roughly 13 kms far from the landfill. They are not far enough from the landfill to rationalize the establishment of transfer stations. When considering mere distance to the landfill, except Quiha sub-city and Aynalem *Tabia*, not only the existing transfer stations but also all settlements within the urban proper of Mekelle city are not so distant to justify the establishment of transfer stations. Literature sources indicated that transfer station is recommended only if the round trip distance to

the landfill measures is at least 50 km and above. So, the researcher argues that in Mekelle all the neighbourhoods could be reached by small trucks directly from the landfill except Quiha sub-city and Aynalem *Tabia*.

Currently, the local kerbside collection trucks are directly transporting the wastes to the landfill owing to the damaging and being off-duty of the skip-loaders. And this has been a usual phenomenon due to the frequent damaging and longer downtime of the skip-loaders. This implies that it is possible to reach the landfill easily from every point within the urban proper of the city by the local collection trucks.

Moreover, when the setbacks and difficulties associated with site selection, sanitation and administration of the transfer station is considered, the need for transfer station would have been virtually zero. It is very difficult to identify a suitable site for the establishment of transfer station mainly because of three reasons. One of the reasons why it becomes so difficult to select suitable site for transfer station is the diverse and complex nature of the criteria needed to be fulfilled. Unless all these diverse factors are thoroughly considered during site selection process and are fulfilled, transfer stations would have a very high detrimental impact on the social, economic and environmental condition of the society. In fact, it might be ideal to find out a site where all the criteria of site selection have been satisfactorily fulfilled. However, the site should comply with the basic criteria as defined by the expert groups involved in site selection. The second reason why it becomes so difficult to select a site for transfer station is the huge implication they have on cost and transportation fuel. The third reason is that transfer stations could be established for multipurpose such as unloading from local collection vehicles and reloading to larger long distance transporting trucks; compressing the wastes into smaller volume but higher density containers; sorting into different categories of waste; reusing; recycling, etc. Therefore, since it needs purpose-specific criteria, the multi-purpose nature of the transfer station would necessitate multiple criteria to employ and this again complicates the selection process. It is therefore clear that site selection of transfer station is not an easy task to waste experts.

Various criteria for site selection are indicated in different sources. But the research has made use of criteria described in two literature sources. Those criteria indicated in Manaf, et al., (2009) focus mainly on environmental, technical, and socio-cultural aspects of the study area. Environmental criteria may include land use, geology, groundwater, surface water, ecology, visibility, traffic and topography. These criteria are basically used with the intention to reduce environmental impacts during the development and operation of the transfer stations; whereas the engineering, operational and transportation systems are among the most important technical elements used in site selection. Because of their relevance to cost and fuel, these criteria are of great concern to the owner of the transfer station (which in many cases is the local authority). The third categories of sitting criteria are local socio-cultural factors. The socio-cultural criteria include the impact of the transfer station on human beings and their activities. These may include air quality (bad smell), proximity to local infrastructure (water and electricity), proximity to schools, churches, recreation sites, and residences, number of residences impacted, impact on historic or cultural features, impact on neighbourhood character and impacts on existing businesses (Manaf, et al., 2009).

The second literature material consulted is the Regulation 61-107.7 of South Carolina Department of Health and Environmental Control (1993). In this material twenty two criteria, which could be broadly categorized into two as design and operational criteria, have been identified. The design criteria includes, but not exhaustive, the distance from property line, water body, from residence, school, hospital, recreational park, cultural institution, and wetlands and the permeability nature of the ground. Operational criteria are more or less related to the management situation or handling system.

To examine the status of the transfer stations, though in both sources many criteria are mentioned, the researcher has focused on those which are so simple to implement but are believed to have severe effects on the environmental and socio-economic and cultural condition of the site and nearby areas. By so doing, it has been possible to identify the criteria overlooked or given insufficient attention by the site selection committee. Moreover, relevance to the local area has been taken into consideration while site selection criteria are chosen to evaluate the existing transfer stations.

Accordingly, bearing in mind the points mentioned above, the researcher evaluated the appropriateness of the transfer station's sites in terms of their distance from the residences, schools, hospitals, cultural institutions and property line, water bodies, and drainage (water courses); and their topography and other criteria. These criteria have been employed as a frame of reference to develop checklists used during the field observation.

To evaluate the overall status of the transfer stations, this research has used both field observation and interview with the experts of the Sanitation and Beautification Offices of Mekelle City. The field observation supported by checklists and photographs have served to strengthen or triangulate the information collected from key informants. As indicated above, there are five transfer stations (TSs) in the city.

Finally, the information collected from the key informants have revealed that almost all the sites of transfer stations of Mekelle, including the one found in Quiha sub-city, are selected taking mainly two criteria into consideration. These criteria are the centrality to the respective sub-city and availability of space. This implies that the other criteria like the environmental, socio-cultural and engineering criteria were either overlooked or were given little attention.

The data collected from the field visits made to the transfer stations also agree with those collected from key informants. Many of the site selection criteria have been overlooked. One of the criteria which had been overlooked by the site selection team is the criteria of 'distance from the surface water'. This criterion bans any acts of locating TS within two hundred feet (71.42 meters) and less distance from any water body. In other words, transfer station shall not be located within two hundred feet (71.42 metre) distance from any surface water.

It would be more illustrative when specific cases are considered. The Hawelti (Endagebriel) TS, for example, is very close to the water course heading from the Gefih Gereb-Millennium Park towards north of the city. Both Hadnet and Kedamay Woyane TSs were located alongside the main river of the city locally called *Maygifaf*, which flows south-

north direction by dividing the city into Eastern and Western part. The Hadnet TS which was located near Meskerem Hospital is within less than 15meters distance from the *Maygifaf River*. Similarly, the Kedamay Woyane TS is situated north of the Hadnet TS alongside this *Maygifaf River*; in nearly 40 meters distance from the river course. In fact, both of them have recently been abandoned. The other transfer station is the one found in Ayder Sub-city which serves both Ayder and Semen sub-cities. This transfer station like the ones mentioned above is situated very close to the artificial pond locally named as *May Dubba*.

Physically, the problem of the transfer stations is not only limited to their location. But also the topographic condition of the sites is not appropriate. The topography of most of the TS sites has aggravated the problem of distance from water surface or river courses. Most of the transfer stations are sited in sloppy area inclined towards the waster courses and water surfaces. This means that wastewater (rainwater or water used for cleaning or other purposes) easily drains to nearby rivers and ponds, and thus contamination of these water bodies would be more likely.

And this implies that dirty materials and litters are washed down to the water course through runoff particularly during the rainy seasons. Therefore, In addition to their proximity to water courses and water bodies, all transfer stations are situated in sloppy areas where the litters and discharges are getting into the water courses through runoff.

The criterion which defines distance of the TSs from property line and residence, schools, and hospitals has been considered almost in all sites except the previous sites of Hadnet and Kedamy Woyane sub-cities. The Hadnet TS was located in the heart of densely settled area and adjacent to one of the main roads of the city. Though it is not as serious as that of Hadnet's TS site, Kedamy Woyane TS site was also close to private properties (residences and schools). The other three sites have also bridged in many ways the rules pertaining to transfer station selection.

Besides the poor site selection, the sanitation and handling conditions of the transfer stations are the main concern of environmental planners, experts and researchers. Mere

site selection cannot guarantee residents in the nearby settlement to get rid of the negative impacts of TS. In other words, poorly sanitised and improperly handled TS could have severe impacts on the environmental and socio-cultural condition of the surrounding settlements no matter its proper location.

It is, therefore, necessary to examine the sanitation and handling system of the TSs. To this effect, the researcher has tried to observe the compound of the TSs based on the checklist. Litters dropped everywhere, disordered and overfilled waste containers, wastes kept on the containers left uncollected for so long time, etc. are some of the typical features of almost all TSs. The unpleasant scenery, unhygienic condition, and terrible odour offended not only the collection crews and the staff with the tasks of handling of the TSs but also the community residing or walking close to the TS. The photographs (Figure 12) depicted in the next page might explain more than what words can. According to the legislation of the municipality, the public container in the transfer station should be picked up or reloaded and transported to final disposal site within 30 minutes after local collection vehicles unloaded their waste into it. However, all facts observed in the TSs disclose that the practices deviate far from the principle. The length of plants grown in the container confirms that the waste container has been kept for months.



Figure 12: Public Containers Left Uncollected for Indefinite Time Length, sited in May Dubba Transfer station, Mekelle City

Source: Personal photos captured during field observation, 2015/16

The waste management system of both study areas presume that wastes are collected from homes, business houses, institutions and offices using kerbside collection system by local collection trucks and tractor trailers or horse driven carts to TS or directly to disposal sites. Where TS are available like in Mekelle city, wastes are unloaded and reloaded and transported to landfill using skip-loaders. Mekelle has six skip-loaders and large number of public containers though most of them are out of use. Many of the public containers are placed in the TSs. According to the responses of the key informants (the experts of the Sanitation and Beautification Department), the activity of transporting of public containers from the TSs to the landfill has frequently been disrupted due to damage of the skip-loaders. The informants have also made it clear that the skip-loaders are usually off-duty because of various reasons and are encountered by unnecessarily longer downtime. Owing to the frequent damage and longer downtime of the skip-loaders, the local collection trucks are forced to directly transport wastes from collection posts to the landfill subsequent to the deal made with the municipal authorities

In addition to the questionnaire survey, data pertaining to solid waste collection service has been collected through interview from the key informants and, as usual, analysed using the qualitative data analysis software (Atlas ti version 7).

The report of the qualitative data analysis shown in Box 5 focuses mainly on two big issues coded differently. These are, first, the communities' access to solid waste collection service and collection service coverage, and second, the quality of collection service delivery. It is remembered that collection system in the study areas and other urban areas of the Region is kerbside collection system and are outsourced to MSEs or private enterprises. In both urban centres, settlements are expanding outward and thus the demand for service is expanding parallel to the geographical expansion. To meet the demand for collection service in the new settlements, the local governments are trying to involve as many MSEs as possible in the collection activities.

Box 5. Output: Solid Waste Collection Services

Solid Waste Collection Services

Contents

Solid Waste Collection Services	253
Code: SWcoverage {10-0}	254
Code: Swdelivery {9-0}	261

Code: swcoverage {10-0}

P 1: I-SB1-UC1.rtf - 1:4 [Researcher: How do you evaluat..] (9:12) (Super)

Codes:[swcoverage - Family: SW: Collection Services]

No memos

Researcher: What types of collection system do you specifically use? How do you evaluate the extent of collection and transportation service coverage in your city/town? What basic challenges like disparity, interruption of services, etc and opportunities are prevailing in the collection and transportation services in the city/town??

Interviewee_1: As the city is expanding horizontally, new settlements and neighbourhoods are continuously being created. For example, very huge new neighbourhoods have been created within the last three to four years such as *Adiha, Daero, Lachi*, etc. The waste management office has tried to cover these and other newly created neighbourhoods with collection services. A new micro and small enterprises (MSEs) are organized and involved in door to door collection services. The rising interest of MSEs to be involved in waste collection and other similar activities from time to time has been very promising in Mekelle city.

As per the standard of our Region and the Federal Government, there should be at least one collection truck within one *Kebeles* (the smallest administration unit). Accordingly, the Office of Sanitation and Beautification has tried to sign contract with new collection groups in response to the spatial expansion and the growing quantity of waste generated in the city, even though we have not yet met the standard.

Wastes collected from door to door are emptied to the public containers sited in the transfer stations and are thought to be collected after 30 minutes and transported to landfill through skip-loaders. However, because of the frequent damage and longer downtime of the skip-loaders, the local collection trucks are, through immediate negotiation or predefined agreement reached at with the respective MSEs, made to be involved in direct waste transportation activities.

P 2: I-SB2-UC1.rtf - 2:5 [Researcher: What types of coll..] (6:10) (Super)

Codes:[swcoverage - Family: SW: Collection Services]

No memos

Interviewee_2: The collection system being used in Mekelle is a door to door collection. Though the door to door collection system may refer to different options, the system that currently is used involves that receptacles are kept within the premises of the generators till the collection crew horns to notify their advent for collection. Then the house owners will bring their receptacles to collection trucks. This implies that what so ever the collection point is distant and the waste container is big, it is the duty of the residents to carry and bring to the collection point and lift up to the truck. And then the collection crew is supposed to empty and return back the receptacles to the respective households immediately.

Researcher: How do you define the touring line, collection points and depot?

Interviewee_2: There is no system as such to define in detail the collection route, collection point, and depot. The collection groups are simply assigned to neighbourhoods based on their application. Then it usually is up to the collection crew or the drivers of the collection trucks to define the collection tours, points and depots depending primarily on convenience to them. But it was the task of the office to define and determine the collection routs, points and depots bearing in mind the advantage of the beneficiaries. Likewise, the collection schedule and collection frequency are defined by the office in consultation to the standard. Recently, the collection frequency has been raised from once in a week to twice a week for residential areas. Likewise, for business houses it is three times a week. This standard is basically defined taking the volume of waste that could be generated into consideration. The collection groups (MSEs) have signed the agreement to comply with the standards and guidelines. When it comes to reality, however, the breaking of schedules and programs has become a usual phenomenon. There are frequent noncompliance to the standard due to problems linked with both the collection groups and the SB Department. The cancellation of collection programs is not unusual due to various reasons.

The collection schedule is also one point of disagreement between the collection service providers (MSEs) and recipients (the society). The collection schedule was fixed to be 6 Am to 11 Am in the morning and 3 PM to 5 PM in the afternoon. But due to the increase in the volume of waste generated, it has been decided to be held on the whole day (06 Am-06 PM). The community, particularly those who are employed and have no housemaid at home, needs to get service out of working hours such as early morning (before 1:30 AM) and in the late afternoon (after 05:30 PM). But I argued that it would be very difficult for the collecting

groups to serve the whole community only during non-working hours given that the working hours are commonly between 08 AM-05 PM from Monday to Friday. Similarly, the weekends (Saturdays and Sundays), are not enough to cover the whole community of the city. Such types of problems might be resolved when the standard, one collection truck for one *Kebeles*, is fulfilled. In other words, such problems could only be solved if the number of the MSEs involved in waste collection is big enough or if their collection capacity is improved.

P 2: I-SB2-UC1.rtf - 2:8 [Though I personally believe th..] (21:22) (Super)

Codes:[swcoverage - Family: SW: Collection Services]

No memos

Though I personally believe that it is not much serious, it is difficult to say that there is parity or equity in service delivery among the residents. There are certain areas, particularly on the outer part of the city or on the margin of the city and in areas where the *nebbar tihizto* areas are available, that receive no or limited collection services due to various reasons, of which accessibility problem is vital. Moreover, a slight problem of sanitation in the centre of the city (and along the main streets) could easily expose all concerned bodies than it is in the outer part of the city. And one important cause for disparity between the centre and outer city is the difference in the responsiveness of the community and availability of other options. When a program is cancelled the community at the outer part of the city are less responsive which might be due to the presence of other options (though it is illegal) such as open areas for dumping than in the inner city.

The disparity between residential areas and business areas is plainly in place; that is why the number of collection days allowed for business areas and residential areas vary; business areas are allowed to receive collection service three times a week whereas for residential areas only two days per week is allowed. This practically witnesses that commercial areas have got better services than residential areas. In fact, this is because business houses are thought to generate more wastes than residential houses. The other disparity which is slightly observed in Mekelle city is between those settlements with and without public institutions and organizations. There is a tendency to visit more frequently to areas nearer to institutions or organizations mainly because certain institutions could provide them extra payments.

P 3: I-SB3-UC2.rtf - 3:6 [Researcher: How do you evaluat..] (5:8) (Super)

Codes:[swcoverage - Family: SW: Collection Services]

No memos

Interviewee_3: Currently, collection system used in Adigrat is a door to door one. Collection crew with their trucks move round the town and residents are thought to bring their receptacles to the nearest collection point to empty. The collection crew visits beneficiaries' houses as per the standard that is twice a week to the residential areas, and thrice a week to commercial ones.

There were six tractor carriages giving collection services to the whole town. But due to damage, it is only one tractor carriage and two rented medium sized trucks which are giving services. As per the standard, one collection truck for one *Kebeles* is needed. However, it is only one truck serving two *Kebeles*. The frequent breaking down of trucks and thus breaking of collection programs are among the most challenges of the department.

Because of infrastructure (mainly road) problems certain settlements are not totally receiving collection services. The rural settlements which are recently included into the town administration are almost entirely out of the collection services (are not beneficiaries of collection services).

P 3: I-SB3-UC2.rtf - 3:8 [Researcher: Don't you think tr..] (10:11) (Super)

Codes:[swcoverage - Family: SW: Collection Services]

No memos

Researcher: Don't you think transfer station is necessary bearing in mind the slow moving collection tractor carriage and the distance of the landfill?

Interviewee_3: Transfer station is not preferable facility in our town due to the bad situation observed in Mekelle's transfer stations. The environmental and social problems could overweigh the benefits of transfer stations. And tractor carriage is more or less out of function mainly because of damage and the collection and transportation activities have already outsourced to cooperatives (MSEs). If they are repaired, they might give only emergency services during failure of the ISZU collection trucks.

P 4: I-SB4-UC2.rtf - 4:4 [Researcher: What types of coll..] (4:5) (Super)

Codes:[swcoverage - Family: SW: Collection Services]

No memos

Interviewee_4: The collection system is door-to-door. The collection crews collect waste from residents and from streets and pile in certain collection points till the collection trucks or tractors arrive. The main task of the SB is to control the collection crews whether or not they have collected wastes from residential houses as per the program, and the streets whether they have been cleaned by the residents according to the 20 meters radius principles. There were six tractors, of which one is assigned to slaughter house, donated by non-governmental agency. However, mainly due to damage and administrative problem (related with fuel supply and maintenance), the tractors are becoming frequently out of function. Indeed, there is no a system of defining collection points and collection routes mainly due to shortage of collection trucks. During shortage, the collection truck(s) or tractor(s) is/are assigned to the worst area(s) instantaneously. There is no as such a schedule or program to be implemented. Besides to the shortage of the collection tractor carriages, the long distance to travel to the new landfill, which is about 11kms far from the town, further toughen the waste collection problem of the town. Either there should be transfer stations very close to the collection points, or there have to be large and very fast trucks that could make more turnovers within a day.

P 4: I-SB4-UC2.rtf - 4:7 [Researcher: Are disparities cl..] (17:18) (Super)

Codes:[swcoverage - Family: SW: Collection Services]

No memos

Researcher: Are disparities clearly observed in collection services provision and/or controlling and inspecting activities among different social groups or communities?

Interviewee_4: It is not unusual to come across disparities in service delivery among different areas in the town. The disparity in services among residential and commercial houses is plainly observed. Commercial houses or areas are visited by collection crews more frequently than the residential areas. In other words, the collection frequency standard for commercial areas is on a minimum three times a week whereas for residential areas it is twice a week. Likewise, the collection groups give additional services to organizations and institutions like Adigrat University and the Adigrat Zonal Prison and thus receive additional payments. The collection groups are paid by the municipality, but they also make deals privately with business establishments and institutions to render them additional services

with additional payments. The office of municipality is actually lenient to such practices because it believes that it could motivate and encourage the collecting groups or cooperatives (MSEs) to be widely involved in waste management. But I personally feel discomfort because it overrides the right of communities who are unable to provide tips or bonuses to collection groups to get satisfactory services as per the schedule.

P 5: I-SB5-RC1.rtf - 5:1 [Researcher: What types of coll..] (1:4) (Super)

Codes:[swcoverage - Family: SW: Collection Services]

No memos

Researcher: What types of collection system is used in the urban centres of the region in general and Mekelle and Adigrat in particular? How do you evaluate the extent of collection and transportation service coverage in Mekelle and Adigrat? What basic challenges like disparity, interruption of services, etc and opportunities are prevailing in the collection and transportation services in the city/town?

Interviewee_5: The collection system in all urban centres of the Region is door to door. And in most of the urban centre, collection activity is outsourced to micro and small enterprises. When compared to most urban areas of Ethiopia, we believe that Tigray has better collection and handling system mainly due to the awareness of the community and the 20 meter radius principle introduced and implemented in all urban areas. Every resident is responsible to control and keep clean the areas within 20 meters radius of his/her house. SB workers at every *Kebeles* are responsible to conduct inspection every day in their respective territory.

But it is clear that the collection system has faced many types of challenges. Usually, the MSEs are complaining for they are not paid on time by respective urban centres including Mekelle and Adigrat attributed to budget shortage. Moreover, unhygienic and substandard collection vehicles and equipments (substandard) are part of the problems related to collection services. Likewise, most of the collection and transportation vehicles and all carts have no cover and thus drop litters in streets while they are travelling to landfill or moving around for collection in the town or city. Likewise, while they are travelling inside the waste containers, one can imagine how risky and grave the problem could be to the collection crews.

With regards to transfer stations, it is only Mekelle which is bestowed with the right to

establish transfer stations. But, it is up to the city administration to decide the number and site of the transfer stations needed. It was permitted taking the size of the city, and the distance from the different edges of the city to the landfill into consideration. The main purpose to establish open transfer stations was to ensure fast and reliable collection service to residents and to conduct sorting, reusing and recycling (composting) activities in them. But, the likelihood to establish transfer stations in other urban centres is not closed; other towns could claim to establish transfer station if conditions permit and criteria are fulfilled. For example, in Adigrat the new landfill is about 11km far from the town; so it could claim and conduct feasibility study to establish transfer stations.

P 5: I-SB5-RC1.rtf - 5:18 [In the case of transfer statio..] (12:12) (Super)

Codes: [swcoverage - Family: SW: Collection Services]

No memos

Researcher: What types of facilities, equipments or machineries are seriously deficient in the urban areas in general and Mekelle and Adigrat in particular?

In the case of transfer stations (TSs), they are only found in Mekelle. When the TSs of Mekelle is evaluated in terms of the benefits they are conferring to the city and their negative sides, it is more likely that their detriment (negative side effect) overweighs. Besides, due to the damage of the skip loaders many of them have been out of function for long time and the containers sited in the transfer stations have been left uncollected for so long time. Moreover, they are not properly managed and the containers are not collected on time as per the guideline (30 minutes after waste is emptied to the container).

P 5: I-SB5-RC1.rtf - 5:19 [Researcher: What types of faci..] (9:10) (Super)

Codes: [swcoverage - Family: SW: Collection Services]

No memos

Researcher: What types of facilities, equipments or machineries are seriously deficient in the urban areas in general and Mekelle and Adigrat in particular?

Interviewee_5: The types of collections vehicles are not of standard. The Isuzu trucks, tractors and even carts are used to collect the waste from door to door and transported to the landfill. Except in Mekelle which uses skip loaders to collect and transport the public containers sited in the transfer station to the landfill, all urban centres of the Region use Isuzu, open trucks

and /or tractor carriages or horse-driven carts for collecting and transporting waste.

Code: swdelivery {9-0}

P 1: I-SB1-UC1.rtf - 1:5 [In fact, for the problems appe..] (13:14) (Super)

Codes:[swdelivery - Family: SW: Collection Services]

No memos

Researcher: Have you observed any constraints on the solid waste collecting groups' services provision?

In fact, for the problems appearing during the door to door collection service delivery, both the beneficiaries and the service providers accuse each other. The service providers in Mekelle city have complained that some residents especially the youngsters treat us as useless and generally they do not respect us. Moreover, the youngsters sometimes attempt to brawl us.

Likewise, the community raises several complaints. Some of these complaints are the collection crews do not return back the waste containers or receptacles to the respective owners, and sometimes the receptacles they return back to the owners are someone's else which are very old and useless; they do not whistle properly to let all the beneficiaries know their arrival at the collection point, they rather rush to go leaving the beneficiaries behind carrying waste. Moreover, beneficiaries complain that the collection service programs are frequently cancelled and the collection crews are ill-mannered. Our office has observed and verified that both parties (service provider as well as recipients) do have their own problems. To minimize such types of problems, we frequently arrange a meeting and discuss with the collection groups (MSEs) on the complaints coming from a number of residents. We also tried to orient the collection groups about the quality of behaviours they had to be shouldered. The service is outsourced to MSEs and we frequently discuss with them regarding their performance. And we identified big problems in certain areas and collection groups.

P 2: I-SB2-UC1.rtf - 2:1 [The door to door waste collect..] (2:2) (Super)

Codes:[swdelivery - Family: SW: Collection Services]

No memos

The door to door waste collection activities have been totally performed by MSEs. But secondary collection or transportation from transfer station to the landfill and the overall management tasks of the transfer stations and landfill are carried out specifically by the Centre Department of SB. In fact, due to frequent damage and shortage of secondary collection trucks (the skip loaders), most of the secondary collection and transportation tasks have been handled by the MSEs. The door to door collection trucks are transporting the waste directly from the collection points to the landfill. This is solely done to fill the gap created due to the frequent damage and unnecessarily longer downtime.

P 2: I-SB2-UC1.rtf - 2:6 [Researcher: Do you have observ..] (11:15) (Super)

Codes: [swdelivery - Family: SW: Collection Services]

No memos

Researcher: Have you observed any constraints on the solid waste collecting groups' services provision?

Interviewee_2: Complaints are coming even to the centre in addition to those going to the sub-cities and *Kebeles*. The collection groups have diverse problems; some of them are related to missing from the programs (cancellation of collection programs), rushing and escaping quickly leaving beneficiaries behind (they do not give enough time to beneficiaries to bring and empty their receptacles into the collection trucks), they do not whistle properly so as every residents around the collection points are able to hear and bring their waste on time, etc. The community also seriously accuses the collection crews for they are misbehaved and refuse to return back the properties (receptacles) of the residents. The wastes dumped on open areas, though it is part of their duties which is boldly stated in the contractual agreement, are usually overlooked by the collection groups. And most of the problems are aroused mainly because the contract takers (the group that signed in the agreement) are not involved themselves in the collection activities; instead they carry out the collection works by recruited persons.

Researcher: How do you assign the MSEs in to sub-cities? Do you consider the capacity of the MSEs vis-à-vis the volume of waste generated from the sub-cities? And do you have a mechanism by which you could control whether or not they are discharging or accomplishing their duties and tasks properly?

Interviewee_2: MSEs are simply assigned to sub-cities based on their application and

preferences. In fact, there could be clear differences in capacity (in terms of collection trucks and workers and experiences they have) among each of the MSEs. But all the MSEs do not comply with the standard, one collection truck to one *Kebeles*. Regarding to controlling and monitoring works, previously it was totally the duty and responsibility of the landfill manager to record their attendance and report to the Centre for payment. But it has created additional workload to (burden on) the landfill manager and becomes beyond his capacity. Then, the whole responsibilities of inspecting and controlling tasks have been given to the *Kebeles* level Sanitation and Beautification unit. However, all information we have collected from beneficiaries and from formal reports indicate that the waste collecting groups are not properly discharging their duties (service delivery) to the community as per the contractual agreement. Usually, they focus more on business making, intending to inflate (maximize) the number of turnover they could make but not on whether they have collected the right volume /magnitude/ of waste as per the agreement and the standard.

Moreover, they are not involved themselves on waste collection activities. But they are using employed labour instead of participating themselves, which is out of the agreement and the principle to outsourcing the waste collection and other activities related with waste management to micro and small enterprises (MSEs). This implies that the group members of the MSEs are considering themselves as employers but not as employees, so they are trying to maximize their profit by employing cheap labour provided with poor services (like safety wears, hygiene materials, detergent materials, etc) to the employees. This has been the main cause of dissatisfaction of collection crews. The problems are created mainly due to lack of consistent and rigorous controlling and regulating system by the responsible bodies. Though there is a program to discuss with the MSEs regarding the quality of collection services they are providing and challenges faced during operation from both the service recipients and providers sides, the problem has not yet been solved.

P 2: I-SB2-UC1.rtf - 2:7 [Researcher: Have you observed ..] (16:20) (Super)

Codes: [swdelivery - Family: SW: Collection Services]

No memos

Researcher: Have you observed any disparity in service delivery (collection service and regulating and controlling activities) among different social groups residing in different neighbourhoods or parts of the city?

Interviewee_2: One of the strong side of the collection groups is that they are courageous enough to be involved in the most socially ostracized and unsafe occupation and able to make money. Despite the fact that it is socially unacceptable activity, the collecting groups are trying to promote the waste management endeavours though deferent mechanisms. They convey messages using different flyers, posters and mottos posted on their collection trucks that could raise environmental awareness of the community.

On the other hand, solid waste collecting MSEs do have a range of weaknesses. By forgetting their duties and responsibilities, MSEs chase only businesses. For example, giving extra services to those who call and promise them to pay extra money (tips or bonuses), leaving or cancelling the program of someone else has been a common phenomenon. For they are simply focusing only on the number of trips they travel (because payment is made based on the number of trips they travelled), it is more likely for the collection groups to transport wastes to the landfill using the collection trucks which have not yet been fully loaded.

Besides, the problem of declining to return the properties (receptacles) of the beneficiaries is among the most common types of complaints that have been directly reported to the Centre. Moreover, program cancellation, delay, and misbehaviour are major mistakes committed by the MSEs.

I come to know that there are disparities in service delivery among different social groups living in different neighbourhoods while I met the communities in different occasions. There is a tendency to visit more frequently to some people's houses and establishments who promised to pay them more privately.

P 2: I-SB2-UC1.rtf - 2:9 [Researcher: When you consider ..] (23:28) (Super)

Codes: [swdelivery - Family: SW: Collection Services]

No memos

Researcher: When you consider the geographical or spatial extent of Mekelle, the location and distance of the existing landfill, and the present function, distribution and availability of space for transfer station, do you think Mekelle needs five transfer stations?

Interviewee_2: Transfer stations are opened for various purposes, among which are to speed up collection frequency; to reduce cost (by reducing hauling distance to landfill); and to carry out

waste sorting activities into different categories. But when it comes to Mekelle city, the transfer stations were established primarily to speed up door to door collection and thereby reduce transportation costs to landfill. But when the location of the existing transfer stations, the location and the distance of landfill from the city, the status and types of secondary collection trucks, the availability of appropriate space in the city, and the transfer station management system are considered, I believe that at present Mekelle does not need transfer stations, if not only one that might serve Quiha sub-city.

The locations of most of the transfer stations do not comply with the set standard., Either they are close to settlements or to environmentally sensitive areas like water courses, artificial water bodies (e.g. *May Dubba* pond). Due to lack of appropriate spaces, two sub-cities (Addi Haqi and recently Kedemay Woyane sub cities) have no transfer stations. Moreover, for the reason that skip loaders (secondary collection trucks) are frequently damaged, the public containers placed in the transfer stations stay uncollected for so long time and hence create unpleasant odour which could be detected from a distance.

Secondary collection (transportation) of waste was thought to be handled by the SB's collection trucks using the skip loaders. But because of similar reasons, i.e., shortage and frequent damage of trucks, the MSEs who are involved in primary collection have covered almost the whole secondary collection activities; they directly transport the waste collected from door to door to the landfill.

Researcher: What major problems do you observe on the secondary collection?

Interviewee_2: In addition to the shortage and damage and unnecessarily long process to repair the collection trucks, there is a misfit between types of collection trucks (skip loaders) and public containers found in the transfer stations. Basically, there are two types (models) of skip loaders and public container; one type of public container is fit only to one particular type or model of skip-loader. This means that the skip loaders of a particular model could not pick up all types of public containers placed in the transfer station. When the skip loaders of a particular type are out of use, all the public containers fit to such truck model will remain uncollected.

P 3: I-SB3-UC2.rtf - 3:7 [Certain problems are created d..] (9:9) (Super)

Codes:[swdelivery - Family: SW: Collection Services]

No memos

Certain problems are created during collection service delivery by both service providers and recipients. The collection crew is accused of rushing, intolerance to serve residents who come late to empty their receptacles. There is also a tendency to drop waste with their containers on road sides by residents when the collection crews leave them unserved. If they missed the collection truck, residents are not willing to come back with their waste. But these types of incidences are not common; we are trying to control the waste collecting crews by inspecting the unsigned waste bills of residents. We have also a fixed program to discuss with the collection groups.

P 4: I-SB4-UC2.rtf - 4:3 [Researcher: Are there complain..] (6:9) (Super)

Codes: [swdelivery - Family: SW: Collection Services]

No memos

Researcher: Are there complaints frequently heard from the community in relation to waste collection service? If there are, what are they?

Interviewee_4: The key problem is the long delay of the collection trucks to visit door to door as per schedule. Moreover, the collection truck driver's impatience while they are collecting from door to door annoys the community; they rush to go before all residents empty their receptacles onto the truck or tractor carriage, and residents run after the trucks carry their wastes.

Regarding the frequency of visits, the standard is three days per week for business houses, and two days per week for residential houses. In Adigrat, this standard was being practiced more or less fully for sometime just after the first advent of the collection tractors. But later, as the tractors started to be damaged, the frequency of visit to the different neighbourhoods started to be disrupted frequently. For instance, currently, it is only one truck obtained through rent that is giving service to the whole town.

The complications in administrations have also been part of the problem. Complications linked with fuelling and maintenance of the collection trucks (tractors) has contributed considerably for collection trucks to be out of duty. Partly due to this problem, it has been difficult to comply with the collection time schedule as per the predefined standard. Delay for only hours is not unusual or uncommon phenomenon even after immediate announcement has been done. It is very difficult to stick on the program let alone for hours but also for days,

and it is very difficult to announce with certainty when the collection trucks could visit residents and neighbourhoods. It is very difficult to state let alone the time when but also the day when the collection trucks could visit residents and neighbourhoods.

P 4: I-SB4-UC2.rtf - 4:6 [Researcher: How do you evaluat..] (15:16) (Super)

Codes: [swdelivery - Family: SW: Collection Services]

No memos

Researcher: How do you evaluate the satisfaction of residents by the service they receive?

Interviewee_4: It might be very difficult to evaluate the level of satisfaction of residents because it highly varies from time to time. When the collection tractors or trucks were operational on duty, the satisfaction of the community would be good but when they are damaged as it is true these days, the community became highly dissatisfied.

P 5: I-SB5-RC1.rtf - 5:2 [Researcher: How do you evaluat..] (5:8) (Super)

Codes: [swdelivery - Family: SW: Collection Services]

No memos

Researcher: How do you evaluate the quality of service provided and the satisfaction of the beneficiaries in the urban areas of the region?

Interviewee_5: Due to various reasons, the urban communities in almost all the urban centres of the region are not satisfied by the collection services provided due to problems connected to the MSEs and the local administrators including the Sanitation and Beautification Departments. The services provided by the MSEs may have a variety of constraints in almost all the urban centres but it is higher in the big city and towns including Mekelle and Adigrat. Cancellation of collection service programs, visiting beneficiaries' houses in inconvenient time, the personal behaviour of the collection groups (rushing, denial of adequate time to the beneficiary to bring his/her receptacles to empty, inadequate notification of their advent, etc) are among the most common problems particularly in Mekelle city. Though it is not as serious as in Mekelle, some of these constraints are also prevailing in other urban centres of the region. According to the MSEs groups, some of the problems are related to insecurity, inconvenience and impracticality to cover the whole beneficiaries' houses only during early morning (before 7:30 AM) and late afternoon (after 5:30 PM). Early morning is also inconvenient to beneficiaries. The community is not willing

and cooperative to wake up early in the morning when the collection group whistles; they also raise the safety or security issues. On the MSEs side, they raise safety and security issues while they are going round within the city and to the landfill dark. Likewise, the sanitation and beautification workers (landfill administrators) could not avail themselves early in the morning and at night in the landfill. Moreover, the numbers of MSEs assigned to collect are so few that they could not pick up the whole waste expected to be collected within a day.

The government and non government institutions and big hotels are instructed to collect their waste by their own collectors. But usually, they deal privately with the MSEs who have already engaged in collection duties from residential and commercial establishments. This caused the MSEs to break collection programs of the residents and business houses and visit to institutions and big establishments like hotels instead. There is also reliable information that the MSEs visit more frequently to those who offer them tips.

Otherwise, it has been decided that commercial houses and residential houses should get collection service three days and two days per week, respectively. MSEs are not abided by this rule; institutions and big commercial establishment like big star hotels should get service using private collection facilities and manpower or privately signed contracts with the MSEs. Though MSEs are allowed to deal with the institutions privately to offer them service out of their regular programs, the practice is different. By cancelling their regular programs, MSEs visit the institutions and big hotels. They are not in most cases obedient to their agreement and to the instructions of the responsible bodies.

However, because of various reasons, the key informants agreed that there were many settlements which could not be accessed by the collection fleets mainly because of lack of road access, and shortage and limited capacity of the MSEs. Besides, relatively remote areas which are usually newly incorporated settlements and traditional settlement have limited or no access to collection services. The key informants of the two urban centres have also acknowledged the problem of access to services as per the standard due to the shortage of collection fleets. The standard is one collection truck to one *Tabia* or *Kebeles*. But it has not been possible to fulfil the standard of the region as well as the country that oblige to use or allot one collection truck per one *Kebeles*. In Mekelle for instance, the MSEs are assigned to the sub-cities simply based on their application but not in view of

their capacity (at least number of collection fleets they could allocate) and population size (potential waste generation rate) of the Sub-cities. As a result, collection service frequency is fixed as only twice a week for residential areas and thrice per week for commercial areas.

Regarding to the transfer stations, the key informants have pointed out that Transfer stations' negative sides outweigh positive sides though they are only found in Mekelle city. Mainly because of the frequent damage of the skip loaders, and their poor management and improper location, transfer stations have been sources of serious environmental and social problems.

The other serious problem observed in collection service delivery is the disparities among different groups and settlements (discussed in detail in sub-chapter 5.2.4). The informants have recognized the disparities among the residents either due to difference in land use types (between commercial areas and residential areas, institutional areas and others, etc), their location or distance from the centre and accessibility (between inner and outer part of the town or those very close to and far from main road), settlement type (modern settlements and traditional settlements), etc.

The issue of quality of waste collection service delivery has also been raised to the key informants. They said that they have usually arranged discussion and evaluation programs with the MSEs, and have come to know that there were basic mistakes committed by the MSEs, such as cancellation of collection programs, inadequate notification and rushing, ill-manneredness, dissatisfaction with their jobs.

4.2.3.3. Solid Waste Disposal System

Waste management involves several activities of which collection, transportation and disposal of waste are the most important ones. Waste disposal is placed at the bottom of the waste management hierarchy. This implies that the ultimate fate of waste generated is disposal. Waste disposal is the last but not the least element in the waste management system. It would be very difficult, if not impossible, to ensure effective and efficient waste management system anywhere unless wastes are deposited and managed properly in a

properly selected place (disposal site). Thus, disposal sites are essential part of any waste management system; the area of land onto which waste is deposited is commonly called landfill (Narayana, 2009).

Disposal sites are, therefore, essential part of any waste management system. Solid waste disposal is of great concern and challenge to decision makers, practitioners and researchers owing to the serious environmental, social, economic, and even political repercussions associated with improper disposal of wastes. The problems of disposal might be linked with diverse issues but the most important ones that received the attention of the researcher are site selection and operation or management issues.

One of the major problems in waste management is linked with the selection of the appropriate site for waste disposal. Disposal site selection is a crucial issue in solid waste management mainly because the consequence of inappropriately selected waste disposal site is critical. Identifying the best disposal site is the first and the most important step for pollution control and minimizing environmental hazards in solid waste management. However, the criteria used for site selection are many and are very complex. Disposal site selection is a difficult, complex, tedious, and protracted process requiring evaluation of many different criteria since it has to combine social, environmental, technical, and financial factors (Nas, et al., 2010).

The importance of disposal site selection in solid waste management has been well noticed by different researchers. For instance, Khorram, et al. (2015) have pointed out that Convenient Landfill Site Selecting (CLSS) is one of the most important choices in the process of secured and controlled waste management that may play a significant role in reducing the environmental contamination. Identifying the best disposal site is the first and the most important step for pollution control and minimizing environmental hazards in solid waste management.

Nas, et al., (2010) have also pointed out that the environmental factors are very important because the landfill may affect the biophysical environment and the ecology of the surrounding area. Economic factors must also be considered in the sitting of landfills,

which include the costs associated with the acquisition, development, and operation of the site. Social and political opposition to landfill siting have been indicated as the greatest obstacle for successfully locating waste disposal facilities.

The researcher has, therefore, tried to evaluate the disposal site of both the study area based on these criteria but not exhaustive. The old (the one which was functional before 2016) and the new (which comes into function since 2016) disposal sites of Adigrat and the existing landfill of Mekelle have been considered in this evaluation. There are a wide range of criteria which could be employed to evaluate and select the location of a best disposal site. However, the researcher has tried to employ only few manageable criteria related to environmental, socio-economical and technical (feasibility attributed deficiency in expertise and simplicity) issues. To evaluate the sites, the researcher has employed the information obtained from field observation and key informants and, in some cases, records where possible.

Though not exhaustive, the criteria adopted from the materials entitled 'Solid Waste Management' published by Agrawal & Gupta (2005) and a research article published in the '*Environ Monit Assess*' journal by Nas, et al. (2010) have been used in this research to evaluate the location of the disposal sites of Mekelle and Adigrat. These criteria are listed, of course with some minor modifications, as follows: distance of the disposal site from densely settlement (mainly urban settlement), socio-cultural and historical sites; land use specifically agricultural use and water bodies and courses; site accessibility and transport (transportation routes and railways); topography; and soil. Most of these variables have distinct parameters and thus the researcher has tried to employ them where possible (Nas, et al., 2010).

As indicated earlier, the disposal site of Mekelle city is located nearly 8 km west of the city. It has been serving since 2010 after the *Harena* dumpsite was abandoned. Likewise, Adigrat's old disposal site was (before 2016) located within the urban proper of Adigrat town, specifically in the water gorge locally known as '*Huga*' in *Kebeles* 01 (in the south-east of the town). It was serving for so long time but abandoned in 2016 when the new landfill started to serve.

The researcher has gone through all these criteria one by one to review the extent the disposal sites do comply with these criteria. The first criterion examined was the distance between the disposal site and the (urban) settlements and agricultural area (if any). With respect to the criteria of 'distance from settlement', the researcher has observed that the problem of distance has been aggravated by the direction and strength of the prevailing wind. There are few rural settlements close to the landfill. A few settlements in the south and southeast direction are relatively more close to the landfill, about 100 meters far from the landfill fence. It has also been identified that Mekelle's landfill is largely situated in protected greenery areas.

In the case of Adigrat's old dumping site, it is totally located amidst settlements such as residential houses and public institutions (hospital, school). Similarly, the new disposal site in Adigrat is totally located within the geographical boundary of other local administrative unit. This implies that there could be a possibility to be a source of conflict between the two administrative units if it is not properly managed. Peasant houses are almost 150 meters far from the landfill. However, the northern and north-eastern and western edges of the landfill have touched the property line (farm lands) of many peasants.

On the other hand, Mekelle's disposal site is situated at the western edge of the city where the rural and urban settlements have approached the property line of the disposal site in its southern, south eastern and eastern direction. As it can be understood from the explanation of the experts, the reason why the criterion of 'being distant from settlement' is unmet by the disposal sites selection of both Mekelle and Adigrat is different. In the case of Mekelle, it is due to the afterwards illegal encroachment of settlements. Unlike to the case of Mekelle, in Adigrat, most of the residential houses situated around the new disposal site have been there long before the establishment of the disposal site. As a consequence of proximity to the settlements, the experts pointed out that the municipality has entertained serious complaints from the residents suffering from severe social and environmental problems such as foul and litters driven by wind and carried by scavengers including dogs.

The second criterion examined against the disposal sites is proximity to water bodies and watercourses. Despite the universal restriction made on the utilization of river courses and water bodies for waste disposal, knowingly or unknowingly this criterion has been overridden for many years in Adigrat town. The old disposal site of the town was situated on the main river course crossing through the town. Many of the key informants from the Sanitation and Beautification sector of the town have no clear information on how this old disposal site is selected. They are not even sure whether a formal site selection procedure have been held on and has been officially allowed. However, the researcher has been aware of that new disposal area was established by local administration in collaboration with non-governmental organizations. In fact, the new landfill is relatively better with respect to its effect on water bodies, except that there is doubt that seepages could travel up to boreholes found in the southern lowland area.

Though the problem is not as severe as that of Adigrat's old disposal site, the Mekelle's landfill has the possibility to pollute the surface water in down catchment. Mainly owing to the fact that it is situated on a relatively upper ground where its elevation is falling down rapidly to the west and northwest direction, the run-off which drains from the disposal site and surrounding areas could reach the river courses after short distance's travel.

As the disposal sites are examined in terms of their 'distance from socio-cultural and historical sites' criterion, the researcher has come to know that the previous landfill of Adigrat did not comply with this criterion. At least two institutions, Adigrat Zonal Hospital and Agazi Secondary and Preparatory School are situated very close to the disposal site where Adigrat Hospital is found on the top of the gorge and Agazi Secondary and Preparatory School is situated downward, about 200 meters westward. With respect to this criterion, the new landfills of Adigrat and Mekelle have no problems.

In connection with the criteria of accessibility (in terms of hauling cost) and nature of road, the study has not revealed significant problem in both cases. It is well known that the criterion of accessibility is particularly needed in order to consider the cost of transporting waste to the landfill from the collection points. As it has been indicated earlier, the old disposal site of Adigrat is located almost in the centre of the town, nearly 2 kms far from

the centre of the town towards the south. This implies that the hauling cost will be minimal. The main disposal site of Mekelle city is located on the western margin of the built up area (urban proper) of the city at about 8 kms distance. When viewed in terms of proximity to the collection areas, the landfill, its being located on the western margin, is generally more preferable than its being in the northern, southern or eastern edge of the city. This is primarily because the north-south length of the city is longer than its east-west, and therefore any point at the northern and southern edge of the city could not be taken as location at the centroid of the collection areas of the city. In other words, when the radius from the centre to the outer edge of the city in all direction is measured, the shortest possible distance with relatively suitable topography would be to the western direction. In fact, the eastern and western edge of the city are somewhat similar in terms of physical distance to the collection points but due to the unsuitable topographic feature of the eastern edge, the western margin would be the best possible option for sitting disposal area. Therefore, the disposal site of Mekelle has no problem with regard to proximity.

The other issue related to transport is the nature or quality of the road. The nature of the road leading to the disposal site is particularly significant issue in determining the economic cost of transporting waste because poor quality of road and thus poor access causes to both delays of travel and damages of vehicles. Thus, access to the site should preferably be paved roads or all-weather unpaved roads (Nowak & Dwyer, 2007). When it comes to the study areas, except the old landfill of Adigrat, both the new landfill in Adigrat and Mekelle, qualify the criterion of 'nature of road', wherein the currently in use landfill site of Adigrat is located very close to the main asphalted road that runs from Adigrat to Zalanbesa; and, the road that leads to the disposal site of Mekelle is an all-weather road.

Land use compatibility is another criterion which determines the suitability of a site for waste disposal. Compatibility of the landfill use with the present and future uses of adjoining land areas is very essential requirement. The area where the disposal site of Mekelle is situated is generally identified as green area, reserved from any types of major construction activities. Thus, the vegetation around it, and which would come in the future could be beneficial to mitigate some of the environmental effects of the site. In recognition to the importance of vegetation, Nowak & Dwyer (2007) have pointed out that trees and

shrubs are planted to serve as a buffer; to reduce dust, noise, odor, and visibility problems, and for site beautification.

Moreover, the vegetation cover reduces or even eliminates wind and rainfall erosion of the landfill cover; improves aesthetic quality; and enhances moisture removal by way of evapo-transpiration. However, except the older site which is situated totally within the river course called *Huga*, the new landfill of Adigrat is located in agricultural area which has been a challenge for the local people to engage in agricultural activities.

Finally, two criteria which have been used to examine the suitability of the disposal sites of the study areas are topography and soil. The concern of topography may arise from different aspects but the researcher has dealt only with the slope of the disposal site. The importance of topography arises in part from the fact that rainwater will sleep easily on a relatively flat site. On the other hand, it may erode an excessively steep site. In either case, operational difficulties are created. It is generally recommended that the slope of disposal sites should not be too flat and too steep. This is not only because that excessively steep site creates difficulties to construct and maintain the site but also it causes high runoff and decreased infiltration which in turn allows the contaminants to travel greater distances from the disposal site. Likewise, disposal area sited in too flat lands would be affected by the higher flood (poor drainage). But disparity exists on the figure how steep it should be. For instance, slopes greater than 1% and less than 20% are considered satisfactory. However, others recommended 8% to 12% slope as an appropriate one. Slopes greater than 1% and less than 20% generally would be satisfactory (Nas, et al., 2010).

With respect to the criterion of topography such as slope, neither of the disposal sites of the study areas meets the criteria; Mekelle disposal site is excessively steep and high runoff in steep slopes is a usual phenomenon. On the other hand, ponds are created in the terraced areas during the raining season. The new landfill in Adigrat has no a better slope in terms of this criterion; it is located on a steep slope.

The other issue that needs to be addressed in the study regarding waste disposal is the operational and management aspect of the waste disposal site. Obviously, the problems related with the physiographic characteristics of the landfill could be aggravated by the poor management of the landfill. Based on their features and management system, disposal sites might be classified into three: the open dump sites or open landfill, semi-controlled or operated landfill and sanitary landfill. To identify which types of landfill system are practiced in these study areas and show how strong the problem is, it would be essential to characterize each of these landfill types. Accordingly, the researcher has come to know that open dumps are characterized as a land disposal site wherein solid wastes are disposed of in a manner that does not protect the environment, and is susceptible to open burning, and is exposed to the elements, diseases and vectors and scavengers. As a default strategy for municipal solid waste management, open dumps involve indiscriminate disposal of waste and limited measures taken to control operations of waste generation/ storage, collection, transportation and disposing as well as the environmental impacts of landfills. Open dumps pose significant risks to human health (including their cattle) and the environment. Such types of uncontrolled disposal sites are usually animal feeding areas, children playing grounds, sources of nuisance, gathering areas of wild animals, etc. Furthermore, open dump sites make very uneconomical use of space and often produce unpleasant and hazardous smoke from slow-burning fires; the present disposal situation is expected to deteriorate even more as, with rapid urbanization, settlements and housing estates encircle existing dumps and the environmental degradation associated with the dumps directly affect the population. Open dumps or open landfills, which are the most common in all developing countries, involve the refuse simply being dumped haphazardly into low-lying areas of open land. The second type of disposal system is Semi-controlled or Operated Landfill. It is designated site where the dumped refuse is compacted and a topsoil cover is provided daily to prevent nuisances. All kinds of municipal, industrial, and clinical or hospital wastes are dumped without segregation. This type of landfill is not engineered to manage the leachate discharge or emissions of landfill gases. The third type of disposal system called Sanitary landfill is used in developed countries and is the best landfill with the necessary facilities for interception and treatment of the leachate using a series of ponds. This type of landfill also has arrangements for the

control of gases from waste decomposition (Zurbrugg, 2003; Narayana, 2009; Tchobanoglous, 1993).

Thus, at least based on the features described above, it is possible to identify the types of landfill utilized in Mekelle and Adigrat. The older landfill of Adigrat owns almost all of the typical features of an open dump or open landfill. It is very simple and rudimentary disposal system. Dumping in open landfill was taking place haphazardly where no effort had been made to involve disposal site selection procedure. Moreover, it is characterized by indiscriminate dumping of waste, open burning, unpleasant and hazardous smoke from slow-burning fires, and no or limited measures to control the operation and environmental impacts of the land fill. Because of its severe consequences on environmental and human health and safety, open dumping of waste cannot be considered as a long-term environmental method of disposal. Some of the dangers of open dumping are health hazard to scavengers at the dump site, pollution of ground water, spread of infectious diseases, highly toxic smoke from continuously smouldering and foul odour from decomposing refuse (Ogwueleka, 2009).

Fortunately, Adigrat has built up a new landfill by the local administration in collaboration with a non-governmental organization, mainly the World Bank, and commenced its function in 2016. It is only Adigrat and Mekelle which have modern landfills in the region established at different times. They were built up with the assumption that they would be sanitary landfills. An effort has been made to maintain the quality of sanitary landfill in both landfills at least in terms of their physical and structural design.



Figure 13: The old dump site of Adigrat town left with no proper closure

Source: Photos captured during field observation, 2015/16

Notwithstanding the fact that, at least in theory, the disposal sites of Mekelle and Adigrat have passed through formal process of site selection, and certain efforts have been made

to fulfil the material (machineries) and facilities requirement of the landfills, both the city and the town could not maintain sanitary landfill. The structural design includes some of the modern environmental and human health and safety problems controlling systems like leachate controlling systems and liners. The landfill of Mekelle is fenced with concrete walls, whereas the landfill of Adigrat is fenced simply by barbed wire. There have also been meagre efforts to fulfil the basic machinery and facility requirements of the landfill.

Nonetheless, despite the need of the local administration to establish a modern landfill which is called sanitary landfill, the prevailing facts in the landfills confirm that they are far from being sanitary landfill. Even some basic features of an open dumpsite are clearly observed in the landfills. In fact, the problem of management is more severely observed in Mekelle landfill and in the Adigrat's former landfill former landfill of Adigrat has been in use for many years (nearly 10 years), where as the new one has yet served only for nearly three years. The occasional field visits made by the researcher to the landfills reveal that indiscriminate dumping of waste, open burning, unpleasant and disagreeable scene, uncontrolled scavengers and rag-pickers including under-aged children are typical features of the landfill in Mekelle. Similarly, some of these features like unpleasant and disagreeable landscape, terrible odour and nuisance; intermittently covering by soil, substandard layering system, lack of standard fence, etc. also characterizes the new landfill of Adigrat.

Specifically in Mekelle, during the rainy season, ponds are created and, coupled with the steep slope topography of the site, there are possibilities for runoff creation. Besides, the site manager has recognized that many of the basic operational activities required for landfill are missing. One of these missed operational activities is regular waste compaction works. This is mainly due to lack of machineries, facilities and infrastructures. Heavy-duty machineries like dozers, compactors, and excavators are among the key machineries required to properly manage the landfill. Nonetheless, the Sanitation and Beautification sector of Mekelle Municipality owns one loader only which is used to disperse and level the waste heaps. The landfill manager added that his office has been trying to rent machinery; yet it has rarely succeeded.



Figure 14: An interview with the landfill manager

Source: Photo captured during field observation, 2015/16

It is known that soil covering, which is one of the typical features of sanitary landfill, has enormous social and environmental values. It uses to control nuisances, to protect the environment, and to protect the health and safety of workers and the public. However, despite the presence of appropriate soil type within the landfill compound, regular covering of soil and compacting of waste is occasionally executed.



Figure 15: Rag-pickers visiting the landfill of Mekelle
Source: Photo captured during field observation, 2015/16



Figure 16: Loaders leveling the heaps of waste in the landfill of Mekelle City
Sources: Photo captured during field observation, 2015/16

It is these valuable operational issues that are missing or lacking attention in the landfills of both study areas. Mekelle being the capital city of the region, unlike its function, all these valuable operational activities are overlooked. Therefore, it can be argued that the landfill of Mekelle is not better than open dumping and too far from being sanitary landfill. It is not a typical controlled landfill as well. Merely because of these reasons, Mekelle's landfill is more unlikely to be sanitary landfills and, so long as it retains most of the typical features of open dumps, the environmentally and socially impacted area will continue to be widened.

In terms of accessibility (centrality) or proximity to the collection points, the western and southern end points of the urban proper of Mekelle are preferable for sitting the disposal site. This is because the east-west expanse of the city is shorter than its north-south extension. This means that any point in the western or eastern margin would be more accessible than points at the southern and northern margin of the city. But due to the topographic problem, where the eastern margin of the city is upland area forming a range of hills with steep slopes, it would be more sounding and less costly to locate the disposal site in the western margin of the city.

Box 6. Output: Landfill

Landfill

Contents

Landfill.....	283
Code: lfsite {4-0}.....	284
Code: lfstatus {5-0}.....	286

Code: lfsite {4-0}

P 2: I-SB2-UC1.rtf - 2:10 [Researcher: How do you explain...] (29:30) (Super)

Codes: [lfsite - Family: Landfill]

No memos

Researcher: How do you evaluate the location of and explain the criteria employed to select the landfill of your city/town?

Interviewee_2: The landfill of Mekelle is located about 7 kms west of the city. The site was selected almost 10 years ago, and its location is within the jurisdiction of Mekelle City Special Zone of Administration. The location of the landfill lies within the green zone area delimited by city Administration. But owing to the improper management, the environmental and social effects of the landfill are perceived in a wider radius of the landfill. Settlements (both rural and urban settlements) within few km radiuses of the landfill are affected by smoke blowing from the burning of waste dumped in the landfill. Smells from the landfill is also perceived as far as Daero neighbourhood and the nearby rural settlements.

P 3: I-SB3-UC2.rtf - 3:9 [Researcher: How do you explain..] (12:13) (Super)

Codes: [lfsite - Family: Landfill]

No memos

Interviewee_3: The landfill is newly established with the help of non-government organization; it started its function almost 2 years ago. It is located 11 kms north of the town. It is sited on the area about 300 meters east direction from the main Adigrat-Zalanbesa asphalted road.

P 4: I-SB4-UC2.rtf - 4:8 [Researcher: How do you explain..] (19:22) (Super)

Codes: [lfsite - Family: Landfill]

No memos

Interviewee_4: The previous dumping site (abandoned almost two years ago) did not comply with any of the dumping site criteria. The landfill is situated in one of the largest river courses of the town and it is surrounded in a close distance by residential houses. Besides, it was poorly managed, clearly an open dumping site. There was no effort to manage and to bring it at least to the level of controlled open dumping site. Moreover, when the new site began the

old site had to be properly closed but this has not been the case so far.. Though it was necessary to ensure proper closure of the abandoned dumping site, the responsible body has overlooked it and thus it has continuing being a source of serious social and environmental challenge to the nearby settlement.

The new landfill site has been established and started functioning since 2015. It was established with the assistance of a non-governmental organization. It is located 11 kms north of the town. It diverts about 1 km towards the east direction from the Adigrat – Zalanbesa road. The site is totally out of Jurisdiction of the town Administration.

The site may have a positive as well as a negative quality. Its location being far from the town and the geological and soil condition of the site may be considered as an advantage. But unless it is properly managed to ensure a sanitary landfill, for the simple reason that it is sited in a village which is out of the property right (administrative boundary) of the town, the consequence will be so severe.

P 4: I-SB4-UC2.rtf - 4:10 [Moreover, as it is very far fr..] (25:25) (Super)

Codes: [lfsite - Family: Landfill]

No memos

Moreover, as it is very far from the town, it is necessary to establish transfer stations primarily to speed up the collection process. Otherwise, it would be difficult to meet the demand of the society for service using tractor carriages which could make only one turnover in a day.

Code: lfstatus {5-0}

P 1: I-SB1-UC1.rtf - 1:6 [Researcher: How do you explain..] (15:16) (Super)

Codes: [lfstatus - Family: Landfill]

No memos

Researcher: How do you explain the status of the landfill, if any, in your city/town when evaluated in terms of its location and management condition?

Interviewee_1: From the very beginning, the Mekelle's existing landfill was established with the

assumption that it would be a sanitary landfill. The structure was almost fully constructed: leachate controlling facilities like liners and leachate collecting tankers were set up. But due to an improper management, the landfill of Mekelle could not maintain the status of sanitary landfill. The existing landfill is not more than an open landfill. Wastes are not properly compacted, not layered by selected earth material immediately after dumping. For several years, it has been suffering from spontaneous firing and since the last two years, this has been a continuous phenomenon. It has been a serious headache for the local and regional administrators.

P 2: I-SB2-UC1.rtf - 2:11 [Initially the landfill was est..] (31:34) (Super)

Codes: [lfstatus - Family: Landfill]

No memos

Initially, the landfill was established with the assumption that it would be sanitary landfill. Most of the basic structures like leachate collection pipes (liners) and storage (containers) are there; certain heavy duty machineries are there, and spreading, layering and compacting activities though infrequently (occasionally) are carried out. But in reality it is not sanitary landfill, but it is not also typically open landfill. It tends to be a controlled landfill at least because it is fenced, and occasionally compacted. Mainly due to shortage of the necessary machineries and facilities and management systems, including human power, the landfill is far from being a sanitary landfill.

There are no rigorous efforts or works to control indiscriminate dumping of waste in the landfill. But I believe that the micro and small enterprises (involved in waste collection activities) would not allow the community to bring and empty special wastes into the collection trucks. The MSEs as well as the special waste generators know that there is special service provided to such types of wastes.

Previously, there were special groups who have got permission from the concerned administrative body to undertake sorting and collecting reusable and recyclable materials and other activities. Except these people, no one was allowed to get into the landfill compound. They were also involved in controlling activities, not to allow others to get into the landfill. But when the group abandoned the work, it becomes very difficult to control, and the visitors to the landfill scavenging or collecting reusable items easily get into the landfill through the main get and others jump through/over the fence.

Besides, wild fire break out has been beyond the capacity of the responsible bodies particularly since the last two years; the smoke that comes out from the landfill covers wider area wherein many rural and urban settlements are affected by it. Because of its poor management, the landfill has created varied environmental and social complexity on the nearby settlements (both rural and urban). As a result, strong complaints are being raised from the urban residents and rural communities.

P 3: I-SB3-UC2.rtf - 3:10 [Structurally, it is thought to..] (13:13) (Super)

Codes: [lfstatus - Family: Landfill]

No memos

Structurally, Adigrat's landfill is alleged to be a sanitary landfill. The leachate controlling system has been installed; leachate collecting liners and containers are there. Regarding the management aspect, sorting is permanently carried out though not regularly, compacting activities take place. The moment it was believed that it needs compaction, a dozer and a compactor were brought to the landfill and the work of compaction is carried out.

P 4: I-SB4-UC2.rtf - 4:9 [Currently, the landfill is not..] (22:24) (Super)

Codes: [lfstatus - Family: Landfill]

No memos

Currently, the landfill of Adigrat is not managed properly in a way that a sanitary landfill requires. And if it continues as it is now, the fate of the landfill will not be better than the open landfill (open dumping). And I am not sure whether all conditions are leading towards a sanitary landfill bearing in mind the current situation of the landfill and the negligible attention given to. For instance, due to the appeal and pressure mounting from the community and the administrative body of the village where it is found, after almost two years of operation, one cell compaction work has taken place for one time only.

There are certain machineries but they are usually involved in other activities which are none of the businesses of the Sanitation and Beautification section. The compaction and layering work has not been done as it should be. Scavengers including domestic animals like dogs are freely visiting the landfill and spread bones everywhere out of the landfill compound. Plastic materials have been spread out by wind to the surrounding settlements. This is because the landfill has not been fenced properly to prevent all these problems. The worst of

all is that the container made to collect leachate through the liners has been cracked within less than two years stay, and has not received basic and reliable maintenance. And the boreholes found down the landfill are facing the risk of pollution.

The landfill has no basic infrastructure like water (for compaction and for washing to the workers of the landfill) and electricity. Water is transported through septic suction trucks.

P 5: I-SB5-RC1.rtf - 5:3 [Researcher: How do you explain..] (13:16) (Super)

Codes: [lfstatus - Family: Landfill]

No memos

Researcher: How do you explain the status of the landfills of the urban areas of the Region and particularly of Mekelle and Adigrat when evaluated in terms of their location and management condition?

Interviewee_5: Landfill is the most important facility in solid waste management. Mekelle and Adigrat are the two urban centres which are thought to have modern landfill. When it was established, the landfill of Mekelle was thought to be a model sanitary landfill where wastes are properly managed and energy could be generated. However, because of poor management, it has not been better than an open dumping site. The Adigrat landfill, though it is established and started its operation recently (almost two years ago), the management condition is not good. Not only it is suffering from scanty machineries, but also the machineries are involved in out of their main duties.

The landfill workers are not properly sorting the waste; the heaps of water packing plastic containers are not properly handled, etc. Because of mainly shortage of budget and human power and dismantling of the municipality system, the landfill management could not continue as it was expected.

All landfill are expected to be fenced at least to prevent the blowing of plastic and papers and other materials to the surrounding areas and the visit of animals. Some urban areas have implemented it, but many including Adigrat have not yet.

The basic sources of information related to landfill are key informants and personal observation (Note that the identity, and selection process of the key informants have been explained in Chapter Three but with great caution not to go against the principles of

research ethics particularly the responsibility to 'respect the anonymity and confidentiality' of research participants, and the ideas they forward). As the detailed analysis presented in Box6 shows, the key informants of both areas have asserted that the landfills have been situated in appropriate location. Both landfills fulfil many of the location criteria of a landfill. Mekelle's landfill was established 10 years ago. Likewise, Adigrat's landfill was established three years ago by a non-governmental, international organization. But the landfill in Adigrat which had been used for a long time but abandoned two years ago was not only sited inappropriately but also it was abandoned without a proper closure. Though the old dumping area was almost a vacant area (lying in between two escarpments) before it was converted to dumping site and was situated at the edge of the urban proper, yet it had not undergone through the formal site selection process and, in a little while, it had been enclosed by settlements.

Regarding the active landfills of Mekelle and Adigrat, most of the informants are dissatisfied by the management condition of the landfills even if they were established hoping that they would be sanitary landfills. The informants argued that Mekelle's landfill is virtually open dumping. Some of the basic indications include that layering and compaction are not properly and regularly undertaken; fire has been beyond the capacity of the administration; indiscriminate dumping is more likely; it has been unprotected from scavengers and rag pickers, etc. Likewise, though it is new, the Adigrat landfill has started creating social and environmental problems to the surrounding rural settlements because it has not been properly managed. For instance, the landfill is not properly fenced and thus, plastic materials are blowing to the settlements and grazing lands; scavengers are spreading bones and other waste items out of the compound of the landfill; flies and bad smells are spread to the farm lands and settlements in the surrounding areas owing to the lack of layering and compaction of the wastes. For this reason, it has been a source of conflict between the society and the administrative bodies of the rural *Kebeles* found around the landfill and the municipality.

Almost all informants believe that both landfills have no serious problem related to their location. Yet, due to their poor management, they have been creating serious socio-economic and environmental problems to the nearby settlements. The management

problem of the landfill of Mekelle, as pointed out by Mekelle's key informants, is particularly severe.

One of the major problems in Adigrat town linked with landfill is that the old dumping site, which was being used for many years till the start up of the new landfill, has been abandoned without proper closure scheme, and has continued to be the major sources of diverse problems to the nearby settlements. Tigray's Waste Management Regulation no 81/2005 Article 16 sub-articles 4 stipulates that the Environmental Protection, land Management and Use Agency of Tigray has the responsibility to determine the conversion of an abandoned landfill safely and properly to other types of services that go with it. Nevertheless, it is a pity that the Agency has not yet exercised its duty and authority as far as such issues are concerned.

4.2.4. Spatial Disparity in Waste Management Service

As mentioned before, the problem of 'spatial disparity in service' has been one of the three components extracted using the principal component analysis. The problem of liquid waste and solid waste management services are not limited only to the inability to keep pace with the rapid urbanization. Solid and liquid waste collection services cover only a fraction of the total population. But the worst thing is the inequity and disparity prevailing among the communities in different neighbourhoods in service delivery depending on various factors. It is not unusual phenomenon where certain areas and specific groups of society are more favoured than others in the services they received. Major disparities and inequities are created depending on various factors but the demographic, geographic, and socio-economic features of the beneficiaries are the major ones.

The demographic feature of the society refers, among others, to the density of the population. Very sparsely settled areas (for example, the newly established and those which have not yet fully occupied neighbourhoods) within the city are infrequently visited by waste collection service providers. Moreover, settlements situated on relatively steeper slope and upland areas or areas of undulating topography may receive no or limited services. The social and economic features of the society directly imply that certain

community groups are more likely to be deprived of collection services, either because of their social or economic status.

With respect to the issue of inequity and disparity of waste management services, the intent of the researcher is to reveal whether or not the problem exists and to estimate the extent of the problem existing in the study areas. To this effect, he employed primarily the questionnaire survey which focuses on two factors, the socio-economic status of the community and the geographic (location and topography) feature of the service areas. The researcher has not been able to obtain data or records on the socio-economic characteristics of the residents at household level. To address this issue, it would be necessary to have demographic data on neighbourhood level which might not be precisely matched to the administrative units of the city and the town. That is why the researcher has taken the socio-economic and the geographic features only.

For this specific issue, the researcher has largely relied on the data obtained from the residents through questionnaire and experts from the responsible bodies. Based on literature and practical experiences, the researcher has tried to list down all possible disparities such as among inner and outer location, residential and commercial areas, areas or settlements with and without institutions and offices, areas or settlements with and without authorities or wealthiest persons and common folks. To describe the disparities in the waste service delivery among various communities and social groups as a result of locational advantage or disadvantage the reverse and socio-economic imbalance, the researcher has heavily relied on the information supplied by the community for they are the main beneficiaries or deprived of the service. Accordingly, residents were asked their opinion through questionnaire, and filled in their reflection in the questionnaire, and the data were analyzed with the help of SPSS package and the result is presented in Table 23 below.

The proportion of the residents who believe that there is significant disparity between the inner and outer part of their town is disproportionately larger. 321(71.4%) household heads agreed on the existence of disparities on waste management service provided to the community dwelling in the inner and the outer part of the urban areas. But, which part of

the city is more favoured? The inner or the outer? It is more unlikely the community dwelling in the outer part of the city or town to receive better waste collection service than the inner part mainly due to one or both of the following fact(s): 1) Slums and disadvantaged communities are found in the periphery of the urban areas of the developing countries, and 2) Distant (remote) location coupled with poor infrastructure might have hindered access to service. Not only in the newly included settlements but also the neighbourhoods far from the centre of the city are exposed to either nonexistent or frequent cancellation of collection programs. Moreover, the traditional settlements which are locally called '*Nebbar tihizto*', roughly translated as "*previously held possession*" hardly receive collection service. For example, in Mekelle, Aynalem, the settlements situated far from the centre receive almost no services; in Ayder sub-city, specifically the settlement around the Kidanemihret Church, has not received regular program of waste collection service. The settlements situated at the foot and the west facing slope of the Chomea hill do not receive waste collection service mainly due to problems related with topography of the area. These are sample areas which lack collection services almost constantly. But the cancelation of collection programs is almost common phenomena in the distant neighbourhoods in Mekelle. Similarly, the settlements which have been recently designated as part of the urban settlement in Adigrat town hardly receive any form of waste management services. The outer settlement in *Kebeles* 06, 04, and 02 which are identified as '*nebbar tihizto*' are some of the most suffered society from lack of waste collection services in Adigrat town.

Table 23: Disparities among Neighborhoods in Waste Collection and Regulating Services in the Study Areas

Alternatives		Among Inner & outer		Among Residential & commercial		Among Authorities & common Folks		Among those With & without institutions		Among Wealthiest & poor people	
		Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%
Valid	Strongly disagree	1	.2	-	-	10	2.2	-	-	12	2.7
	disagree	39	8.7	37	8.2	167	37.1	69	15.3	165	36.7
	neutral	89	19.8	94	20.9	58	12.9	101	22.4	41	9.1
	agree	224	49.8	237	52.7	205	45.6	244	54.2	217	48.2
	strongly agree	97	21.6	82	18.2	10	2.2	36	8.0	15	3.3
	Total	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0

Source: Questionnaire survey, 2015/16

As per the number of responses of the household heads, the second most disparity observed among community is between commercial and residential areas. 319 (70.9%) of the household head respondents believe that there is quite significant disparity among the commercial areas and residential areas in waste collection service delivery is quite significant. There is relatively more frequent visit and even stronger controlling systems in the commercial areas. In other words, better waste collection service is delivered in the areas where business activities are concentrated which might be attributed to the magnitude and nature of waste generated. There might also be a possibility where waste collectors and generators could make an agreement privately to render extra service and offer extra payment, respectively. Whichever way, it is apparent that the commercial areas are more favoured in service rendered by the municipality than the residential areas.

The causes of disparity which are agreed by very large number of responses are the distribution of public and private institutions and offices within the respective urban areas. Household heads whose responses are agreed (or strongly agreed) to the question 'there is significant disparity between neighbourhoods with and without institutions and offices accounted for 62.2% (280 household heads). Indeed, the impact of the spatial distribution of institutions and offices on infrastructure and public services distribution is

unquestionable. Unsurprisingly though, more often, institutions and offices tend to attract infrastructure and relevant services. However, the researcher has included this question item just to estimate the extent to which it has created disparity and hence dissatisfaction in the society situated far from the area where institutions and offices are found.

The other cause of disparity in service among community groups is socio-economic status (mainly wealth), between the haves and the have not. Every urban centre has both socio-economic groups, relatively more affluent and poorer neighbourhoods. And it is not surprising that poorer neighbourhoods do have lower levels of basic services including waste collection than the wealthiest neighbourhoods particularly in developing countries (Cohen, 2006).

With respect to this issue, it seems that residents of the study area do have the feeling that the areas or neighbourhoods where more affluent people (when they estimate their wealth at least in terms of their property mainly the quality of the houses they live in) are living receive relatively better services than neighbourhoods of the poorer people. More than half (51.5%) of the respondents have affirmed their agreement to the idea that there is significant disparity in service delivery within their town depending on the socio-economic status of the occupants.

Obviously, every city or town has residents who are living in relatively more affluent or poorer neighbourhoods. But in developing countries, poorer neighbourhoods can have dramatically lower levels of basic services. Consequently, a large number of urban residents in developing countries suffer to a greater or lesser extent from severe environmental health challenges associated with, among others, insufficient access to clean drinking water, inadequate sanitation facilities, and insufficient solid waste collection and disposal services (Cohen, 2006).

The last question raised to residents pertaining to disparity from the questions raised to the household heads was whether or not disparities among neighbourhoods inhabited by authorities and the common folks are significantly prevailing in the study area. Unlike the other disparities mentioned above, the number of residents who recognized the presence

of disparity among the neighbourhoods of authorities and the common folks is much lower. It is only 47.5% of the residents who expressed their agreement that the extent of disparity between the residential area of authorities (one or more) and residential area of the common folks is considerable. This might be due to the fact that the number of relevant higher authorities in the respective neighbourhoods could be few in number so that they (and their influences) are unnoticeable by the majority of the residents. The other possibility is that authorities are not so influential to exploit every opportunity to their advantage either because they are incapable or reluctant to influence service providers.

In general, from the analysis of the responses of the data collected from residents, it has been obvious that municipal services associated with waste management are not impartially provided to all neighbourhoods in the study areas. More specifically, inner settlement, commercial areas, wealthiest persons' neighbourhoods, and the areas with important institutions and offices, and the neighbourhoods where people in authority reside are relatively advantaged localities but in different levels. Disparity between the inner and outer neighbourhoods and between the residential and commercial areas is clearly observed in both study areas. Though they tried to justify why it happened, the experts of both Mekelle and Adigrat Sanitation and Beautification (SB) Departments agree on the existence of disparity in services, and, of course, in the attention given to the different neighbourhoods within the city or town. Therefore, a large number of urban residents and more specifically the urban poor and outer neighbourhoods in developing countries are suffering from, among others, insufficient waste collection and disposal services due to either deficiency in capacity or inequity in basic service delivery.

4.3. On-site Waste Handling Practices of Residents

Obj.2. To examine the on-site waste management practices and problems of residents in the study area.

On-site waste handling refers to the general management condition of wastes at their sources of generation mainly by the generators. It is part of the overall waste management system of the urban and/or settlements and plays a key role on the efforts of the local administrators to create clean and healthy environment. It could be a futile effort to the

responsible bodies to ensure proper waste management in cities and towns unless proper handling of waste at the source of the generation is in place.

The researcher is particularly interested in assessing how wastes are managed and the extent to which wastes are properly managed at source of generation by residents (generators). In this topic, he mainly focused on both solid and liquid waste handling of wastes and has tried to address them separately.

4.3.1. On-site Solid Waste Handling

Waste is generated from every household, shop, and establishment on a day to day basis and should be stored at source where it is generated (at sources of generation) until they are collected for its disposal. The first step in waste management is the placement of waste at the proper storage. On-site storage refers to the storage of wastes within the confinement of the waste generators' property lines or at sources of waste generation. Proper handling of waste at source of generation would have a paramount importance at least to keep streets, public places, open areas and drains clean. It is also necessary to keep the sanitation condition of our houses. Moreover, residents should form a habit of storing waste at sources in their personal bin and deposit such wastes into the municipal door-to door collection system only at specific times.

Therefore, it is not only an issue of necessity but also it is obligatory to have on-site waste storage and to properly handle wastes at source of generation so as to avoid the occurrence of externalities. In general, proper on-site handling of waste may involve different activities such as use of proper types of storage or receptacles, collecting and placing every item of waste in storage, separating of wastes and placing them in different storages. To fulfil all these requirements, therefore, house owners should primarily take responsibility of proper handling of waste in their home. Moreover, house owners should recognize that usually children (particularly under aged) and housemaids feel relatively irresponsibility. The researcher argues that if residents are developing all these habits, it could be said that half plus the course of waste management has been travelled.

To examine whether the residents' practices comply (fully or partially) with these requirements of proper on-site waste handling, the researcher has presented certain questions to the residents through questionnaire. The researcher has tried to collect data pertaining to both solid and liquid waste handling, but in an attempt to differentiate the strengths and weaknesses of the society by waste type the data of both waste types have been analysed separately.

The output of the analysis (Table 24) reveals that a significantly larger proportion of household heads believe that the residents have bad practices of dumping wastes outside, in streets, pathways, drains, open areas etc. Almost none of the residents have disagreed to the opinion that the practice of dropping litters exists anywhere in the urban areas. . But more than 17% of the respondents were not able to decide (to agree or disagree) mainly because they commented that the question doesn't state to what level the practice is prevailing. Otherwise, almost everybody living particularly in the study areas believe that mishandling of waste is a widely observed phenomenon. More specifically, 82% (369 respondents) of the respondents have asserted their agreement on the idea that residents drop their litters illegally on open areas, streets, drains etc.

Wastes are usually dropped with their containers (sacks) on streets, walkways and open areas. Even the natural drains and ditches and canals constructed for storm water drainages are open, and readily available dumping areas. The problem of dropping wastes in drains and storm drainage canals is especially severe in the centre of the city and the town. Mekelle city, mainly because of its size and the availability of relatively many and longer stretches of storm drainage canals, suffers the most. In consequence, the storm drainage canals are clogged and flood explodes out of the canal frequently in many areas of the city (this has been discussed thoroughly in sub-content (5.6.2). For this reason, the municipality has tried to clean the storm drainage canals every year before the advent of the rainy season.

Table 24: On-site solid waste Handling Practices of Residents

Responses		Common Waste Handling Practices									
		Dumping of waste in illegal areas		Using worn out and useless receptacles		Keeping waste long at home		Waste handling exclusive responsibility of housemaid and children		Reluctance to sort waste	
		Frq.	%	Frq	%	Frq	%	Frq.	%	Frq	%
Valid	strongly disagree	-	-	-	-	1	.2	8	1.8	9	2.0
	disagree	3	.7	22	4.9	20	4.4	30	6.7	78	17.3
	neutral	78	17.3	99	22.0	97	21.6	58	12.9	132	29.3
	agree	233	51.8	238	52.9	228	50.7	303	67.3	211	46.9
	strongly agree	136	30.2	91	20.2	104	23.1	51	11.3	20	4.4
	Total	450	100	450	100	450	100	450	100	450	100

Source: Questionnaire survey, 2015/16

The problem of illegal dumping of waste could be associated with poor or lack of collection services provisions. It is to be recalled that the cancellation of collection program (schedule), as one of the key services provided by municipality, for a long or short time, has been identified as one of the problems of collection services provided by the municipality in the previous sub-chapter. To identify the association between collection services provided and incidences of illegal acts like dumping of wastes on illegal areas by residents, the researcher has used correlation model. Provided that the data at hand are scale data and more specifically likert scale, a non parametric model is necessarily used to find the relationship between collection program cancelation and dropping of waste in illegal areas by residents. So, the spearman's correlation coefficient serves the purpose. The H_0 (null hypothesis) states that at .05 level of significance, there is no significant association between the incidences of cancelation of waste collection program and the dropping of waste illegally in open areas and streets. As can be seen in Table 25, the correlation coefficient is computed as .43 and thus the null hypothesis is not rejected (is accepted) at 0.01 level of significance. However, the researcher argues that it should be kept in mind that though the computed coefficient is less than 0.5 (and the correlation is

significant at 0.01) it is not considerably lower to reach at absolute generalization that there is no association between the two variables. In short, there is a weak positive correlation between the two variables. This implies that there are some more variables that also contributed to the dropping of waste in illegal areas.

Table 25: Association between Collection Program Cancellation and Dropping of Litters Somewhere Illegally

Correlation

Correlations			Cancellation of collection programme	Dropping of waste illegally
Spearman's rho	collection programme frequently cancelled	Correlation Coefficient	1.000	.430**
		Sig. (2-tailed)	.	.000
		N	450	450
		<hr/>		
	residents drops litter somewhere illegally	Correlation Coefficient	.430**	1.000
		Sig. (2-tailed)	.000	.
		N	450	450

** . Correlation is significant at the 0.01 level (2-tailed).

The next issue raised to residents was about the on-site storage. Storage of waste at source is the first essential step of solid waste management. In connection to the value linked with and the understandings they hold on to 'waste', the attention given to and thus the way it is handled by residents is insufficient. Besides, the materials residents are willing to spend for waste handling like storage is cheapest, if not useless, and discarded materials. That is why city leaders are strongly urged to bring a fundamental change in the mindsets and attitudes of the community towards waste (Modak, et al., 2011).

In the region in general, and the study areas in particular, despite the quite disparities observed among the different waste generators, the most common types of receptacles used at source of generation includes plastic bags, cardboards, sacks (made up of plastic synthetic), bin (usually made up of plastic), baskets, etc. In residential areas, sacks are the predominately used receptacles. But the important thing is the status of the bags used by

residents which partly reflects the poor commitment of the waste generators to properly handle their wastes. Most residents' receptacles are overused and too old and as a result, they are worn out and torn. There might be a slight difference among the households in the status of the receptacles used by individual homes; and this has been a source of conflict with the collection crews when the crew fail to return the right receptacle to the right person (the owner) because each resident believes that his/her receptacle is better than or less worn out than someone else's. Worst of all, such old and worn out receptacles are used repeatedly.

From the above discussion and literature sources, storing wastes at sources of generation in bins and other storage materials is taken for granted as good habits or practices of the society. But the question is for how long would it be tolerable to store wastes at home? Be it either due to negligence, carelessness or lack of options, for how long should waste stay at home before its collection? When the nature and composition of the wastes generated is considered, in urban areas of developing countries. primary waste collection services should be more frequent because solid waste generated in residential areas of the study areas are predominantly organic, biodegradable like remnants of food items, grasses and plants which could easily and rapidly decay and emit unpleasant odours unless they are quickly picked up.

If the collection crews disappeared, then for how long should the community tolerate before everything is reversed to the inferior options? Of course, to keep streets and public places clean throughout the day, it is necessary that waste producers co-operate and effectively participate in the waste management efforts of local bodies. In short, the waste should normally be stored at the source of waste generation till collected for its disposal. To this effect, it might be, therefore, possible to educate citizens so as to develop a habit of storing wastes at source in their personal bin and within their premises and empty into the municipal, legal collection system at specified times.

But the question for how long could the community be tolerant would be consequential and needs a precise answer because the consequences of storing waste within ones dwelling and working house or premises for indefinite time on the health and over all life condition

of the family would be fatal. Because of the nature and composition of the wastes produced and the geographical location, wastes produced in developing countries like Ethiopia, Tigray Regional State, need to be picked up quickly just after generation. To achieve health motives, Knausenberger et.al. (1996) recommended that waste in tropical regions should actually be collected daily. Similarly, in the temperate regions during summer and winter every two days and three days, respectively, is recommended to be collected from sources of generation. In light of the climatic regime and nature and composition waste of Ethiopia in general and particularly the study areas, wastes should be collected quickly at least every three days.

For this reason, residents were asked whether wastes are kept at home (or at sources of generation) unnecessarily for long time. Accordingly, nearly 74% (332 respondents) of the respondents agreed that because of different reasons, wastes remain uncollected at sources of generation and about 32% of them have agreed with the idea strongly. It is, therefore, more likely for the waste-borne diseases to spread and become main health challenges to the family. Therefore, inappropriate receptacles (on-site waste storage) coupled with more delay in collection would create environmental and human health problems, especially when wastes start stinking quickly due to putrefaction.

In developing countries, on-site waste handling is exclusively the duties and responsibilities of females. Except for some types of works which need hard physical works and need support from males, the task of on-site waste handling, almost in all streams, is predominantly retained for females. In the study area, housemaids, as they are females and it is one of their key job descriptions, are more responsible to waste handling at their sources of generation. However, the researcher argues that unless close inspection and controlling works are in place by the household heads, mishandling and dumping of waste anywhere illegally is more likely to be committed by the housemaids and even children especially when they are under-aged.

Therefore, information on the extent to which children (mainly under-aged) and housemaids are given exclusive responsibility of on-site waste handling could be informative to estimate the possibility for all types of mishandling including dumping on

illegal areas. As a result, the researcher has asked the respondents to reflect their opinion whether or not on-site waste handling is exclusively the responsibility of children (mainly under-aged) and housemaids. The responses of most of the households (78.6%) have been that on-site waste handling is an exclusive task and responsibility of children and housemaids.

The last question raised to respondents is about their willingness to sort and then store their wastes in different receptacles. Sorting is one of the essential activities of waste management. Sorting involves the separation of wastes based on their nature (specific or general nature) into different categories depending on the immediate purpose separating waste. If the basic objective of sorting is to produce compost, for example, it would be necessary to sort the waste into organic (biodegradable) and inorganic items. But the purpose of sorting could much more than compost production. It could be important to sort the waste items into more categories.

The role of sorting of waste in waste management is not only limited to one or two element(s) of waste management because sorting has a significant and direct impact on the waste quantity and composition because it is followed by activities like reusing, recycling or recovery. Ultimately, sorting impacts collection, storage, transportation, disposal, basic facilities like transfer stations and landfills, and equipments and collection vehicles. To ensure sustainable and integrated waste management system, the practice of sorting as an activity is inevitable. In general, sorting of waste into different categories would make waste management simple and efficient. It makes possible to employ integrated waste management (IWM) approach and then minimize the burden on collection, transportation and disposal activities. Moreover, it makes solid waste management very cost effective and simple.

Sorting may be done in the different phases of waste management system such as at sources of generation, in transfer stations, in disposal sites and in special areas where recycling and treatment of waste is taking place. But, the earlier the separation, the cleaner the material, and, in the end, the higher its quality and its value would be to users (Oduro-Appiah & Aggrey, 2013). Environmentally, most preferable and very much cost-

effective phase for sorting is at source of waste generation. It would be easy and simple to sort wastes just at source of generation by their generators because it is done before it is mixed and becomes so stinking and unhygienic. The separation of material from mixed refuse at a central processing facility or transfer station or landfill would be more difficult and unsafe and thus very costly (Singh, et al., 2014). Waste should be recovered at the source, during transport or at the disposal site. The earlier the separation, the cleaner the material, and, in the end, the higher is its quality and its value to users. The role played by residents in separating waste at sources of generation is also very important for it also facilitates collection of waste. This could be due to personal reasons and/ or institutional constraints, however, residents of the study area decline to voluntarily participate in the activity of sorting.

Unfortunately, as shown in Table 24, more than half (51.3%) of the respondents are not willing to be involved in the sorting activity. It is only 19.3% of the residents who showed good faith to sort their waste. But when the very limited practice of reusing, recycling and recovery activities existing in the study area is considered, the proportion of residents who expressed their willingness to sort their waste is not low. Moreover, the 29.3% of the residents who have not yet decided whether or not to participate in sorting could be potential participants in sorting activities provided that the local government works on awareness creation activities. Of course, separating of waste into many categories could be more challenging to residents than into two or three categories.

4.3.2. On-site Liquid Waste Handling

According to Water (2015), liquid waste contains a number of pollutants and contaminants which includes plant nutrients (nitrogen, phosphorus, potassium); pathogenic microorganisms (viruses, bacteria, protozoa and helminthes); heavy metals (e.g. cadmium, chromium, copper, mercury, nickel, lead and zinc); organic pollutants (e.g. polychlorinated biphenyls, polyaromatic hydrocarbons, pesticides); and biodegradable organics (BOD, COD); and micro-pollutants. It adds that all these pollutants and contaminants if they are improperly treated and released can directly or indirectly have an impact on the environmental and human health and the economic and financial aspects as

well. Therefore, proper management of this liquid waste is a crucial issue which should be in place at all phases including at sources of generation. The proper handling of liquid waste at sources of generation (on-site), as part of the overall liquid waste management, would be more effective and economical.

The scope of on-site handling of liquid waste is so broad and could be beyond the scope of this topic and may require expertise beyond the professional qualification of the researcher. Therefore, the researcher has tried to focus only on issues related with facilities and residents' practices in liquid waste handling. The researcher has been able to identify and analyze the most common facilities used to handle domestic liquid waste on-site in the study areas based on the classification system indicated by Water (2015). It is indicated that these classification system designated as 'sanitation ladder' were employed for MDG (Millennium Development Goal) monitoring.

This ladder consists phases like open defecation, unimproved facilities, shared and improved sanitation facilities but they have different prevalence rate. As explained by Water (2015), open defecation refers to human faeces disposed of in fields, forests, bushes, open bodies or other open spaces. It also includes faeces disposed of with solid wastes. Unimproved sanitation facilities, which include pit latrines without a slab or platform, hanging latrines and bucket latrines, are simple and poorest types of sanitation facilities wherein human excreta are not separated from human contact. The second and better type facility but positioned in the third level of the ladder, is shared sanitation facility. Except that it is shared by more than one family or it is public, shared sanitation facility could be categorized within an improved one. The fourth and best of all types of facilities are the improved sanitation facilities. These types of facilities are more acceptable and are believed to be very preferable because they are more likely to ensure hygienic separation of human excreta from human contact. Improved sanitation facilities include flush (pour flush to piped sewer system), septic tank, pit latrine, ventilated improved pit, pit latrine with slab and composting toilet.

As per the explanation of the health office experts of both Mekelle and Adigrat, almost all types of sanitation facilities indicated in the sanitation ladder are available in their

respective town but at different rate of prevalence. Though the system of classification they employ is different, all sanitation facility types, ranging from no sanitation facilities at all (where people practice open defecation) to facilities that have been defined as improved sanitation, are not uncommon in the study areas.

Open defecation (including urinating) is a common experience and data was collected from the respondents (whether or not s/he use open toilets for defecation and/or urinating) in an attempt to estimate the extent of the problem respondents were asked whether or not they use open toilets (defecation and/or urinating). In fact, open defecation is practiced not only because of lack of sanitation facilities at all. The reasons why people practice open toilet have been discussed later (see on page 367). Open toilet (urinating and defecation) is a widely rampant practice not only in the study areas but also in the country as a whole.

Table 26: Basic Problems Linked with On-site Liquid Waste Handling of Residents in the Study Areas

Responses	Wider use of open toilet		Lack of Access to toilet		Unhygienic & substandard private toilet		Connecting Pr.tlt* to SDC**		Dumping on SDC		Seepage and spill over of toilets	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Valid												
strongly disagree	9	2.0	4	.9	5	1.1	-	-	-	-	-	-
disagree	20	4.4	31	6.9	35	7.8	20	4.4	15	3.3	35	7.8
neutral	58	12.9	85	18.9	86	19.1	104	23.1	114	25.3	103	22.9
agree	210	46.7	194	43.1	247	54.9	229	50.9	168	37.3	275	61.1
strongly agree	153	34.0	136	30.2	77	17.1	97	21.6	153	34.0	37	8.2
Total	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0

Source: Questionnaire Survey, 2015/16

*Pr.tlt. = private toilet

** SDC= Storm water Drainage Canal

As shown in Table 26, except 19.3%, who disagreed (6.4%) or remained neutral (12.9%), all respondents have agreed (or strongly agreed) to the idea that there is high problem of wider use of open toilets in their city/town. The researcher has also deeper observations on the practices of many people in the study areas and other parts of the region and the country as well, where open toilet has not been considered as unethical or environmentally

non-friendly practices. Rather, many people try to put themselves out of sight while they are practising open toilets. Open toilet practices could be consequences of different factors which would be discussed later.

One of the problems related to liquid waste management is access to toilets. As it has been pointed out by the experts of the responsible offices and the questionnaire survey results, a significant number of residents have no access to private or any other types of toilets. The experts said that residents living especially in old and traditional settlements, locally known as *nebbar tihizto*, and in rental houses where they share toilet with home owners have serious problem of access to toilet. The problem of access to toilets in rental houses is particularly higher if the house owners are living together with the rented households in the same house unit (premises)/compound. In Mekelle, the proportion of residents who have no or limited access to toilets is highest particularly in *Kebeles* 19 and 20 (Jibruk area), *Kebeles* 14 and 15, and 4, the pockets areas of traditional settlements widely distributed in the city, and almost the whole village of Aynalem. Similarly, in Adigrat the proportion of residents with no or limited access to toilet is in areas like *Kebeles* 01, *Kebeles* 04 (the outer part), and 06 (particularly the outer part and areas where more houses of traditional drinks are found) and totally the pocket areas of *nebbar tihizto*.

Irrespective of its quality, the sanitation coverage in the region in 2003 EFY (2011) was 87%. However, the same source indicates that the utilization rate of latrine facilities at the end of 2003 EFY (2011) was 34% which resulted in poor hygiene and sanitation condition. The poor hygiene and sanitation condition in turn has been one of the top ten killer diseases in the region (Admasu, et al., 2011).

The questionnaire survey indicated that 73.3% of the respondents believe that there is serious problem of access to toilet of any type. Lack of access might be defined in many ways, but in this study, it is to mean that toilets are not readily available to beneficiaries either due to total absence and/or limited access (for example, the sudden or invariable sanctions made in shared toilets of rental houses).

Significant numbers of respondents have also recognized some more problems in their urban areas in relation to liquid waste handling at sources of generation. These problems which could be identified as bad practices include lack of sanitation and of being substandard sanitation facilities, connecting private toilets to rainwater drainage canals illegally, dumping of waste (both liquid and solid) into storm drainage, and seepage and spill over of toilets (or septic tanks). In general, significant number of respondents believes that these all bad practices are prevailing in their town. 69% to about 80% of the respondents agreed that these all problems are typical features of the city and town where they live in. Though, due to data deficiency, they could not support it with clear and precise figures, the authorities in charge of ensuring proper waste management in the city and town are familiar with these all problems. Put differently, authorities of the respective urban areas recognize the prevalence of these problems within the urban territory of their jurisdiction. Besides, most of the toilets are substandard and unhygienic. There are larger numbers of pit latrines with and without slab in both study areas though Adigrat takes the lion's share. For various reasons, seepage and spill over of liquid waste from toilets and septic tanks is also a common phenomenon. In Mekelle, the problem of seepage of liquid waste is particularly serious problem in *Kebeles* 19 and 20 (in the area known as *Jibruk*) and *Kebeles* 04 and parts of *Kebeles* 11.

Moreover, the overflow and seepage of waste water from septic tanks in the condominium houses like in Hawelti Sub-City near the Regional Office of Tigray, Addi Hawsa sub-city *Edaga Bieray* area, Ayder Sub-City around *Kebeles* 03, communal houses of the demobilized fighters of the TPLF (Tigray People Liberation Front), public institutions like many campuses of Mekelle University, the Regional Correctional Institute, etc. have been the main concern of the local government in Mekelle city.

The problem of seepage and spill over of latrines and septic tanks is not uncommon in Adigrat town too. Though the problem is not as severe as that of Mekelle's, the problem of leaking out liquid waste on to the surface is clearly observed especially in the areas where traditional drinks selling houses are found in large number such as in *Kebeles* 06, 02, 03 and many other pocket areas.

The other serious problem in the study areas related with on-site liquid waste handling is an illegal dumping of waste (both liquid and solid) into storm drainage canals and natural drains, open areas and streets, and connecting private toilets with natural water courses and storm water drainage canals. In light of illegal dumping of waste on to the surface, the local governments have employed the rule that requires every household and housing unit to keep the area within 15 meters radius of his or her home clean. Though such regulation is claimed by the responsible bodies to be most effective to maintain the sanitation of neighbourhoods in the urban areas, residents are complaining because it is difficult to implement. Moreover, residents argue that it has been a source of conflict among neighbouring houses. The illegal dumping of liquid waste into the storm water drainage canal has been a common practice in the residential areas and the business areas. The people living or working alongside and close to the storm water canals are more accountable for the misuse of the canal. Usually, it is the business houses which produce huge discharge like tea rooms, restaurants, beauty salons, beverage houses, health centres, and even religious institution (where large people gather) are accused more by sanitation workers. Likewise, these people are the most but not the only affected ones by the bad odour coming out through the manhole and the clogging of the canal which causes overflowing of storm water. The bad smell that comes out through the vent (*manhole*) of the storm water drainage canal creates unbearable situation not only to the people living alongside it but also to the pedestrians. To prevent such problems, many of the manholes are temporarily closed for most of the year but reopened during rainy seasons by the residents alongside the canals. Since the storm water drainage coverage is so wider, the magnitude of the problem related with storm water drainage is more severe in Mekelle than in Adigrat.

Worse of all, many people have been caught red handed in different times by the Office of the Sanitation and Beautification (municipality) while connecting their private latrines to the storm water drainage and natural drains covertly. When Mekelle – Adigrat- Zalanbesa road was reconstructed, unexpectedly many canals connecting residential and commercial houses' toilets with the storm water drainage were detected. And this was very shocking mainly to the responsible body. For partly they are coming from long distance, and partly

the complicated plan of the town, it was very difficult for responsible body to detect the sources easily. The authorities are also convinced that the same problem could exist in other storm water canals as well.

The natural drains were also not free from such problems. For one thing, most of the storm water drainage canals end up at water courses. Secondly, most of the liquid waste collected in pit latrine or septic tanks are heading to the water courses either through seepage, spilling over, or by directly linking of liquid waste to storm water canals. As a result, it is more likely that most of the drains and rivers crossing the town are polluted though they are being used for various purposes like irrigation, domestic purposes and cleaning.

In general, this research has revealed that on-site handling of liquid waste is exposed to various malpractices. Malpractices of the society in relation to waste management in general and solid and liquid waste in particular at sources, as it has been discussed above, are manifested in different ways like the practices of open-toilet; dumping in open areas, streets, drains, and storm water drainage canals; poor or inappropriate waste storage facilities and receptacles, unhygienic and substandard toilets, and so on. The researcher has also tried to explore some of the possible reasons for mishandling of liquid waste at the sources of generation. Based on his literature consultation and previous experiences, the researcher has identified some possible options and included in the questionnaire for respondents to answer their responses either as agreement or disagreement. Obviously, the primary reason for many of the malpractices of the society is an economic reason, but there could be various specific reasons peculiar to each malpractice. But it is difficult to enumerate all possible reasons for every malpractice and analyse accordingly. It is to be remembered that 'open toilet', as per the responses of residents, is among the most common problems of the study area. Hence, the researcher has focused on the most common and detrimental practice such as the use of open-toilet. What is more, the researcher has tried to describe some possible reasons for open-toilet practice.

The possible reasons for the wide occurrence of open toilets were listed as lack of options (lack of access to sanitation facilities), lack of environmental awareness, shortage of water supply, cost of service charge paid to septic suction trucks, poor controlling and regulating system, poor (ineffective) fines, and being a long time tradition. Then, the data collected through the questionnaire have been analysed and the results shown in Table 27.

Table 27: Causes for Open-toilet Practices by Residents in the Study Areas

Responses	Lack of options/ access(3 rd)		Lack of Environmental awareness (2 nd)		Reduce cost of suction (4 th)		Shortage of water at home (5 th)		Poor or no controlling system (1 st)		Weak fines or enforcements (7 th)		Tradition prolonged habit (6 th)	
	Freq.	%	Freq.	%	Freq	%	Freq.	%	Freq	%	Freq.	%	Freq.	%
Valid														
strongly disagree			6	1.3	1	.2			2	.4	13	2.9	23	5.1
disagree	26	5.8	13	2.9	21	4.7	12	2.7	20	4.4	140	31.1	55	12.2
neutral	56	12.4	58	12.9	75	16.7	126	28.0	52	11.6	199	44.2	136	30.2
agree	325	72.2	291	64.7	254	56.4	274	60.9	153	34.0	87	19.3	224	49.8
strongly agree	43	9.6	82	18.2	99	22.0	38	8.4	223	49.6	11	2.4	12	2.7
Total	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0	450	100.0

Source: Questionnaire Survey, 2015/16

Virtually, all the possible reasons for a wider use of open toilet described in the questionnaire have received more acceptances by the residents. More than 80% of the respondents have agreed that lack of access to sanitation facilities, lack of environmental awareness and poor or no controlling system are the three main reasons why people are using open areas, streets, river courses, bushes, and so on to defecate and urinate. Residents are strongly complaining why the responsible body does not recruit special group with a specific purpose of inspecting, controlling and monitoring illegal waste handling activities. It is the community itself that should try to control at least its nearby places though usually it has been ineffective and sources of conflicts. That is why the reason 'lack of controlling system' has been considered as number one cause of extensive practices of open toilet by large number (83.6%) of respondents. Very surprisingly, most of the community strongly believes that reasons like 'weaknesses or strengths in fines or enforcements' has nothing to do with the prevalence of open toilets but it is lack of efforts

to implement waste management rules and regulations that have serious cause of the problem of open toilet practice in their town.

When measured in terms of the proportion of responses of residents (agreed and strongly agreed), the options such as 'lack of environmental awareness' (82.9%) and 'lack of access to any types of sanitation facilities' (81.8%) have also been the second and the third most important reasons for open-toilet practices, following 'poor or non-existent controlling system'. As per the responses of respondents, the effect of the 'need to reduce cost of suction' and 'shortage of water' on the expanse of practices of open toilet is also significant wherein 78.4% and 69.3%, respectively, of the respondents have shown their agreement. Despite the fact that the proportion of agreed respondents is little more than half (52.5%), the effect of it being long stayed habit could not be underestimated (or taken as insignificant) while designing environmental policy and implementation plans.

So far, we have seen that the cleanliness and sanitation of an urban area is also a function of the community's practices. The role of community practices to either positively or negatively affect the sanitation condition of their working or living area and the whole area of the urban centre is significant. It would be more likely to fail the efforts made to ensure the cleanliness of a particular urban centre unless the move is supported by suitable community practices. That is why the researcher showed interest in the assessment of the community practices with respect to waste management. To this effect, the researcher collected primary data from the community and key informants of the study areas using questionnaire and in-depth interview, respectively. Whereas the questionnaire data have been analyzed using SPSS and presented above the qualitative data have been analyzed using the Atlas ti version 7 and the report is presented in Box7.

For this research purpose, community practices are referring to activities made and thought to be made by individual waste generators at the sources. The major practices of the community are discussed under the theme 'On-site waste handling'. As indicated earlier, on-site handling is the initial phase of waste management to which the waste generators are more liable. The theme on-site handling is meant to different issues identified in three codes. One of the codes refers to malpractices of the individual

residents carried out in or around his/her living or working area. The second and third codes refer to the way how both solid and liquid wastes are handled and stored at home.

Box 7. Output: On-site Waste Handling

On-site waste handling	
Contents	
On-site waste handling	312
Code: malpractice {9-0}	313
Code: swstorage {2-0}	317
Code: wwstorage {3-0}	318

Code: malpractice {9-0}

P 2: I-SB2-UC1.rtf - 2:18 [Researcher: How high is the pr..] (49:51) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

Researcher: How high is the problem of illegal acts committed by residents like open toilet practices, dumping solid waste in open areas and streets and storm water canals, connecting private toilets and septic tanks to storm drainage canals and natural drains, etc. in your city/town? How do you evaluate the care and commitment of the society to handle properly its waste at the sources?

Interviewee_2: Open toilet is really a serious problem in Mekelle. Many people tried to use open toilets (to urinate and even to defecate), some openly and others out of sight, in wrong days and night time. It has also been difficult to control and penalize them. There is no as such proper, adequate and simple workable system through which illegal acts (like open toilet users) could be controlled and enforcements are applied. Wider practices of open toilet are often observed in areas where traditional drinks are being sold, and in the traditional settlements and houses are widely found. In Mekelle, the problem of open toilet related with location of traditional drinks, and traditional houses and settlements is widely observed in *Kebeles* 14, 15, 04, 19 and 20 (locally known as *Jibruk* neighbourhood), and in many pocket areas within almost all sub-cities. I believe the main causes for open toilet practices are partly lack of access to sanitation facilities and it has been a deep rooted habit.

Dumping waste illegally in open areas, streets, storm water canals, and river courses are practised by a considerable number of residents in Mekelle. Often flood explodes out of the storm water canals when they are clogged by solid wastes. The Sanitation and Beautification Department is regularly cleaning the storm water canals before the advent of the rainy season. Owing to such problems, sanitation campaigns are, though infrequently, arranged.

P 2: I-SB2-UC1.rtf - 2:19 [Researcher: What types of prob..] (37:38) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

Interviewee_2: Mekelle city has a wide range of problems related to liquid waste management.

Among the liquid waste management problems, misusing of the storm water drainage is a serious problem in the city. Some connect their septic tank or pit latrine unsightly to the storm water canals, others empty their liquid waste containers into the canals which causes severe odors in the areas around the storm water drainage lines. This type of problem is brutal in the centre of the city, particularly in Kedamay Woyane Sub-city. For example, about 28 houses have been identified recently along roadside from Hawzen square to Addi Haqi Open Market area connecting their septic tanks and pit latrine to the storm drainage canal.

P 3: I-SB3-UC2.rtf - 3:12 [Connecting septic tank/latrine..] (16:16) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

Connecting septic tanks and latrines to storm water drainage canals was serious problem in Adigrat; while the main asphalt road was being constructed, many houses and establishments were detected connecting and made to cut. But still there could be some more houses and establishments connecting to the storm drainage though it has been very difficult to explore. It needs considerable amount of budget to implement the restriction.

P 3: I-SB3-UC2.rtf - 3:16 [Researcher: How high is the pr..] (22:24) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

Interviewee_3: Open toilets, both urinating and defecation, are common practices particularly in the outer part of the town, along river courses, in bushes and open areas. It is not also unusual to find open toilet practices in the inner part of the town, especially in areas where there are drinking houses. The worst of all is found in the settlements where local drinks (e.g. *Tella/siwa*) are widely found, in places *Kebeles* 06, 02, and 03. The main causes for most open toilet practices are lack of access to toilet facilities. Carelessness and intoxication of the drinkers and lack of controlling and regulating activities are among the factors that contributed to open use of toilet mainly in the inner part of the town. The

problem related with access could be solved by increasing the distribution and services of public toilets.

The local administration has tried to recruit illegal act controllers (locally called *munichibe*) who are responsible to control any illegal acts linked with sanitation and beautification. However, it has been very difficult to control because of the complex legal process required to bring the perpetrators to the respective courts and for payment to the finance office.

P 4: I-SB4-UC2.rtf - 4:14 [To escape such types of inconv..] (31:31) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

To escape such types of inconvenience, many residents empty their liquid waste containers to the storm water drainage canals, natural watercourse (waterways) and on to the surface (including to the cobblestone) by exploiting the advantage of darkness and the condition of being out of sight.

P 4: I-SB4-UC2.rtf - 4:18 [Researcher: How high is the pr..] (37:39) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

Interviewee_4: The number of people using open toilet is significantly large. If one wakes up early morning, he/she could estimate easily how widely open toilet is practised. Open toilets are commonly practiced in open areas, bush areas, drainage areas and even in streets. People get up early in the morning and visit these areas for urinating and defecation. The reason for practicing open toilet is so varied but lack of access is the basic one. Had there been adequate number of and properly or fairly distributed public toilets, the prevalence of open toilet would have been significantly minimized.

Previously, the problem of connecting private toilets to the storm drainage canals was a serious problem in Adigrat. Very surprisingly, such practice was vague to the decision makers and even to the Sanitation and Beautification Department staff, whether or not it is an illegal act. While the cobblestone roads and the Mekelle-Adigrat-Zelanbesa asphalt road were constructed, many houses (residential as well as business) are detected connecting private toilets to the storm water canals. But still, it is believed that there are more

undetected connections particularly alongside the main roads such as Piazza - Geza Gerlase Hotel- Woldu Sbagades Hotel and Piazza-bus station.

P 4: I-SB4-UC2.rtf - 4:21 [Researcher: How do you evaluat..] (43:44) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

Interviewee_4: Due to the increase in streets covered by cobblestones in the town and conversion of open areas into different land uses (minimization of open areas), the incidence of open toilet practice is decreasing. But it is difficult to say that it has reduced significantly. If access to private or public toilet is improved, strict and smooth controlling systems are put in place, access to collection services is improved, and the Department of SB is strengthened in terms of manpower and is supplied with very key facilities like transportation services, it would be possible to minimize the illegal practices of the community.

P 5: I-SB5-RC1.rtf - 5:9 [Conversely, lack of access to ..] (25:25) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

Conversely, lack of access to collection services for a number of days or weeks are typical features which forced the community to be involved in illegal acts (dumping illegally in open areas, streets, etc). There are also significant number of residents who attempt to dump their wastes exploiting the advantage of darkness and unsightliness on open areas, water courses and streets unless they are checked by strong inspecting and controlling systems.

P 5: I-SB5-RC1.rtf - 5:11 [Open toilet is a serious probl..] (27:29) (Super)

Codes: [malpractice - Family: On-site handling]

No memos

Open toilet is a serious problem not only in Tigray but also all over the country. And it has been very difficult to control partly due to the complex system to control illegal practices and implement enforcement on the perpetrators, and partly due to lack of access to toilet

services. Besides, some of the house owners feel discomfort when tenants are using toilets inside their house. Many house owners are reluctant to allow the tenants to share toilet due to fear of unnecessary cost incurred for emptying septic tanks, and fear of being unhygienic due to shortage of water. Business houses like tea rooms, hotels, bars, etc. are also reluctant to let the needy to use their toilets. The reason 'it has been a habit for a long time' could not be totally ignored or overlooked because a sizeable number of people, though they have an option, are seen while using open areas for urinating and defecation.

For all these illegal acts, the contribution of 'ignorance' of both the community and the responsible local administrators about the problem is significant. More than any else the, the liquid wastes and toilets of institutions and public offices are mismanaged. The local administrative bodies are not well aware of the role of the Sanitation and Beautification (SB) Units and thus do not appreciate and respect the duties and responsibilities of the SB office and their staff which have been reflected in many ways.

The community, for instance, the business houses, gets into difficulties to dig at night to connect their septic tanks and toilets to the public storm water canals so as to reduce cost of emptying. The cost incurred for emptying (Septic suction truck suction), and the difficulties they could face to connect their septic tanks with the storm water canal are not comparable. Usually, they did it at night clandestinely. It is not only a matter of miscalculation about the advantages and disadvantages of connecting private toilets and septic tanks to storm water canals, but the greed and ignorance of the illegal doers about the importance of environmental quality is overwhelmingly the reason.

Code: swstorage {2-0}

P 2: I-SB2-UC1.rtf - 2:12 [Exploding and seepage of septi..] (39:40) (Super)

Codes: [swstorage - Family: On-site handling]

No memos

Exploding and seepage of septic tanks is also one of the severe problems in the city of Mekelle. Almost the whole Jibruk neighbourhood, the condominium houses found everywhere, the newly constructed military residential areas in *Kebeles* 18, the communal houses of the demobilized fighters of the TPLF, the Mekelle University (mainly both the Addi

haqi and Ayder Campuses), the Regional Correctional Institute, etc are creating serious environmental and social problems in the city due to frequent exploding of their septic tanks. Liquid waste from these sources is overflowing to the surface and reaches river courses after short distance of travel.

Seepage, whether or not it occurs on the surface, is the problem of the whole city mainly because of the very idea that the design of the septic tank shall be in such a way that it allows the watery part to escape through seepage. In other words, the septic tanks are designed and constructed in such a way that the wall of the septic tank or pit latrine allows the watery substance to escape through seepage. This was the very reason to use septic tank system introduced by the responsible bodies into the city or other urban areas. But this was not a correct thinking; rather, septic tanks and pit latrines should be plastered and watertight.

P 5: I-SB5-RC1.rtf - 5:8 [Researcher: How high is the pr..] (24:25) (Super)

Codes: [swstorage - Family: On-site handling]

No memos

Researcher: How severe is the problem of illegal acts committed by residents like open toilet practices, dumping solid waste in open areas and streets and storm water canals, connecting private toilets and septic tanks to storm drainage canals and natural drains, etc. in Mekelle city and Adigrat town? How do you evaluate the care and commitment of the society to handle properly its waste at the sources?

Interviewee_5: Most of the society is aware of the problem of dumping wastes everywhere and knows that it is an illegal act. But the problem arises when the collection group disappears and cancels the programs for a longer time. Health wise, it would be so risky to store waste at home for unlimited period of time. For one thing, most of the wastes are easily decayable and create bad smells quickly. Secondly, the materials used for storing wastes are too old and could be easily torn.

Code: wwstorage {3-0}

P 1: I-SB1-UC1.rtf - 1:8 [In Mekelle as it is true every..] (18:18) (Super)

Codes: [wwstorage - Family: On-site handling]

No memos

In Mekelle, as it is true everywhere in the urban areas of the region, on-site liquid waste management (septic tank) system is used. In fact, what we conventionally called septic tank is an underground hole where the retaining wall is constructed by stone, but not plastered and hence allows liquid to seep into or seep out. Normally, septic tanks should be plastered and should have compartments or cells which could be used turn by turn. This type of septic tank is not available even at the national level.

P 4: I-SB4-UC2.rtf - 4:13 [Researcher: Do you believe the..] (29:31) (Super)

Codes: [wwstorage - Family: On-site handling]

No memos

Researcher: Do you believe the on-site or septic tank system measure up the status or rank of the town?

Interviewee_4: Actually, bearing in mind the construction and operational costs and the complexity of management of sewerage line on the one hand, and size and growth of the town on the other hand, I strongly argue that on-site or septic tank and associated septic suction trucks systems could adequately serve the purpose in Adigrat town. The problem is the poor management system existing in the town; otherwise, sewerage system should not be the precedence of the town at this time. The management of septic suction trucks and availability and quality of septic tanks, and the existence of liquid waste dumping site and their management should be a priority issue or concern of the town.

Lack of access to standard septic tanks is a serious problem. Many houses do not have septic tanks. Moreover, most of the septic tanks in Adigrat are old, and they have problems related to their sizes and construction designs. Usually, the size (volume) of the septic tanks is not proportional to the beneficiary's size (or household size) and the types of use. Because, many houses have either been changed fully or partially to business houses (which may have more beneficiaries or a type of activity that have more discharge) or they have accommodated more tenancies, many of the previously constructed septic tanks are forced to hold much more liquid waste which is beyond their capacity. As a result, exploding/overflowing of septic tanks often takes place. Moreover, owing to the fear that

their septic tanks could be filled rapidly, some house owners create troublesome in different ways to the occupants and/or tenants. .

P 5: I-SB5-RC1.rtf - 5:10 [In relation to liquid waste mana..] (26:26) (Super)

Codes: [wwstorage - Family: On-site handling]

No memos

In relation to liquid waste management, the problem of design and management of septic tanks prevails almost in all urban areas of the region. Septic tanks are designed in such a way that they could infiltrate the watery substances which makes the occurrence of pollution of ground water and boreholes more likely. These types of mistakes are attributed to mainly lack of awareness and have not yet been corrected. Moreover, the volume of the septic tank should be proportional to the number of beneficiaries. In reality, the volume of most of the septic tanks is not proportional to the number of beneficiaries, mainly due to the conversion of the previous land use (usually from residential to commercial houses) to other types. Besides, many single house units may have many tenants and, thus, more beneficiaries depend on a single household septic tank. As a result, many septic tanks explode/overflow frequently and create serious environmental and social problems on the surrounding settlements. What is happening in the condominium houses in Mekelle and Adigrat is a good example of mismatch between septic tank and the size of the respective beneficiaries.. Seepages and explosion of septic tanks and latrines prevail in all sub-cities but are frequently prevailing in Keddamay Weyyane, Ayder, Hawelti and Hadnet sub-cities. For example Jibruk, Addi Shimdhun, Adihaqi, and other neighbourhoods are severely affected areas. The problem becomes so intense during the rainy season.

The most common bad practices of residents as pointed out by the key informants include open toilet (both urinating and defecation), dumping liquid waste and solid wastes into the storm water canals, open areas like streets, bushes, and vacant areas, connecting private latrines and septic tanks with storm water canals and water courses.

As can be seen in Box7, the data on on-site waste handling situation of the two urban centres collected from the key informants is organized in three codes. These are malpractice (practices or activities of the residents that are not proper), swstorage (the

way the solid wastes are stored at sources) and wwstorage (the way waste water are stored at source). The malpractices mainly refers to the open-toilets (defecation and urination in illegal areas), dumping of waste illegally in open areas such as streets, storm water canals, river courses and vacant areas.

It has been stated by the key informants that the defecation and urination in illegal areas (which commonly called open-toilet) is serious problem in the urban areas of the region in general and the study area (Mekelle city and Adigrat town) in particular. People use particularly defecation in open areas in wrong days and night times though it is also usual to look people using open toilet openly in day times. The problem of open-toilet practices is particularly serious in the neighbourhoods with large number of houses selling traditional drinks like *t'ela* and *tej*. For example, neighbourhoods like Jibruk, *Kebeles* 14, 15, 04 and 19 are common places where open-toilet practices are serious problem in Mekelle city. In Adigrat, *Kebeles* 06, 02, and 03 are also known for their traditional drink houses and, thus, wider open toilet practices. Generally, it has been apparent from the discussion with the key informants that the problem of urinating and defecating occurs everywhere in urban areas but it is more severe in vacant areas, streets, and water courses including the storm water canals. Relatively, older and traditional settlements where particularly sanitation facilities are limited suffer more from the open toilet practices. Moreover, areas where more beverage houses particularly traditional drink houses are available suffer from the problem of open-toilet practices.

The informants from both Mekelle and Adigrat argued that many factors could be mentioned as causes to open toilet practices in the urban centres of the study areas, but the effect of lack of access to any types of sanitation facilities (private, shared or public toilets) is worth mentioning. Equally important, the controlling and regulating mechanisms put in place are either ineffective or totally absent. The informants from the regional office have mentioned some more factors that encourage open toilet practices in the urban areas of the region as well as the country at large. Many house owners are not happy or do not feel at ease when renters share toilet with them. Thus, renters usually try to use other options like open toilet for sanitation. It is mainly the nuisance (unhygienic situation) that is more likely to be created (due to shortage water supply) while more people are

sharing single latrine that creates discomfort to house owners. As to the key informants of the regional office, the causes of open-toilet practices like it being a tradition for so long time and unawareness of many residents about its consequences should not also be ignored or underestimated.

The informants mainly from Adigrat have also argued that the trend of open toilet practices is declining attributed to expansion of infrastructure (cobblestone roads) and built up areas in vacant places particularly in the inner part of the town. The expansion in the sanitation facilities largely in Mekelle has also contributed a lot to decline the trend of open toilet practices.

The second case of malpractice is dumping of waste in illegal areas such as in vacant areas, streets, water courses and storm water canals. Both solid and liquid wastes are dumped illegally anywhere in towns by waste generators. The key informants of the towns and the regional bureau have corroborated that vacant areas, streets, water courses, and storm water canals are receiving ends of waste generated within the towns.

The third case of malpractice refers to the misuse of storm water canals and the natural water courses. Private and public houses and institutions' latrines and septic tanks are linked to canals and rivers courses and institutions, and thus liquid waste is released into the storm water and rivers. Still, many other people empty their liquid waste containers and solid waste receptacles into the canals and the rivers. As a result, the rivers that flow through the towns are physically and chemically damaged. The storm water canals are clogged by waste causing overflow of floods in streets and in built up areas. To prevent flooding, the Sanitation and Beautification Department of Mekelle is forced to regularly clean up the canals before the advent of the rainy season. Moreover, sanitation campaign programs, though infrequently, are arranged to clean up the storm water canals.

The key informants have revealed that the problem of connecting liquid waste storages like septic tanks and latrines to water courses and canals is severe in areas where the business houses with relatively large volume of waste water is generated, and are situated alongside (or very close to) the storm water canals or river water courses. Many illegal

houses in Mekelle are often detected connecting their septic tanks to waterways when sudden monitoring and inspecting are conducted. Interviewees from Adigrat also recognize the extent how the problem is severe in their town. Very surprisingly, the concerned office and its staff have come to know the existence of such problem while the Mekelle-Adigrat-Zelanbesa road was reconstructed. During construction a number of canals, connecting septic /latrines to the storm water canal and water courses were uncovered. It was the conviction of the interviewees that there could be some more cases in other parts of the town, but they admitted that they have no capacity to inspect and detect all illegal acts related with this issue.

The informants argue that the reason why persons link their septic tanks or latrines to storm water canals and river courses is very shocking to them. Unlike others, this type of malpractice is committed not mainly due to lack of other options but it is to avoid or minimize their costs incurred on suction truck service fee. The effects of the misused storm water canals are widely perceived in towns almost throughout the region. Very appalling smells emitted through the manholes are particularly severe problems in Mekelle city.

The researcher has also tried to examine the on-site waste handling problems in relation to waste container or storages at sources such as receptacles and septic tanks. Regarding solid waste storages, coded as 'swstorage', the informants elucidated that the type and status of the receptacles used by most of the community in all urban areas of the region are inappropriate and are sub-standard. Most of the time, used and too old receptacles are used for solid waste storage. However, the informants strongly argue that bearing in mind residents' socio-economic background and attitude towards waste material, it is unlikely to imagine other options available for the residents. For almost all people, waste is meant useless, worthless, of no value or rubbish material. They have also disclosed that there are many people who show carelessness to handle their waste.

The second issue raised to the key informant regarding waste storage (container) is liquid waste storage, coded on its own as 'wwstorage'. Liquid waste storage generally refers to one of the sanitation facilities where septic tank is the most important facility, which

concerns the researcher. In fact, septic tank is not only a storage but also it is a primary treatment facility. As shown in Box7, many types of problems are mentioned by the informants related to septic tanks. The most common problems are related to the design, holding capacity (volume) of the septic tanks, and incidences of overflow and seepage of the liquid waste. Nevertheless, what can be seen from the report of the interview is that the extent these problems are prevailing and creating social and environmental problems in the two urban centres varies. The information attained from the informants of both Mekelle and Adigrat and the Regional Bureau (Bureau of Urban Development, Trade and Industry of Tigray) clearly shows that overflowing of waste water from septic tanks and/or latrine is typical of both towns though, comparatively speaking, it seems more serious in Mekelle. The informants have mentioned some examples like Mekelle University in Ayder and Adi Haqi Campuses, residences of the demobilized TPLF fighters in *Kebeles* 18, almost all condominium houses which have been playing great role in complicating the waste management system in Mekelle.

The liquid waste exploded from these and other septic tanks travel long distance crossing many neighbourhoods and ultimately join to water bodies damaging the social and environmental conditions of the city. Seepage from the liquid waste storages (septic tanks) and latrines confinement have also been revealed by informants as one of the problems caused due to poor waste handling at source in the urban centres of the region. Seepages occur as an overflow after a short distance travel from their confinements and travel long distance like the exploded ones.

The problem of seepage and exploding of liquid waste are linked with the problems of the design of the septic tank.. The interviewees believe that many of the septic tanks are structurally sub-standard. Moreover, it is not only that large number of houses has no latrine but also most of the existing latrines are sub-standard and traditional. Most awful of it, the problem of seepage is directly linked with the design of the septic tanks or the masonry of the latrines' walls. It is publicly accepted that septic tanks or latrines shall be built in such a way that the watery part will be lost through seepage. The informants also argue that it should be legally prohibited and any liquid waste confinements should be water-tight.

The informants explain that the main reason why septic tanks or latrines are frequently exploding and cause overflow of sewage is the mismatch between the size of the septic tanks and the number of beneficiaries. Usually, the volume of liquid waste generated is disproportionately larger than the size of the septic tanks thought to hold the liquid waste. They revealed that this situation often takes place when more renters or households dwell within one housing unit. It also happens when residential houses are converted into other types of land use (mainly business houses like restaurants, tea rooms, beauty salons, drinking houses, and so on) which could generate large volume of liquid waste, or in condominium houses, or communal houses like university residences and hospitals.

The analysis of the data obtained through questionnaire and in-depth interview pertaining to on-site waste handling have revealed some salient facts. One of the facts reflected by both sources of data (respondents in the questionnaire and informants in the interview) is that there are widely observed malpractices regarding waste handling in the study areas. Urinating and defecating (open toilet) in illegal areas have been common practices in the urban centres. The open toilet practices usually take place in neighbourhoods where houses selling traditional drinks like *t'ela* and *tejj* are available in vacant areas and river courses. It is common to observe people urinating alongside streets and into the storm water canals in areas where modern drinking houses are found.

Dumping private wastes in illegal areas, as one of the malpractices of residents, have also been identified as a serious problem in the study area. The data collected using questionnaire, interview and personal observation revealed that wastes are found thrown outside of premises. The storm water canals, water courses, and vacant areas suffer more strongly from illegal dumping of wastes. Its effect is apparent that water canals are clogged and flooding of streets obstructs movement of pedestrians and vehicles particularly during rainy time.

The function of storm water canals is abused by a considerable number of residents in the urban areas. Wastes (both solid and liquid) are dumped into the storm water canals and latrines and septic tanks are connected to the canals. The natural water courses are not

free from such types of abuse. This implies that the rivers and water bodies found in the urban areas are at serious risk of pollution. Moreover, bad smells emitted from the canal disturb pedestrians, homes and working places.

The on-site waste handling situation has also been examined vis-à-vis the waste (liquid and solid) storage used at sources by waste generators. All sources of information have disclosed that unsuitable (old enough, worn out and inappropriate) receptacles are used to collect wastes at home. Being structurally inappropriately designed and disproportionately smaller, in relation to the volume of waste they are thought to hold, liquid waste happens to explode out of septic tanks and then overflow to the upper surface.

4.4. Waste Management Policy Document

Obj. 3. To evaluate the extent the waste management policy documents in Tigray have adequately and properly address (measure up to) the main challenges posed by the urban environment problems of the region.

The basic sources of data employed to examine this objective are key informants and relevant documents. Accordingly, the researcher has tried to consult diverse documents. Whether or not urban environmental problem (waste management problem) has received policy responses is reflected in many ways, among which is the presence of pertinent policies and proclamations and associated provisions (eg implementation guidelines), is the first necessary condition. The successful implementation of a strategic objective often depends, among others, upon the existence of appropriate policy documents. In other words, successful achievement of waste management objectives is partly the function of the availability of relevant quality policy document. Therefore, the availability of policy document is an initial condition, and a pre-requisite for proper waste management. In fact, though presence is one indispensable condition, mere presence would not guarantee proper waste management. Quality of the policy documents, when measured in terms of feasibility, relevance, comprehensiveness, simplicity (uncomplicated), and so on, is the next essential element for the implementation of proper waste management. However, mere policy would not guarantee proper waste management unless it is supported by effective and efficient implementation measures, guidelines, or implementation details.

Assessment of the policy responses involves reviewing policy and proclamation documents on the one hand, and policy measures, practices, implementation processes on the other. To this effect, the researcher has primarily made a survey on the policy documents available particularly in the region. Next, the responses of the key informants have been analyzed.

Accordingly, the researcher has tried to explore primarily the major policy and legal documents pertinent to urban waste management enacted at the National, Regional or City level (if any). Subsequently, the researcher has examined the extent to which measures have been taken pursuant to these policy and legal documents to ensure sustainable waste management in the urban areas. The two main policy measures considered in this research are institutional capacity and waste management approaches. The extent to which these two issues have received responses from the decision makers and management bodies to ensure proper waste management systems in the study areas have been discussed in the next two Sub-chapters (Sub-chapter 5.5. and 5.6).

To reveal the extent to which waste management issues have directly or indirectly considered in the environmental policy and proclamations enacted in different periods (mainly since the ratification of the existing constitution, that is the currently active constitution) of the country, it has been important to explore the main ones. It is apparent that environmental problems have been addressed in the FDRE's Constitution ratified in 1994 (1987 E.C) which upholds the right of every person to live in healthy and safe environment.

Subsequent to the Constitution, varied environmental policies and proclamations that address various environmental issues have been enacted at different times. Some of these include:

- Environmental Policy of Ethiopia, 2 April, 1997
- FDRE Solid Waste Management Proclamation No. 513/2007
- FDRE Environmental Impact Assessment Proclamation No.299/2002
- FDRE Environmental Pollution Control Proclamation No.300/2002

- Ministry of Urban Development and Construction, Urban Planning, Sanitation and Beautification Bureau: Solid Waste Management Manual: With Respect to Urban Plans, Sanitary Landfill Sites and Solid Waste Management Planning, April, 2012 Addis Ababa
- Tigray National Regional State, Waste management proclamation No. 191/2011
- Tigray National Regional State, Waste Management Proclamation No. 220/2012
- Tigray National Regional State, Waste Management Regulation No. 81/2013

The critical assessment of the details of the more relevant working documents reveals that waste management problems have been addressed in the environmental policy of the country. It holds that items 2.3 (a) under the guiding principle (sub-item 'a'), 'every person has the right to live in a clean and safe environment'. Under section three entitled 'Sectoral Environmental Policy' item 3.8, 'Human Settlement, Urban Environment and Environmental Health' (almost all items stated under it), and item 3.8 'Control of Hazardous Materials and Pollution from Industrial Waste' (sub-items 'f', 'g', 'h' and 'i') have particularly focused on waste management issues. Likewise, the Federal Democratic Republic of Ethiopia (FDRE), Solid Waste Management Proclamation no 513/2007, which is composed of 19 Articles presented in five parts, addresses only the solid waste management issues of the country. Unfortunately, the researcher could not be sure whether or not proclamations or associated provisions pertaining to liquid waste (liquid waste) management at the national level are in place. The Tigray National Regional State, as it is stipulated in the region's Waste Management Regulation No. 81/2005 E.C (No. 81/2013), owns waste management Proclamation No.191/2011 (No.191/2003 E.C) article 24(1) and No. 220/2012 (No. 220/2004 E.C) article 2(12).

Generally, having appraised these policy and legal documents and other relevant provisions, the researcher argued that waste management issues have been addressed directly and indirectly in a range of details in the environmental policy, proclamations, regulations and associated provisions of the country and the region.

However, very critical constraints have been found out in the waste management system of the urban areas of the region. At the outset, it should be noted that in consequence to the change, among others, in level of urbanization, wealth and life style of the people, the characteristics of waste has been changing from time to time. The nature, composition and generation rate of waste is changing giving rise to huge and diverse types of waste production. This in turn makes waste management a very complex and challenging task. Yet, Ethiopia and the Regional State of Tigray have no Waste (Solid and Liquid) Management Policy.

The informants included from the policy makers' side have disclosed that there are waste types which have not received attention from the policy and decision makers. These include agricultural waste, construction waste, special waste like e-waste and hazardous waste. Because of their distinct and complicated nature, they believe that such types of waste need their own proclamation or regulation and implementation directives or guidelines.

Moreover, the informants have boldly argued that, though most of the issues of both solid waste and liquid waste are blended together even in documents, liquid waste management has not received no or little from the responsible local as well as regional authorities. They strongly recommended an institutional rearrangement wherein liquid waste management endeavours are better merged with the cities' or towns' Water Supply Services. Moreover, they urge liquid waste management to have its own policy documents, organizational structure or office, and workforces or employees of relevant profession and expertise. They argue that liquid waste is a most overlooked problem not only at the regional and lower level administration units but also at national level.

A key issue particular to Mekelle city, as raised by the informants, is that being the capital city of the region and second populous /largest city in the country, it deserves its own waste management policy documents (policy statement, proclamation, regulation, etc), organizational arrangement, human and material administration system that matches its status (size, socio-economic condition, etc.). To date, there is one and same policy documents and structural arrangements thought to be operational in all urban centres of

the region regardless of their disparity in their size. Waste management system is very sensitive to the social, economic and political context of the urban areas. It is apparent that the context of a town inhabited by 2000 people (minimum number of population size required to be honoured a status of a town in Ethiopia) is quite different from a city that has a population greater than 360,000 and functions as a regional administration centre (capital of the Tigray Regional State). This implies that because of difference in contextual background, the urban centres of varied size could have different waste characteristics and, thus, varied level of complexity of waste management. Nonetheless, virtually all waste management policy documents and measures and associated implementation directives endorsed by the regional government applies uniformly to all urban centres granted with municipal status.

The researcher has also detected certain gaps in the documents that could have a serious impact on the waste management endeavours. One of these gaps is that certain guidelines and directives have not yet been prepared and come to be executed as per the recommendation of the Waste Management Regulation enacted in 2013 (2005 E.C.). This includes Article 9 and sub-article 2 and 3, Article 21 sub-article 2, etc., Article 16, and Article 17.

Moreover, it has been identified that certain articles in waste management regulations like Article 4(3) of Waste Management Regulation of the Tigray National Regional State have not clearly defined the public office or sector, which should be accountable in their implementation. This implies that this part of the waste management regulation has been floating on air without specific owner. For instance, no specific office or section has been given the power by law to regulate and penalize those who disregard or violate waste management rules and regulations. The Sanitation and Beautification Department, for instance, has no the right to execute enforcements though different experiences are observed in certain urban centres.

Opinions of the informants have also been collected to discover whether they have recognized defected documents which are either impracticable (due to various reasons) or too weak to serve the purpose. Of course, certain waste management rules and

regulations are not simple to implement. The informants have confirmed that there are certain rules which trouble the community as well as the practitioners to implement them. For instance, the rule that obliges residents to take responsibility for any illegal acts committed within 20 meters radius of their premises is very demanding to implement. If wastes are dumped or somebody urinates or defecates in streets or vacant places unsightly (in wrong days or dark nights) within 20 meters of radius of one's premises or home, the house owner should clean it. The informants, particularly the decision makers, accept that it brings additional burden to the community but also they argue that there is no better option than to bring it to effect.

With respect to enforcements, informants have shown serious complaint. They pointed out that the unfairness of certain enforcements and the mismatch between the wrong deeds committed and the penalty thought to be effected on is the basic feature of the enforcements indicated in the waste management regulation of the region. They argue that it is not fair to penalize birr 2500 to one who has not properly handled and disposed his/her solid waste outside of his/her premises while one whose septic tank or latrine explodes and flows out of his premises and pollutes the surroundings is subjected to birr 1500 fine. Another case that confirms unfairness is that those who urinate or defecate in street or any illegal area are levied only birr 15 penalty whereas business houses and residential houses who pour their waste water (including hand wash) are made to be penalized birr 500 and 50, respectively.

However, despite all these shortcomings revealed pertaining to the documents in place, informants argue that most of the environmental problems particularly the waste management problems prevailing in their towns are not mainly attributed to problems linked with the implementation. The informants recognize that implementation problems could be attributed to the effect of the defects appearing in the documents, or non-existence of necessary policy documents (like policy statement, proclamations, rules and regulations, directives, guidelines etc.) on waste management implementation system. Obviously, a defected document could be a major barrier to effective implementation. Nonetheless, as pointed out by the informants, the effect of the weak institutional capacity

and low commitment of the responsible body on the poor waste management observed in the major urban centres of the region is more remarkable.

Thus, the informants strongly argue that the rules and regulations and directives are not fully and properly implemented largely due to weak capacity and low commitment of the responsible, local administrations and institutions. The issue of institutional capacity has been addressed in detail in the next sub-chapter 5.5 (see page 359).

In general, the waste management regulation adopted by the council of Tigray in 2005 E.C (2013) has addressed the main issues of both solid waste and liquid waste management including enforcements and associated penalties though certain articles and sub-articles lack clarity and specificity. However, as it has also been disclosed by the key informants, the researcher has observed that the existing documents are not properly and satisfactorily implemented. The researcher argues that, despite their paramount importance to ensure proper and sustainable waste management system, the existing urban environmental problems in general and waste management problems in particular are not primarily created because of the non-existence of or the defect in the policy and legal documents. Of course, the researcher would disregard the impacts of the defected documents that have been crippling the waste management endeavours in the urban areas.

Box 8. Output: Waste Policy Document

Waste Policy Documents

Contents

Waste Policy Document.....	333
Code: documents {6-0)	334

Code: documents {6-0}

P 1: I-SB1-UC1.rtf - 1:14 [Researcher: Have you ever face..] (28:32) (Super)

Codes: [documents - Family: Waste Policy documents]

No memos

Researcher: Have you ever faced or observed any problem in waste management in your city/town owing to the inexistence of necessary or defected policy and /or legal document(s)?

Interviewee_1: We have a solid waste management legal documents and proclamation at the regional level. Rules and regulations and enforcements of solid waste management are there. The basic provisions related to solid waste are there. It can be said that almost all necessary legal documents related to solid waste management are available, though some very specific issues like construction waste, special wastes like e-wastes, hazardous, etc. are not properly and adequately addressed in the proclamation and legal documents of the region. But the problem is mainly linked to implementation. It is very difficult to implement the rules and regulations. For instance, one who committed illegal acts and found red-handed could not be penalized directly by the Sanitation and Beautification Department, , what can the department do is only to establish charge in civic courts. And this is a very monotonous process. In short, the processes of implementation of rules and regulations of waste management in particular and sanitation in general are very complex and difficult. Moreover, the enforcements are too weak to correct illegal acts. But I hope it will be corrected when the new restructuring plan of the municipality is implemented.

However, with respect to liquid waste management, I can say that it is not totally addressed right from the federal level up to the town/city level. At least in theory, the assumption is that liquid waste management issues are handled together with solid waste management by the Sanitation and Beautification Department at the regional and city/town level. But liquid waste management has no its own policy and legal documents. Furthermore, the Department of Sanitation and Beautification at all administration levels has no workers or experts specialized in liquid waste management. In short, there is no policy document that specifically addresses liquid waste problems on its own, no workforce specialized and engaged in, and no structural or organizational arrangement that focuses on liquid waste

management.

Besides, an overlapping of duties and responsibilities among different sectors is a common phenomenon; there is no clear demarcation in job description (duties and responsibilities) regarding waste management (mainly liquid waste management) among each of the related sectors such as environmental protection, Sanitation and Beautification, health, construction and industry sectors, etc.

Researcher: Does your town have its own policy and/ or legal document such as policy, proclamation, legislation, rules and regulation, directives or any other document which either adopted by its own City Council or by the Regional Council?

Interviewee_1: Mekelle does not have its own policy or legal document; it uses the same documents that other smaller towns use. which are adopted by the Bureau of Urban Development, Industry and Trade (BUDIT), Sanitation and Beautification Department. And this has been one of the challenges of the Sanitation and Beautification Department of Mekelle city to manage the waste generated in the city. Mekelle is by far larger city than the other urban area of the region. The socio-economic characteristics and life style of its people is significantly different from the other urban areas' residents of the region. As a result, I believed that the waste characteristics and complexity of the waste management is significantly different from the rest urban areas of the region. This implies that Mekelle city needs a policy document and other policy measures that measure up its urban status.

P 2: I-SB2-UC1.rtf - 2:20 [Researcher: Have you ever face..] (52:54) (Super)

Codes:[documents - Family: Waste Policy documents]

No memos

Researcher: Have you ever faced or observed any problem in waste management in Mekelle owing to the inexistence of necessary or defected policy and /or legal document(s)?

Interviewee_2: When it is evaluated in terms of the documents and provisions in place, except that of liquid waste management, there has not been a serious problem of solid waste management caused due to lack of policy documents or provisions. But the main problem is linked with the process of implementation of rules and regulations and enforcements. The process to implement rules and regulations is very lengthening and discouraging; it is

challenging to control and punish illegal acts or malpractices observed in the society. Even when people are red handed while committing illegal acts, the Office of the Sanitation and Beautification have no the right to punish them, but to present a charge to the mandated, civil court. Worst of it, the enforcements are so week, unable to correct rules and regulations violators. Likewise, the attention given to illegal acts linked with environmental safety and quality (sanitation and beautification) by the lawyers is also insufficient.

P 3: I-SB3-UC2.rtf - 3:17 [Researcher: Have you ever face..] (26:30) (Super)

Codes:[documents - Family: Waste Policy documents]

No memos

Researcher: Have you ever faced or observed any problem in waste management in Adigrat owing to the inexistence of necessary or defected policy and /or legal document(s)?

Interviewee_3: Regarding solid waste, lack of policy document or legal document (policy objectives, legislations, rules and regulations, proclamations, and so on) is not a problem. Rather, the problem is mostly linked with implementation.

When it comes to liquid waste, it has no its own policy document and legislation that either states policy goals or rules and regulations or proclamations, etc.

Particularly, the implementation of rules and regulation and enforcements becomes very difficult because it involves three parties: Sanitation and Beautification Office, finance sector, and legal offices. As per the rules and regulation of the town, when malpractices are detected but the violators/ illegal doers show reluctance/unwillingness to fulfil their obligations (pay fines/environmental fee), the SB Department shall bring them (the illegal committers) to civic courts and then to finance office to pay. This clearly confirms that the long and complicated processes needed to control and to implement enforcements has discouraged the staff of the Sanitation and Beautification Department of the Town. In general, monitoring and controlling system of illegal acts pertaining to waste management is complex and beyond the mandate of the Sanitation and Beautification Departments.

P 4: I-SB4-UC2.rtf - 4:19 [Researcher: Is there regular a..] (40:41) (Super)

Codes:[documents - Family: Waste Policy documents]

No memos

Researcher: Is there regular and effective controlling and regulating systems to illegal acts and implementation of enforcements on illegal acts such as on open toilet practices, exploding and seepage, misusing of storm water canals, etc.? If any, what types of problems do you face?

Interviewee_4: Regulating and controlling of illegal acts is our main task but not to penalize. First of all, the SB Department is not mandated legally to penalize illegal doers. The Department is not allowed to administer receipt voucher and penalize violators. Moreover, the lengthy process of law_one has to go through to penalize birr 20 and the reluctance or resistance of the illegal doers to fulfil the requirement is unreasonable, discouraging and not viable. This implies that the document that states the rule and regulation implementation process has a problem; it is not feasible to implement and instead, makes things very complex during implementation.

P 4: I-SB4-UC2.rtf - 4:22 [Researcher: Have you ever face..] (45:47) (Super)

Codes:[documents - Family: Waste Policy documents]

No memos

Researcher: Have you ever faced or observed any problem in waste management in Adigrat owing to the inexistence of necessary or defected policy and /or legal document(s)?

Interviewee_4: I do not remember whether I faced a problem while discharging my duties and responsibilities brought about due to absence of relevant policy document, except that the rules and regulations have not clearly specified the responsible body or group to implement enforcements. But there are certain legislations and documents which are inconsiderate to the (lower) socio-economic -status of the community. Moreover, certain enforcements are unfair_or unreasonable and are weaker when the effects of the wrong acts are considered. For instance, one who has not properly handled and disposed of his/her solid waste outside of his/her premises is made to pay birr 2500 ; whereas, one whose septic tank or pit latrine explodes and flows out of his premises and pollutes the environment due to mishandling or carelessness is subjected to birr 1500 penalty. A business house and residential house who pours liquid waste (including hand wash) out of his/her house is forced to pay birr 500 and 50 respectively, but one who urinates or defecates in streets or other areas is punished only

birr 15. Moreover, the informant presumes that the rule and regulation revised recently, as stipulated in the proclamation, seems a bit stronger to most of the community living in Adigrat town.

P 5: I-SB5-RC1.rtf - 5:12 [Researcher: Have you ever face..] (30:32) (Super)

Codes: [documents - Family: Waste Policy documents]

No memos

Researcher: Have you ever faced or observed any problem in waste management in the urban centres of the region in general and Mekelle and Adigrat in particular owing to the inexistence of necessary or defected policy and /or legal document(s)?

Interviewee_5: Most of the key policy and legal documents are available. But there are some necessary documents that are missing or incomplete. For instance, special wastes (e.g. e-wastes), hazardous wastes, construction wastes, and agricultural wastes need their own proclamation and legislation and guidelines. For example, what is construction waste is vague; for how long should construction materials be left on site so as to be labelled as waste? It is usually linked with construction permits. And much of the construction materials left over might be useful in the same way as before. This means that they could be used for the same purpose as before.

Unlike solid wastes, liquid waste management problem has not been addressed independently and fully in any policy documents. There is no policy document (policy, strategies, proclamations, legal framework, legislations, etc) that covers directly and fully liquid waste management issues.

4.5. Institutional Framework of the Waste Management Sector

Obj.4. To assess the organizational and operational capacity as well as the political commitment of the institutions that is in charge of providing waste management services and monitoring and regulatory works in the region.

Policy responses could be reflected in diverse dimensions. Specifically, policy responses to urban environmental problems in general and waste management in urban areas might be examined from different angles, among which institutional capacity is taken as the most important one following the policy document by the researcher. In view of this, the researcher has asked the opinion of the key informants of the two urban centres regarding the extent to which efforts are being made to strengthen the capacity of the respective institution, mainly the Sanitation and Beautification Department.

The researcher has tried to examine the current capacity of the institution and efforts made to build up the capacity in terms of three factors such as the organizational structure, human power resources, and financial and materials resources. The organizational structure of the sanitation and beautification office has been severely commented by informants of Mekelle City. They argued that, when the urban status of the city, as measured in terms of its size and function, is taken into consideration, it would be irrational (unreasonable) to organize the sanitation and beautification works of Mekelle City at department level. This is because the magnitude and complexity of waste management activities and thus problems increases proportional to the size of the city and its socio-economic circumstances. Therefore, they claimed that the sanitation and beautification endeavours of the city as a whole need to be organized at the agency level. But one important decision passed on recently by the decision makers is that the institutional structure of the Sanitation and Beautification sector has been extended from city level up to sub-city and to *Tabia* level in Mekelle or from town level up to *Kebeles* level in Adigrat.

Moreover, because of its distinct socio-economic and environmental conditions, Mekelle needs environmental directives, guidelines, and even regulations or legislations of its own

that match its status. This could be prepared and endorsed by the city's council. It is also noted that co-ordination among the relevant offices and sectoral offices as stipulated in the waste management regulation enacted in 2013 (2005 E.C) of the region is absent.

The human resources of the Sanitation and Beautification Department have also been evaluated in view of their adequacy, qualification and commitment and satisfaction. As it has been shown in Box9, the informants have agreed that the human resource that is deployed by the department in the study areas, especially in Mekelle, is far. The informants stated that there is a serious problem of shortage of manpower when evaluated as per to the BPR (Business Processing Reengineering) structure and as compared to other Municipal Sectors Departments and Offices. For instance, in Mekelle as a whole (including the seven sub-cities and 32 *Tabias*), the department is allowed to recruit only 102 employees (vacancies). In view of the massiveness, complexity and sensitiveness of the activities of the waste management sector, the informants have also severely complained that the staff size (the human resource to be allocated) as defined in the BPR is extremely low. In sharp contrast to the expectations of the informants, the Sanitation and Beautification sector is suffering from turnovers of employees; for instance, in 2017 it was only 67% of the total manpower that was permitted to continue to work in the sector on the basis of the BPR in Mekelle. This is largely because of the reluctance of the management body to recruit the necessary manpower on time. The manpower problem of the waste management sector is also reflected not only in quantity but also in the quality of the manpower. They said that it has been very difficult to attain manpower with appropriate qualification from the market; usually, it was those with related fields of specialization that were recruited. Moreover, coordinators or heads of the Sanitation and Beautification Department are usually politically appointed by the chief decision makers, irrespective of their professions or qualifications.

Box 9. Output: Institutional Capacity

Institutional Capacity

Contents

Institutional Capacity	341
Code: financial /material resources {5-0}	342
Code: human resources {8-0}	344
Code: Organizational structure {3-0}	351

Code: financial/material resources {5-0}

P 2: I-SB2-UC1.rtf - 2:22 [Insufficiency of budget alloca..] (58:59) (Super)

Codes: [financial/material resources - Family: Institutional Capacity]

No memos

Insufficiency of budget allocated to the Department of Sanitation and Beautification is also one of the indicators of inadequate attention given to sanitation and beautification. Not only is budget insufficient but also the financial process and procurement system is so complex and lengthy. As compared to other offices/sectors and the magnitude of the task, the budget allocated to Sanitation and beautification is not fair.

The department of SB section is highly deficient of machineries such as secondary collection trucks, heavy duty machineries, facilities and equipment in the landfill.

P 3: I-SB3-UC2.rtf - 3:4 [Besides, the revised BPR (Busi..) (4:4) (Super)

Codes: [financial/material resources - Family: Institutional Capacity]

No memos

Besides, the revised BPR (Business Processing Reengineering) structure in relation to manpower, the yearly increase in the budget allocated for waste management, and others by the office of the SB and the local administration of Adigrat town and the Bureau of Urban Development, Trade and Industrialization Bureau (BUDIT) are some of the responses to the changing characteristics of the waste in Adigrat town. As compared to the magnitude of change in the waste characteristics, the responses of the responsible bodies are however not adequate. For instance, the collection trucks are so few to provide adequate and rapid collection services to the whole town.

P 3: I-SB3-UC2.rtf - 3:20 [The financial capacity of the ..] (36:37) (Super)

Codes: [financial/material resources - Family: Institutional Capacity]

No memos

The financial capacity of the town in general is very low. As a direct effect of this, the budget allocated to the SB section is very low. But when compared to the other sections or

departments within the (local) municipal administration, SB section does not get lesser amount. But the long and complex finance and procurement processes are very disappointing. It has created serious hindrances during material purchase, machinery and collection tractor carriages maintenances, and fuelling activities.

Regarding material capacity, it is clear that the basic material resources of the SB section are the landfill machineries, the collection tractor carriages and water transporting septic suction truck and one liquid waste transporting septic suction truck. In the landfill, there are one dozer and one compactor machineries though their capacity is low. Likewise, there are five tractors and carriages which are currently out of duty due to damage. Since the distance to landfill is so long, the Department of SB needs one medium scale transport vehicle and motorcycles to the *Kebeles* experts.

P 4: I-SB4-UC2.rtf - 4:24 [When the material resources of..] (51:52) (Super)

Codes: [financial/material resources - Family: Institutional Capacity]

No memos

When the material resources of the SB section are considered, it would be important to evaluate the collection services and the operation of the landfill. It is clear that the waste collection service in the town is paralyzed mainly because of shortage of collection trucks and frequent damage and unnecessarily long downtime. The landfill has one dozer and one compactor though they are not large enough to carry out their tasks. But these are not the only necessary machineries needed in the landfill. Moreover, these machineries are not working what they have to work in the landfill. They are involved more in some other activity such as in constructional activities and illegal business which should to be handled by the town administration, and is not part of the sanitation and beautification task,. Infrastructure like water and electricity are not available. The employees (the environmental engineers) are moving throughout the town on foot; they do not have even bicycles though previously there were.

With respect to budget, as compared to the load and complexity of the waste management activity, it is not adequate. But the main problem as I have observed is management problem. Most activities and plans are failing mainly because of administrative problems; inability to manage and use properly the budget they have; that is poor financial management.

P 5: I-SB5-RC1.rtf - 5:15 [The budget allocated to the se..] (39:39) (Super)

Codes: [financial/material resources - Family: Institutional Capacity]

No memos

The budget allocated to the sectors particularly to project works and the commitment to create clean cities and towns is going up. But still, it is not sufficient. The attention given to waste management and sanitation problems is not proportional to the waste management problems the urban centres have.

Code: human resources {8-0}

P 1: I-SB1-UC1.rtf - 1:16 [Researcher: To what extent the..] (40:43) (Super)

Codes: [human resources - Family: Institutional Capacity]

No memos

Researcher: To what extent do the decision makers recognize the problem of urban environment in general and waste management in particular, and are committed to properly and sustainably manage the waste produced in the city?

Interviewee_1: Whether or not the policy and decision makers are well aware of waste management problem and are committed to maintain the sanitation and beautification (cleanliness) of the city could be reflected in many ways. Among which, the focus given to strengthen the overall capacity of the Department of Sanitation and Beautification at each level and the extent to which new, modern and effective waste management approaches are implemented are most importantly recognized. The institutional capacity of the Sanitation and Beautification partly depends on the quality and quantity of human power it has. The human power requirement could be evaluated in two perspectives: from the perspective of BPR structure and from the nature and magnitude of the activity. Currently, based on the BPR structure, only 67% (68) of the total manpower demand (102) of the SB sector is fulfilled. One of the problems is lack of willingness of the responsible body to recruit and fulfil the manpower requirement of the Department as per the BPR. Besides, it has been very difficult to get the right persons with the right qualification. For most of the people, the nature of the work and the salary scale are not promising. Usually, the office could not find environmentalists specialized in the right field like in solid waste management, liquid waste management, landfill managers or engineers, and so on, but it tries to search and accept from

related fields. In some cases, the office could be lucky to get one or two employees /staff in the right qualification, yet they are not willing to stay long; the turnover of manpower is very high.

Researcher: What is the attention given to elevate the commitment and satisfaction of the workers?

Interviewee_1: This is one of the typical problems of the Sanitation and Beautification Department from the bottom to the top. There is no special treatment, advantage or benefit attained by the workers though the nature of the work is very risky and repulsive socially. Likewise, from health and safety point of view it, is one of the most unsecured jobs. Therefore, it is not surprising if the workers have been very dissatisfied and less committed. Today, there seems to be more concern by the decision makers on the problem of waste management than it was before; but still it is inadequate, the work and workers of solid waste management have not yet received the necessary response from the policy makers which could be explained reflected in many ways. The decision makers at the city as well as the regional levels speak about the need to give attention to waste management of the city for it being the capital of the region. Yet, in practice when evaluated in terms of the efforts made and commitments to fulfil the budget, manpower and material resources of the sanitation and beautification works have not received attention. The main focus of all offices is only land and land related issues because it could raise accountability issues unlike to sanitation and beautification activities. Besides, our decision makers' environmental awareness and sensitivity to urban environment and waste management problems is insufficient.

P 2: I-SB2-UC1.rtf - 2:21 [Interviewee_2: Waste managemen..] (57:57) (Super)

Codes:[human resources - Family: Institutional Capacity]

No memos

Interviewee_2: Waste management is a very sensitive sector. But the attention or focus given to it is not comparable to its degree of sensitivity. This has been reflected in many aspects. For example, the institutional organization and arrangement of the Sanitation and Beautification activities should not be at department level. Waste management works need immediate and necessary response in human power, financial and material resources, and administrative issues. For so doing, primarily Sanitation and Beautification works needs to be

institutionalized at either agency or office level so as to have power to decide and look for immediate solutions to its problems. The human power, though there has been a slight change in the structure since recently (since the last year), required as per the structure is inadequate. Particularly, liquid waste management has totally been overlooked; there is no expert specialized in it. Moreover, due to the insufficiency of the salary scale, it has been difficult to fulfil the manpower demand that have the relevant qualification. Turnover is so high. The payments and incentives are not comparable to the difficulties of the work and the health, safety and social problems encountered by the workers. Due to this, the workers are highly dissatisfied and less committed.

P 3: I-SB3-UC2.rtf - 3:19 [The manpower size of the SB se..] (35:35) (Super)

Codes:[human resources - Family: Institutional Capacity]

No memos

The manpower size of the SB section illustrated in the BPR (Business Process Reengineering) structure, however, is very small when the nature, magnitude and complexity of the job of the Department are considered. Waste management in urban areas is a very sensitive and vast task. Since it demands a range of fields of specialization in terms of qualification, all experts are recruited as per the demand of the BPR. However, there is a high turnover of employees mainly because the payments and remunerations are not proportional to the nature and magnitude of the works of waste management. As a result, the commitment and satisfaction of the workers has been virtually zero/very low. For instance, within 2-3 years, about half of the experts (environmental engineers) recruited in *Kebeles* have left it.

P 4: I-SB4-UC2.rtf - 4:5 [Researcher: Is there consisten..] (10:14) (Super)

Codes:[human resources - Family: Institutional Capacity]

No memos

Researcher: Is there a consistent and strong controlling and inspecting system to ensure proper waste collection services to the society in your town?

Interviewee_4: Due to the shortage of manpower and lack of means of transportation, it has been very difficult to fix program and carry out controlling and regulating activities consistently. Besides, there is a wrong tradition or understanding in the town that the SB unit is responsible

to control every type of illegal acts such as illegal construction, illegal business, illegal slaughter, and so on. But it is not stated in the document sent from the Bureau of Urban Development, Industry and Trade (BUDIT), and particularly, the Sanitation and Beautification Department of the Region that explain the job description of SB staff. But, for the simple reason that manpower recruited to carry out such tasks is non-existent, the duties and responsibilities of the SB has been intentionally abused by the local administrative bodies of the town, and forced the involvement of workers in such types of activities out of their job description. This situation has not only competed the time of the main activities of the SB section but also killed the interest of the workers and become the main cause of high turnover of employees in the SB.

Involving the employees of SB in activities which are out of their duties and responsibilities has been the main cause of dissatisfaction and poor commitment of the SB staff.

Generally, inefficient and inappropriate trucks' fuelling and repairing systems which are more of an administrative problem, shortage of manpower and collection trucks, the tendency to load additional work burden (tasks) on the SB staff out of their duties and responsibilities as stipulated in the regional document are among the key challenges of waste collection services.

The planning system is also a problem. When plans are developed and targets set and then performance is measured, there seems a fallacy. Under estimation of the waste generated results in inflated collection coverage. Moreover, targets are set at town level and are distributed equally to the *Kebeles* levels regardless of their difference in population size. Besides, weaknesses in management or administration are widely seen in many ways: machineries are not repaired in/on time; the attention and respect given to the sector and their staffs are very low; and the financial processes and administration system is very complex and slow.

P 4: I-SB4-UC2.rtf - 4:20 [The extreme or severe shortage..] (41:42) (Super)

Codes:[human resources - Family: Institutional Capacity]

No memos

The extreme or severe shortage of manpower of the SB is also another problem that inhibits to carry out effective and efficient controlling and regulating activities. There is only one staff

at *Kebeles* level who is responsible for handling every waste management issues.

Nevertheless, the SB employees are trying to control and regulate liquid waste occurring outside one's premises due to the explosion and seepage of septic tanks and latrines, misusing of storm water canals, and open toilet practices.

P 4: I-SB4-UC2.rtf - 4:23 [Researcher: How do you evaluat..] (48:50) (Super)

Codes:[human resources - Family: Institutional Capacity]

No memos

Researcher: How do you evaluate the responses of the policy in general and the policy and decision makers in particular when viewed in terms of the efforts made to develop institutional capacity of Sanitation and Beautification Department at all levels to manage properly and effectively the waste produced in Adigrat?

Interviewee_4: When manpower is considered, it could be evaluated from two dimensions: firstly, it should be seen from the view point of BPR structure and the other is from the work load. When evaluated from both perspectives, shortage of manpower is a typical problem of the SB section. Sometimes, through extensive announcement, more professionals are recruited; however, they do not stay long in the office. They leave the work soon. For instance, last year there were six employees recruited together at same time as environmentalists, but now, almost a year after, three of them have left. This implies that, turnover is very high. From my understanding, the main reasons are maladministration and bad or negative attitude of the administration bodies towards the work and the workers, the low payment which does not take into consideration the qualification of the employees and the nature and burden of the work.

P 5: I-SB5-RC1.rtf - 5:14 [Researcher: To what extent the..] (36:39) (Super)

Codes:[human resources - Family: Institutional Capacity]

No memos

Researcher: To what extent has the BPR structure responded to the human power demand, (quantitatively and qualitatively), and the organizational structure of the sanitation and beautification activities of the cities and towns of the region?

Interviewee_5: According to the BPR, Adigrat has two level structures, one is at the centre and the other is at the *Kebeles* levels.. According to the structure of the BPR, Mekelle, the largest city in the Region referred as the Rego-policy, has similar structure to that of the Regional Level SB Department. The second level urban centre including the sub-cities of Mekelle have similar structure, where there is one environmentalist in waste management at each sub-city and one at the *Kebeles* level. This implies that in the second level urban centres, for instance in Adigrat, there is one expert at the centre (town level) and one at *Kebeles* level. I believe that it would not be as such difficult to the *Kebeles* level environmentalist to manage all activities related to waste management taking place within his/her *Kebeles*. Some of the basic tasks of the *Kebeles* level environmentalist include controlling the collection groups whether or not they are rendering collection services as per the schedule, inspecting every streets and houses whether or not the 20 meter radius principle is implemented, ensuring that those residents with ample space within their compound are converting their waste into compost, and so on.

Rather, the problem is not because they are few in number, but because the commitment and satisfaction of the employees is too low. The main reasons for the dissatisfaction of the employees are so diverse. One, the payment and remuneration of the employees of the sanitation and beautification particularly those involved in waste management are discouraging. It does not consider the nature and complexity of the waste management endeavours. The attitude of the local administration as well as the community towards the work and workers of waste management is also disappointing. It is very surprising to come across local administrators who disrespect the waste management workers and their works. Even in office allocation in many towns, the demand of the SB is overlooked. If any, lower grade or/and inappropriate rooms are assigned to them. But usually *Kebeles* level experts have no offices; they either share bench or chair or not at all. No facilities and working materials like computers or other stationery materials either to record data are allocated to the Sanitation and Beautification unit. Mainly, because of these and other problems the high turnover of manpower in Sanitation and Beautification Sector is unbearable. If we see the case of Adigrat, two years ago, almost all *Kebeles* had one environmental engineer each. But by now, almost all have resigned.

In fact, since the last two and three years, there has been a promising improvement from time to time mainly in the higher leadership and to some extent, in the local administrators. This is partly due to the fact that the decision makers are trying to recruit local administrators based

on their profession. Action Response Measures

P 5: I-SB5-RC1.rtf - 5:17 [In general, the performance of..] (11:11) (Super)

Codes:[human resources - Family: Institutional Capacity]

No memos

In general, the performance of urban centre in waste collection and disposal activities in most of the urban areas has not been consistent. Today, certain urban centres perform better than others, but tomorrow they fail partly due to high turnover in both the manpower of SB office and even in the decision makers. Because of this, the Urban Development and Trade Bureau, particularly, the Sanitation and Beautification Department is forced to arrange training now and then to newly recruited employees. Generally, the environmental awareness and commitment of the decision makers, particularly the local administrators of the urban areas, to ensure effective and sustainable waste management is insufficient.

Code: organizational structure {3-0}

P 1: I-SB1-UC1.rtf - 1:15 [Researcher: How do you evaluat..] (33:36) (Super)

Codes:[organizational structure - Family: Institutional Capacity]

No memos

Researcher: How do you evaluate the responses of the policy in general and the policy and decision makers in particular when viewed in terms of the efforts made to develop institutional capacity of Sanitation and Beautification Department at all levels to manage properly and effectively the waste produced in Mekelle?

Interviewee_1: One of the responses of policy to environmental problem in general and waste (solid and liquid) management in particular is reflected in the capacity of the institution in question. The institutional capacity is the sum result of three main elements such as the human, financial and material resources. Moreover, the extent to which waste management has received policy response could be measured by the institutional arrangement and organizational structure of the urban environmental management and specifically the Sanitation and Beautification Office.

In fact, I accept that the expansion of the structure of the SB section up to the *Kebeles* level in

Mekelle is one of the good deeds. But I strongly argue that the way it is organized is not appropriate. We could communicate and help each other from top (centre) to the bottom (*Kebeles* and *ketena* levels), yet every level of Sanitation and Beautification unit is primarily accountable to the respective administration unit. *Kebeles* SB unit is primarily accountable to the *Kebeles* administration body. Likewise, the Sub-city SB Department and the city level SB Departments are accountable to the respective sub-city Administration and the City Administration (or Municipal Manager), respectively. Every level of SB unit presents its budget request to and receives from the respective administration level (the *Kebeles*'s SB receive from *Kebeles* level Administration, Sub-city SB from sub-city Administration, and city-level SB from the Municipality Office). Therefore, though there is in principle a dual accountability system, in practice, it has not been possible to create strong link among the SB offices at each administration level. The same is true among the city level SB Department with the regional level SB Department.

When the scope and complexity of the tasks of the waste management of the city is considered, Mekelle does not deserve the currently existing organizational system. The organizational system does not measure up the present status and size of the city. I strongly believe that the whole waste management activities of the city should be organized under one agency or office that has a structure extended even up to the zone (*ketena*) level. Surprisingly, this organizational system has been practiced in many cities of the country which are smaller than Mekelle City. If waste management activities are organized under one office or agency, it would be possible to smoothly coordinate the whole works of waste management in the city. Above all, organizing the whole activities of sanitation and beautification of a city or town in one all-inclusive institutional organization could have many advantages, among which, the power and mandate to demand and approve its budget and human power would be the key one. Likewise, the long and hectic process of financial process and procurement system could have been significantly shortened and simplified. Moreover, had it been organized at the office or agency level, we could have our own capacity building plan which has totally been run under the local administrative bodies. With respect to the institutional arrangement, there are many sectors as well as offices which have similar duties and responsibilities (overlapping of tasks) to that of Sanitation and Beautification Department, but they have no or limited coordination among each other. For example, the duties and responsibilities of the Environmental Protection Authority, Health sector, and the Sanitation and Beautification Unit overlap on many issues. Even the

Sanitation and Beautification sectors at the centre (city wide) and at sub-cities have no clear demarcation in their duties and responsibilities. In many aspects, they have overlapping duties and responsibilities.

P 3: I-SB3-UC2.rtf - 3:18 [Researcher: How do you evaluat..] (32:34) (Super)

Codes:[organizational structure - Family: Institutional Capacity]

No memos

Researcher: How do you evaluate the responses of the policy in general and the policy and decision makers in particular when viewed in terms of the efforts made to develop institutional capacity of Sanitation and Beautification Department at all levels to manage properly and effectively the waste produced in Adigrat?

Interviewee_3: Bearing in mind the size of the town, the organizational structure of the Sanitation and Beautification unit of Adigrat has no problem. There is one expert at town level who fully focuses on (mainly on solid) waste management, and one at the *Kebeles* level who has a dual responsibility (to the *Kebeles* administration and to the SB Department at town level).

P 5: I-SB5-RC1.rtf - 5:13 [Researcher: How do you evaluat..] (33:35) (Super)

Codes:[organizational structure - Family: Institutional Capacity]

No memos

Researcher: How do you evaluate the responses of the policy in general and the policy and decision makers in particular when viewed in terms of the efforts made to develop institutional capacity of Sanitation and Beautification Department at all levels to manage properly and effectively the waste produced in the urban areas of the region?

Interviewee_5: Organizing the waste management activities of Mekelle at agency level would have more benefits in many ways with respect to ensuring effective and sustainable waste management. The power to decide budget, financial management, and human power requirement and recruitment, and machineries' maintenance and administration would have been maintained had it been organized at the agency level, and this has been recommended in the Structural Plan document of the City. However, to achieve such status, the financial sources of the organization should be ensured. The capacity of the municipality and the local administration is limited. Therefore, primarily, the cost recovery system has to be implemented. This is necessary issue not only to ensure the financial capacity of the institution, but also it is an issue of justice. Those who generate more should pay more for waste collection service.

One of the key issues related with human resource of the Sanitation and Beautification Sector that has been strongly raised by the key informants is the commitment and satisfaction of the employees. Almost all the key informants have strongly argued that employees of the sanitation and beautification sector are very dissatisfied with and less committed to their work. As a result, workers' turnover has been a serious problem of the office. The major causes of the problem as mentioned by the key informants are three. One is the salary and remuneration they received does not measure up to the work nature and difficulties of the job. Second, it could be because of sector's bias or negligence, the local administrative body has no good attitude towards the employees as well as to their jobs. This is reflected in many ways. The local administration body does not properly internalize the role played by the workers, and the extent of the importance of the waste management endeavour to facilitate urban growth and promote the image and status of urban areas. In short, most of the administrators do not respect the employees and their jobs. Third, due to either ignorance or dictatorship behaviour, some key informants complain that employees of the Sanitation and Beautification Department are forced to be involved in tasks which are not part of their duties and responsibilities (as stipulated in the proclamations and regulations and the BPR of the region). They are forced to be involved in controlling and regulating of any illegal acts committed in the city or town like illegal businesses, illegal constructions, and so on.. These types of problems are particularly severe in Adigrat.

The problem of manpower becomes more severe when the issue of liquid waste management is considered. There is no any expert and professional or skilled worker recruited and assigned to carry out matters solely related to liquid waste management issues. Even in the structure, it has been ignored.

The key informants also believe that the training institutions of the country could not satisfy the demand of the employing organizations such as the municipality in general and waste management sector in particular for graduates with an appropriate field of study. For instance, the local administrations of urban areas (or the municipalities) need graduates specialized in waste (solid and liquid) management, landfill management, liquid waste disposal and treatment, and so on, but they hardly found such types of specialists in the

market. As a result, the Sanitation and Beautification sectors, and the municipalities are forced to recruit employees from a related or proxy fields of specialization.

Besides, the organizational structure and human power, the financial and material resources of the sanitation and beautification sector of the municipality waste management office have been reviewed to appraise the extent to which waste management problems have received responses from the policy and decision (policy) makers. The financial resource, when viewed in terms of budget allocated to run the waste management activities smoothly and effectively, should be adequate. Literature sources indicate that due to its vast nature, waste management activities consume the largest share of the municipal budgets. On the average, the budget allocated by the town administration to waste management activities ranges from the lowest 20% to the highest 40% of the municipal budget allocated by town administration. The researcher has tried to assess the budget allocated to the waste management activities in Mekelle City Administration. Unfortunately, the researcher could not find data properly recorded and organized in Adigrat town administration. So, he could not review the relative emphasis given to the waste management activities.

But, he has tried to examine the financial strength of the Sanitation and Beautification sector of Mekelle using the budget allocated in three fiscal years. The financial records of Mekelle show three classification of budget. These are budget approved, budget adjusted, and actual budget expenditure. It has been difficult to access the budget requested by the respective sector. Budget expenditure may measure more the capacity of the institution to utilize the budget allocated rather than the attention given to the institution or activities of the institution. Hence, the researcher has focused on the budget approved and adjusted to reveal the extent to which Sanitation and Beautification Activities in general and waste management in particular has received responses from the decision makers.

Table 28: Budget allocated to Waste management Sector in Mekelle, 2007-2009 EFY (2014/15-2016/17)

Year	2007 EFY (2014/15)				
Description	City Administration Total (birr)	City Greenery and waste mgmt (birr)	%	Solid Waste Mgmt (birr)	%of
Approved Budget	218,991,595	10,614,048	4.85	9,100,000	85.74
Adjusted Budget	230,190,771	3,416,327	1.48	2,292,320	67.1
Actual Expenditure	230,160,715	3,416,326	1.48	2,292,320	67.1
Year	2008 EFY (2015/16)				
Approved Budget	284,930,543	12,100,419	4.25	5,118,750	42.3
Adjusted Budget	302,164,299	16,601,608	5.49	982,565	5.918
Actual Expenditure	302,104,617	16,601,608	5.5	982,565	5.918
Year	2009 EFY (2016/17)				
Approved Budget	373,203,116.00	43,354,359	11.62	NA	
Adjusted Budget	404,174,863	104,614,234	25.88	NA	
Actual Expenditure	404,174,854	104,614,234	25.88	NA	

Source: Mekelle City Finance and Planning Office

NA= Not Available

Very surprisingly, the budget approved and adjusted has very significant variations. As it has been shown in the Table 28 above, the total budget approved to Sanitation and Beautification, which comprises greenery and waste management (both solid and liquid), has been increasing from 2014 to 2017, which could be due to the increase in the total budget allocated to the city administration as a whole. When we view the budget approved to the Sanitation and Beautification Department (SBD) against to the total budget of the city, in 2014/15 and 2015/16, it was only 4.85% and 4.25% respectively. As compared to the previous years, there has been a significant increase in the budget share of the Department approved in 2016/17. It has increased from 4.5% in 2014/15 to 11.6% in 2016/17 though it fell down to 4.25% in between.

With regards to the budget adjusted, except that it showed dramatic fall in 2014/15 as compared to the budget approved, the share of sanitation and beautification sector has been smoothly increasing in the last three years from 1.8% to 25% of the total budget adjusted of the city. However, most of the key informants are not satisfied by the budget allocated though some also have reservation on the capacity of the departments to properly utilization their budget.

Material resource analysis focuses on the key equipment, machineries and facilities of the department focuses on the key equipments and machineries used to collect and transport waste and to pack and compact waste in the landfill. In both Mekelle and Adigrat, the primary collection technique is door to door and it is conducted by micro and small enterprises. In Mekelle, primary collection has been totally outsourced almost eight years ago but in Adigrat it has been introduced in 2016/17. Hence, the collection equipment and vehicles and manpower are private. The Sanitation and Beautification Department of Mekelle owns only the equipment, vehicles and machineries that are used for secondary collection (transportation of waste to landfill) and the landfill operational activities' equipment. These include the skip loaders used to transport the public containers placed in the transfer stations to the landfill and the machineries such as loaders, dozer, compactors, septic suction trucks and others used in the landfill operations (to compact and overlay selected earth materials). The Department of Sanitation and Beatification owns six skip-loaders of which only two are functional. That is why most of the tasks of the Department are covered by the micro and small enterprises (MSEs). In addition to the primary door to door collection, most of the MSEs are involved in secondary collection. They transport the waste they have collected from houses directly to landfill. Besides, not only that the skip-loaders and the landfill machineries are frequently exposed to damage, but also the downtime of the skip-loaders and other machineries is unnecessarily long. They are not repaired on time; there has not been an effort to repair the machineries quickly on time. Thus, most of the secondary collection is carried out by MSEs. In Adigrat, both primary and secondary collections are conducted by MSEs.

The situation in the landfill of Mekelle is not different from that of the transportation works. The researcher has visited the landfill several times but except a loader, no machinery is

regularly found in the landfill. Upon request, the dozer machine visits the landfill to disperse/level the heaps of waste evenly. In general, the researcher has observed serious deficiency of necessary machineries in the landfill not only because they are few in number but also because they have been off duty frequently due to damage and lack of repairs for long time. That is why the landfill is converted virtually to an open dumping ground. Besides, the landfill of Mekelle has been suffering from lack of basic infrastructures such as electric light and water supply.

Similarly, the researcher has examined the material resources of Adigrat Sanitation and Beautification sector in terms of its equipment and machineries and facilities existing in the landfill. Since 2016/17, the primary as well as the secondary collection systems is totally outsourced to MSEs. This implies that the Department of Sanitation and Beautification is not required to have collection vehicles or other similar equipments to perform similar functions to that of MSEs. But when evaluated in terms of the equipment and machineries and facilities needed in the landfill, Adigrat landfill has also been very much deficient. Although certain supervisors claim that they have machinery that come to the landfill upon the request of the person in charge of the landfill management, the researcher has not come across any machinery standing or working in the landfill during his four-time visits in two years. As it has been indicated in the outputs of the qualitative data analysis (Box9), certain informants have stated that shortage of equipment and machineries is typical feature of the landfill of Adigrat. Similar to that of Mekelle, Adigrat landfill has no access to infrastructures like water and light.

4.6. Waste Management Approaches

Obj.5. To examine the extent to which the strategic waste management approaches have achieved policy priorities to bring about sustainable solution to waste management problems.

With an increase in urban population, industrialization and economy and a change in the life style of the community, the quantity and complexity of waste produced increases. As quantity and composition of waste increases, the health and safety of human beings and environment will be threatened. It might be very difficult to consider the issues of proper

waste management and minimization of cost of waste management simultaneously in order to ensure sustainable waste management. Minimization of cost and health and environmental impacts concurrently, though it is difficult, has to be the key objective of waste management in any urban centres. Therefore, there should be an effort to ensure a trade-off between cost and health and environmental impacts. In view of the balance that is needed to maintain, there should be an effort to reduce the overall health and environmental impacts of waste management system introduced, as far as possible, with in an acceptable level of cost. In so doing, it would be possible to realize sustainable waste management system which is an ultimate objective of waste management.

Realizing the objectives of ensuring sustainable waste management in general and the minimization of cost and impacts of waste management in particular might not be an easy task. It is well recognized that it is so difficult and debatable to decide the point of balance between impact and cost; but it is as well recognized that informed decisions (based on reliable data of cost and impacts) could minimize the difficulties of decisions. If these two contradicting objectives (minimization of cost and impact) are reconciled, sustainable waste management system could be readily realized. To reconcile these conflicting objectives and thus ascertain sustainable waste management system, implementation of an appropriate and effective and efficient waste management approach becomes very crucial.

The fundamental aim of any waste approach or strategy should, therefore, be the maximization of resources' efficiency by promoting sustainable waste management. In view of sustainable development, on the one hand, there is a need to curtail the growth in the quantity of waste generated. On the other hand, there is a need to recognize waste as a resource and recover more value from it. One of the most recent and well recognized approaches which could fulfil the demands of sustainable development and could reconcile the conflicting objectives (minimization of cost and impact) is implementation of the basic constituents of waste management approach. These include the 4Rs principle and participation of stakeholders. Hence, the researcher has tried to assess the extent how the 4Rs and participation of approach have been implemented in the study areas. Integrated Waste Management (IWM) in general and 4Rs and participation of stakeholders

in particular aim to providing environmental sustainability, economic affordability and social acceptance for any specific area.

As it has been mentioned in the Methodology Chapter, the only sources of information or data to assess the extent to which waste management approaches are implemented have been the key informants selected from both urban centres. Besides, the researcher has tried to supplement the data collected through an in-depth interview with observation. Waste minimizing, reusing, recycling/composting and recovering (4Rs) are particularly assessed vis-a-vis the trends in the quantity and complexity of the waste generated in the urban centres. The rapidly changing waste in volume and composition demands more efficient and effective waste management systems rather than the traditional collection and disposal systems. Moreover, the change in waste characteristics has made waste management more costly and complex. Therefore, a waste management system which could solve such types of problems effectively and sustainably is needed

The records (annual reports) of the municipalities and the interview with the key informants have confirmed the rapid growth in the quantity of waste generated in the study areas. Likewise, the nature and composition of waste have been changed from the organic to inorganic and more to plastic materials. But the question is how the responsible bodies have responded to such changes, to what extent have the changing waste characteristics received responses from the decision makers and practitioners.

According to the key informants, except that isolated in time and space, different efforts have been made to practice certain elements of waste hierarchy particularly elements of the 4Rs. Separating of waste items at least into two was carried out by many households and business houses at sources. Moreover, sorting of organic and plastic materials was also undertaken in the landfills in Mekelle (before 2016) and in Adigrat (since 2016 in the new landfill). However, the main options of 4Rs could not pursue the work of sorting in both urban centres. Except a few household level composting activities which are spent for domestic consumption, neither recycling nor composting nor recovery of energy from the segregated wastes has yet been carried out. Despite the annual plan prepared for several years by the Offices to implement certain 4Rs options, hitherto nothing has been

implemented successfully. Due to either because of lack of commitment and/or capacity (expertise, capital, or technology), recycling, or composting or recovery has not taken place. Sorting was conducted in significant number of households at sources for long time but no further work was conducted. Finally, particularly in Mekelle, the Municipality, the Sanitation and Beautification Section, has publicly notified or declared that the community was officially informed to discontinue sorting at source. The heap of plastic materials, mainly the plastic containers, which was waiting for new technology to recover energy, in the landfill, has been burnt out. Similarly, heaps of plastic containers (mainly the packed water containers) are found in stores and open areas heaps sky-scraping in the old and new landfill of Adigrat waiting for demand or marketing.

However, despite the different trials shown here and there, the key informants strongly argue that the responsible bodies including the local and regional administrations are not committed enough to implement 4Rs options. In general, the key informants strongly argue that they hardly believe the local administrations (or municipalities) have implemented properly either of the 4Rs options.

These days, there has been a slight change regarding the involvement of private enterprises in recycling activities. In Mekelle, a few private enterprises have been involved in semi-processing of plastic materials wherein the plastic containers and big plastic bags, collected through the informal sector, are chopped, ground and compacted. These semi-processed materials are sent to plastic factory found in Addis Ababa.

Nevertheless, collecting and selling of used items either in cash or bartering has been a long-lived tradition in the whole region. Used items such as shoes, glasses, metals, plastic containers, etc are collected door to door by the informal sectors which would be either reused or recycled. For instance, these days, almost all metallic items do have market in the *Medebbir* workshops of micro and small enterprises in Mekelle. But there has been no or limited efforts to encourage the activities or to even acknowledge the contribution of these informal sectors to the cleanliness of the urban centres by the responsible bodies.

As stated before, literature sources showed that securing participation of key stakeholders in waste management is recognized as one of the most important waste management approaches. In fact, when waste management is considered broadly, identification and inclusion of stakeholders is one important aspect of waste management approaches (Seadon, 2006). Participation may involve various activities ranging from direct participation in operational activities to involvement in decision making and planning activities to awareness rising. The researcher has focused on the operational activities mainly due to lack of tangible and reliable information on other aspects of participation.

The key informants acknowledge and agree that it is possible to say that the efforts of the local and regional administration local administrations have done well to involve the stakeholders, specifically the micro and small enterprises in waste collection and other activities. Securing participation of the stakeholders at least for they have transferred the collection task totally to micro and small enterprises In Mekelle, the whole primary collection and, upon damage of the skip-loaders, secondary collection works tasks are covered by MSEs. Likewise, since 2017, when the waste collection tractor-trailers were entirely out of function due to damage, the whole primary and secondary collection have been undertaken by MSEs in Adigrat.

Pertinent to this theme, the informants were asked about the commitment and environmental awareness of the responsible bodies, particularly to adequately and properly manage the increasingly growing quantity and composition of the wastes generated in the urban areas.

Virtually, all of the key informants recognize the growing concern and efforts to improve the cleanliness of the urban centres since recent times. This could be substantiated by the budget allocated in the last two or three years to the expansion of modern and multipurpose public toilets, the involvement of more micro and small enterprises (to expanded collection services), etc. Nonetheless, the informants argued that despite the slight changes brought about in different aspects of waste management, as compared to the magnitude (depth and breadth) and complexity of the problems, the concern or attention given to and the commitment shown to improve waste management system is

trivial. More efforts and commitments are needed from the responsible bodies to curb the prevailing and, of course, the growing problems of the urban centres.

The key informants have also expressed their opinion regarding the efforts and commitments made by the responsible institutions and administrative body to bring about very efficient and sustainable waste management approaches. They said they felt discomfort by the responsible bodies for their being insensitive and uncommitted to implement new, more efficient approaches particularly the 4Rs options. At a minimum, it would have been possible to, according to the informants, recognize the role played by and support the people involved in informal activities, that are locally known as '*koralio*' or '*liwach*' in reducing the burden of the city and specifically the collection and disposal tasks of the Sanitation and Beautification Department. When significant amount of waste is diverted its direction from the waste collection-transportation-disposal activity line, it is not only that new value is created from the waste but the cost of transporting and disposal of waste would also be reduced.

Box 10. Output: Waste Management Approach

Waste Management Approach

Contents

Waste Management Approach.....	363
Code: 4Rs {8-0}.....	364
Code: Composition {3-0}.....	370
Code: Generation {3-0}	371
Code: participation {2-0}	372

Code: 4Rs {8-0}

P 1: I-SB1-UC1.rtf - 1:1 [Likewise, there was an attempt..] (5:8) (Super)

Codes:[4Rs - Family: Waste Approach]

No memos

Researcher: To what extent have modern waste management approaches received attention in Mekelle in response to the significantly evolving waste characteristics (voluminous and complex composition of wastes) generated in the city?

Interviewee_1: There was an attempt to sort out the waste types at sources at household level. Residents were sorting their wastes into different containers. But during collection, the wastes were mixed together in one container and were dumped altogether in the landfill. Sorting at source or at any waste management element has brought no change. The community got offended and became unwilling to continue sorting and then the Sanitation and Beautification Department of Mekelle notified the community to temporarily discontinue sorting activities at sources.

Of course, these days, there are attempts by few private investors to collect certain plastic materials particularly plastic containers (for oil and different detergent materials) and very thick plastic bags. They collect plastic materials through informal collectors and chop them into particles. Then, they are packed and sent to plastic factories in Addis Ababa.

There is a long lived tradition of door to door collecting of used shoes, clothes, plastic materials, glasses and bottles, metals, etc by informal workers in the region which are purchased in cash or in kind. But it is not possible to identify the operators and estimate their scale of operation and contribution to the cleanliness of the urban areas. Moreover, there is no role played by the responsible bodies to either organize and support or even recognize them as a necessary economic sector.

P 1: I-SB1-UC1.rtf - 1:17 [Researcher: To what extent the..] (37:39) (Super)

Codes:[4Rs - Family: Waste Approach]

No memos

Researcher: To what extent have the modern waste management approaches received

attention in Mekelle in response to the significantly evolving waste characteristics (voluminous and complex composition of wastes) generated in the city?

Interviewee_1: As you can observe it on the ground, the quantity of waste generated is rapidly growing and the nature and composition of the waste is dramatically changing. This could be attributed to the change in the size of the population of the community, and the life style and living conditions of the society. When such phenomena occur and become evident, it is not the conventional technical waste management system (collection, transporting and dumping) which should be focused on. Rather, new approaches which could ensure efficient and sustainable waste management system should receive more attention.

I believe that as the waste characteristic changes from time to time, the management system which was employed 10 years ago would no longer be suitable for the current situation. It is apparent that waste generation has extremely increased; waste composition has changed wherein plastic materials (fluid containers and plastic bags which are commonly used for shopping) have flourished. Moreover, the proportion of the organic waste has been reduced from 60-70% to nearly 50%. Thus, the common practices of collection and disposal would not be the only solution. We need to have a management system that could effectively respond to and solve the problem of massive waste production and the plastic revolution, and, if necessary/possible, to revise the policy and legal documents. One of the solutions to the massive waste production and the change from organic to inorganic waste is the implementation of new, more effective and efficient waste management approaches such as integrated waste management system and participation (and partnership). But the integrated waste management approach has not yet been implemented adequately. In fact, for example, in 2004 E.C. (2012) to 2006 E.C (2014), segregation of waste at source was widely practised. But the steps next to it were not undertaken. To worsen the problem, the segregated wastes were mixed during door to door collection, and transported to the landfill altogether. But the SB Office has not been convinced to continue such an activity. Moreover, there was a complaint from the community as to why they are told to sort if the sorted wastes are mixed and transported altogether in the same container. Finally, it was decided to officially interrupt the sorting activities undertaken at the sources. Even the huge heaps of plastic materials stored in the landfill for long time were fired/burned because the recycling plan of the office could not be practical but such types of wastes continued to occupy more space within the landfill. In other words, the huge heaps of plastic materials in the landfill were competing for space

with other types of solid waste on the waste disposal grounds. But in the last two years, certain promising conditions have been arising where private investors have showed interest in waste reusing and recycling activities. Few investors have tried to collect plastic materials (mainly plastic containers and thick plastic bags) and, after chopping, grinding and compacting them, started to send them to a plastic factory found in Addis Ababa.

P 2: I-SB2-UC1.rtf - 2:24 [But with respect to strategic ..] (61:65) (Super)

Codes:[4Rs - Family: Waste Approach]

No memos

But with respect to strategic waste management approaches, it is difficult to say that it has received attention from the responsible bodies. I also argued that the policy by itself has not properly addressed the most important waste management approaches. For one thing, I have not seen rules and regulations, working documents or guidelines that solely focus on integrated waste management approaches (4Rs principles- Reduce, Reuse, recycling and recovering of waste). There was an attempt to organize model households and business houses which separate organic from inorganic waste items at source and produce compost. But it was not successful; it was short-lived and ceased soon. There was also an attempt to collect plastic materials and packed water containers bearing in mind that they could be used to generate energy. But later, it failed and fires were set to the heaps of plastic materials in the landfill.

Informally, there are used-item collectors. Used plastic materials such as shoes, containers, bottles, metallic materials, are among the most important items collected by the informal collectors. These types of informal activities have been long-lived practices in almost all parts of the region and the rest of the country. But its importance mainly in terms of its contribution to reduce the volume of waste that otherwise would be left for collection and disposal could not be measured.

Researcher: To what extent do the decision makers recognize the problem of urban environment in general and waste management in particular and are committed to properly and sustainably manage the waste produced in the city?

Interviewee_2: I believe that there has been a slight change or improvement since the last two years (since the coming of the existing management body to power). This can be justified

easily by looking at some of the major realities: the yearly budget allocated to SB has increased; very modern public toilets (called green toilets) have been constructed and still are being constructed in many parts of the city. But when compared to the magnitude and complexity of the task, and to other sectors or departments, I argue that the attention given to waste management is still insufficient.

P 3: I-SB3-UC2.rtf - 3:5 [the quantity of waste reduced ..] (4:4) (Super)

Codes: [4Rs - Family: Waste Approach]

No memos

Generally, the quantity of waste reduced (either due to composting or reusing of waste at source) at source (before it incurs costs of collection and transportation to the landfill) is negligible; it has been difficult to provide regular service as it is defined in the standard; the sorted items in the landfill have not yet got solution; they are simply being stored in the landfill and probably the fate of these heaps of plastic materials could be, as it has been in Mekelle landfill, burning down.

P 3: I-SB3-UC2.rtf - 3:21 [Researcher: To what extent the..] (38:40) (Super)

Codes: [4Rs - Family: Waste Approach]

No memos

Researcher: To what extent have the modern waste management approaches received attention in Adigrat in response to the significantly evolving waste characteristics (voluminous and complex composition of wastes) generated in the town?

Interviewee_3: The SB office of Adigrat attempts to convince households to convert their wastes into compost for private garden consumption within their premises. There are different trials to reduce the overall quantity of waste collected and transported to the landfill but they are of insignificant quantity. Except that of sorting conducted at the landfill site, nothing more is done to implement the integrated waste management approaches (4Rs). The sorted materials which are predominantly plastic materials are simply stored in the landfill; we don't know what will happen tomorrow. We are searching for market, but have not yet found a promising solution.

P 4: I-SB4-UC2.rtf - 4:1 [It is known that the volume of..] (3:3) (Super)

Codes: [4Rs - Family: Waste Approach]

No memos

It is known that the volume of wastes generated is increasingly growing and the nature and composition of waste is changing. Consequently, the management of waste has become a huge and complex task not only in Adigrat but also in all urban centres of the region. Therefore, to ensure sustainable waste management, focusing solely on the technical aspect of waste management system is not advisable, but modern approaches like the integrated waste management system (the 4Rs principle such as reduce, reuse, recycling and recovery), and involvement of stakeholders are highly recommended.

P 4: I-SB4-UC2.rtf - 4:25 [Researcher: To what extent the..] (55:58) (Super)

Codes:[4Rs - Family: Waste Approach]

No memos

Researcher: To what extent have the modern waste management approaches received attention in Adigrat in response to the significantly evolving waste characteristics (voluminous and complex composition of wastes) generated in the town?

Interviewee_4: It is known that the volume of wastes generated is increasingly growing and the nature and composition of waste is changing. Therefore, to ensure sustainable waste management focusing solely on the technical aspect of waste management system is not advisable; but modern approaches like the integrated waste management system, the 4Rs principle (Reduce, reuse, recycling and recovery), and involvement of stakeholders is widely believed to be the best option.

The integrated waste management approach has no policy document or legislation or proclamation of its own that exclusively clarifies detail issues or elements of it. There is no document either as policy, proclamation, legislation, or other guiding principles that states in detail integrated waste management approach on its own. This means that integrated waste management approach has not received policy priority. I do not think that the Department of SB of Adigrat town has recognized well the importance or the contribution of such approach to ensure sustainable waste management. There are few workers in the landfill who separate plastic materials from other types, but it is simply stored on open area within the compound. Except this, no effort has been made to implement the 4Rs approach in the town. Therefore, integrated waste management approach has not received the necessary responses from the policy as well as from the local administration, including the SB

Department in Adigrat town.

One basic challenge to implement 4Rs, at least for compost production, is lack of market links. There are residents who are, though they are finger counts, trying to produce compost for their personal consumption in their garden. But for marketing purposes, no one has been involved on compost production. Lack of commitment, which might be due to insufficiency of awareness about the value of 4Rs of the decision makers, is also one big challenge in Adigrat town to implement the approach.

P 5: I-SB5-RC1.rtf - 5:16 [Researcher: To what extent the..] (40:41) (Super)

Codes: [4Rs - Family: Waste Approach]

No memos

Researcher: To what extent have the modern waste management approaches received attention in the urban areas of the region and in Mekelle and Adigrat in response to the significantly evolving waste characteristics (voluminous and complex composition of waste) generated?

Interviewee_5: Due to many factors, the quantity and composition of waste is dramatically changing and it is becoming beyond the collection and disposal capacity of the urban centres. There are attempts to mainly sort wastes at sources (into organic and non-organic items) and convert them into compost. There are households successful in producing compost at their premises for personal consumption. In Adigrat, for instance, there are well known households which could be models to others. However, in general the integrated waste management approach (particularly the 4Rs principles) has not attained attention and commitment from the concerned bodies. There are certain efforts made particularly by private business people to conduct at least semi processing for plastic materials in Mekelle. The acts of collecting and selling of used metallic and plastic items have been widely practised for a long time by informal sectors and its contribution to reduce the volume of waste that otherwise would be dumped in the landfill would not be negligible. However, an organized and formal way of recycling and recovering of waste items has not yet been carried out. The commitment and involvement of all the responsible bodies, the SB units, the local administration, and relevant offices to introduce and implement the new technologies and integrated waste management is insignificant. Comparably, there might be

certain urban centres like Adigrat, Sheraro and Humera which are better than others in terms of the commitment and involvement of the all responsible bodies.

Code: Composition {3-0}

P 1: I-SB1-UC1.rtf - 1:3 [However, because of various re..] (4:4) (Super)

Codes: [Composition - Families (2): SW: Characteristics, Waste Approach]

No memos

However, because of various reasons, we have not yet conducted a survey. In fact, it is clearly observed that the quantity and proportion of plastic materials is increasing. Moreover, the magnitude of inorganic materials produced in the city is growing significantly despite the fact that the proportion of the organic materials of the waste is still higher than inorganic ones. But so far, there is no significant work done by the Office in response to the changing nature and composition of the waste. Whereas in response to the growing quantity of waste generated (which occurs mainly because of the increasing size of population and peripheral expansion of settlements), additional collection groups have been organized and involved in door to door collection activities.

P 2: I-SB2-UC1.rtf - 2:4 [What is particularly difficult..] (5:5) (Super)

Codes: [Composition - Families (2): SW: Characteristics, Waste Approach]

No memos

What is particularly difficult to estimate and express numerically is the relative proportion of each of the key constituents of the waste generated. It can be estimated that the organic wastes constitute predominantly the waste generated in Mekelle. Moreover, since recent time, the proportion of plastic materials is increasingly rising and is creating environmental and social problems.

P 3: I-SB3-UC2.rtf - 3:2 [Likewise the composition, thou..] (2:2) (Super)

Codes: [Composition - Families (2): SW: Characteristics, Waste Approach]

No memos

Likewise, the composition, though no measurement is conducted, of waste is changing.

Currently, the proportion of plastic materials, mainly the plastic bags and water packing plastic materials, is incredibly growing and has complicated the conventional waste management system of our town.

Code: Generation {3-0}

P 1: I-SB1-UC1.rtf - 1:2 [Researcher: Have you observed ..] (1:3) (Super)

Codes:[Generation - Families (2): SW:Characteristics, Waste Approach]

No memos

Researcher: Have you observed significant changes in the waste characteristics in the last few years in Mekelle ? How has your office, in particular and the policy in general, responded to the change, if any?

Interviewee_1: Yes, the quantity of waste generated has been increasing because of various reasons. The waste composition and rate of generation 10 years ago and now has not been the same. As the city grows, waste composition and generation has been significantly changing. Indeed, waste characterization is one precondition for the strategic waste management system to which we are heading to (we are looking to reach at). Whereas in response to the growing quantity of waste generated mainly because of the increasing number of population and peripheral expansion of settlements, additional collection groups have been organized and involved in a door to door collection.

P 2: I-SB2-UC1.rtf - 2:3 [As far as I know the Office ha..] (4:4) (Super)

Codes:[Generation - Families (2): SW:Characteristics, Waste Approach]

No memos

As far as I know, the office has not yet conducted a survey to determine the waste composition and generation rate of the city, but I believe it had to do. Usually, the office employs; figures taken either from other urban areas of similar level of urbanization or studies conducted by different organization or individuals for some purposes. Currently, to estimate the total generation of the city for planning purposes, the department uses figures studied by the Regional Science and Technology Office and accepted by the BUDIT,

Sanitation and Beautification Department of the Region such as 0.39 kg per capita per day.

P 3: I-SB3-UC2.rtf - 3:1 [Researcher: Have you observed ..] (1:2) (Super)

Codes: [Generation - Families (2): SW:Characteristics, Waste Approach]

No memos

Researcher: Have you observed significant changes in the waste characteristics in the last few years in Adigrat? How has your office, in particular and the policy in general, responded to the change, if any?

Interviewee_3: Waste characteristics change is almost a universal phenomenon of all urban areas where there is rapid urbanization and change in life style of the community. Adigrat could not by any means be different from this fact. Particularly, because of its population growth, the quantity of waste produced is increasing from year to year.

Code: participation {2-0}

P 2: I-SB2-UC1.rtf - 2:23 [Interviewee_2: There have been..] (61:61) (Super)

Codes: [participation - Family: Waste Approach]

No memos

Interviewee_2: There have been different efforts to introduce and implement different waste management approaches and ensure sustainable waste management in the urban areas, particularly in Mekelle. Some of the efforts have been successful, yet, many efforts have also failed. The widely involvement of the micro and small enterprises in waste collection works and individuals in different waste management activities like in public toilets administration, and solid waste collection and transportation could be taken as good response to the problem.

P 3: I-SB3-UC2.rtf - 3:3 [Researcher: What has been the ..] (3:4) (Super)

Codes: [participation - Family: Waste Approach]

No memos

Researcher: What has been the response of your office and the decision makers to

Interviewee_3: To deal with the increasingly huge volume of waste generated, the Office of SB of Adigrat has tried to do certain things. These include increasing the number of MSEs involved in waste collection and transportation activities; outsourcing the collection and transportation tasks to cooperatives (Micro and small enterprises); sorting of plastic materials to reduce the volume of waste that is otherwise dumped and compacted in the landfill.

As it has been clearly explained in the literature review section, the strategic waste management approaches mainly refer to the waste management hierarchy. The waste hierarchy is a widely accepted principle which has been applied in waste management policies. It is used as an over-riding principle with respect to the waste management strategy and policy development. The essence of the waste hierarchy principle is characterized by a need to avoid, eliminate, prevent or significantly reduce the causes of environmental problems, as opposed to managing the impacts, wastes and emissions arising further down the product or service life cycle (Gertsakis & Lewis, 2003). In other words, minimizing the adverse impact of waste generation and handling, reducing its negative impact on human health and the environment, and the scarcity of natural resources including land are the ultimate purpose of the waste hierarchy (Ferrari, et al., 2016). Generally, the hierarchy responds to the financial, environmental, social and management considerations of waste management. It has also a key role in minimizing the greenhouse gas emissions (Hoorweg & Bhada-Tata, 2012). The hierarchy also encourages the minimization of GHG emissions.

In the waste hierarchy, five actions are identified. These are: (1) Prevention; (2) Preparing for re-use; (3) Recycling; (4) Other recovery; and (5) Disposal. The “waste hierarchy” ranks waste prevention and management options according to what is best for the environment (Allesch & Brunner, 2014). In other words, as is indicated in Figure 17, the five actions (or options) identified in each layer are arranged in a specific order of priority, according to their relevance for correct waste management (Ferrari, et al., 2016). The shape that best represents the hierarchy is an inverted pyramid, with the vertex upturned and divided into

five horizontal layers. The shape of the figure (inverted pyramid) implies that the volume of waste decreases as it passes downward through the different actions shown in each layer, and ultimately wastes reaching the disposal site (the landfill) will be minimal. Moreover, the management option gets better and better upward the inverted pyramid. Therefore, based on the waste hierarchy principle top priority is given to preventing, but when waste is produced, priority would be given to preparing it for re-use, then recycling, and then other recover (e.g. of energy), and last of all disposal (e.g. landfill).

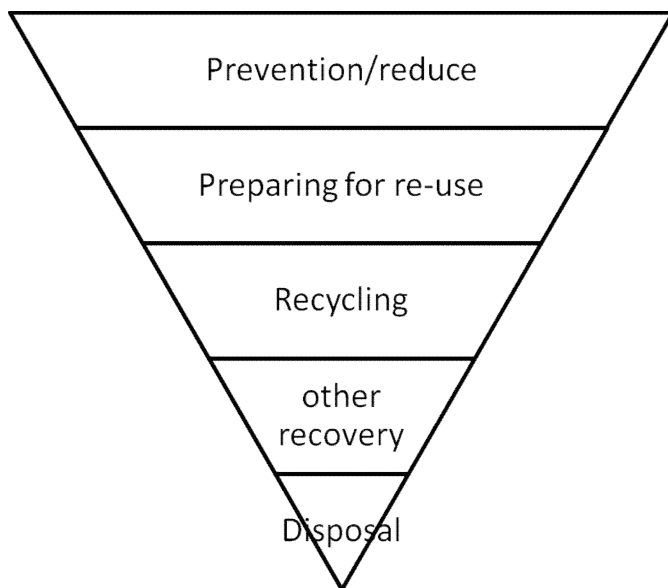


Figure 17: Waste Hierarchy, adapted from K. Ferrari, R. Gamberini and B. Rimini, 2016

It is apparent that the responses of policy to urban environmental problems, particularly to waste management problems, are evident in a number of ways. One of these ways is the attention given to the strategic waste management approach. When the response of the policy to waste management problems is evaluated in terms waste management approach, waste hierarchy, more specifically the 4Rs principle comes to the forefront. In relation to this, the researcher has tried to assess information or data from the key informants selected from the municipal offices of both towns and from the regional bureau. Data of these informants are presented in Box10.

Bearing in mind the responses and tones of the words used by the key informants, and personal observation and experiences in related activities in the study areas, one can plainly perceive that the attention given and the commitment of the responsible bodies to introduce and implement the strategic approaches to ensure sustainable waste management in the urban centres is insignificant. The main focus of the local administration, and of course of the region as a whole, is on the conventional, simple technical aspects of waste management such as collection, transportation and disposal.

As shown before, all sources of information such as documents, reports and the interviews with the key informants have confirmed that the quantity of waste generated is rapidly growing and the composition of waste is changing. In line with this, the cost and complexity of managing these wastes (collection and disposal services) is rising and is creating challenge on the capacity of the responsible institutions at all levels (mainly the Sanitation and Beautification Department at all levels of administration). And yet, the respective authorities and heads of departments are totally engaged merely on the routine waste management activities. In other words, strategic waste management approaches activities or options have received no response from the respective institutions in general and particularly from the decision makers and heads of the respective departments.

Strategic waste management system has diverse benefits and it calls for the implementation of waste hierarchy and securing involvement (active participation) of key stakeholders. The main objectives of waste hierarchy are to minimize and reduce waste in all streams; to maximize environmentally sound waste minimization and recycling activities; and to promote environmentally sound waste collection, treatment and disposal (Kgosiesele & Zhaohui, 2010). Obviously, waste management hierarchy as key component of strategic waste management approach underscores the 4Rs principles. By applying the waste hierarchy, it would have been possible to create value, to minimize cost of collection and transportation and disposal, and minimize health and environmental impacts. Nonetheless, despite its strategic benefits and multi-purpose perspectives, the strategic waste management approach has not received attention in the study areas. City or sub city levels or community level initiatives and efforts made to reduce, reuse, recycle or composting or recover energy formally from waste in the study areas is almost zero.

The presence of household level composting practices for personal consumptions has been recognized by certain key informants mainly in Adigrat. But these household level practices are negligible and could not make a difference.

The involvement of micro and small enterprises in Kerbside collection and in transportation of waste might be appreciated as a good deed/performance; in 2016/17 budget year, almost 100% of the primary door to door collection and 87% of the secondary collection (transportation to landfill) in Mekelle, and 100% primary collection and secondary collection works in Adigrat have been covered by Small and MSEs. But the scope of involvement is broader than mere participation in implementation (collection and transportation); it demands the key stakeholders to participate in wide ranges of waste management activities in addition to the various waste management options such as sorting, reusing, recycling and composting of waste. Furthermore, stakeholders' participation could be ensured in environmental awareness creation, environmental policy making, environmental plan preparation, and environmental evaluation and monitoring.

Increasing amounts of waste, both solid and liquid, are being generated in urban areas following the rapid rate of urbanization. This, in turn, has created greater difficulties for disposal in various ways. The problem is particularly more acute in developing countries like Ethiopia, where economic growth as well as urbanization is more rapid. There is a good opportunity for the MSEs to participate in the production of composts because the waste generated in the study areas, like in any other urban areas of the region, constitutes large proportion of organic wastes. It could also be possible to organize the people involved in informal activities of collecting and shopping and bartering used items in urban areas of the region including in Mekelle and Adigrat. With some fair supports (like training, financial, market linkage, etc), it would have been possible to upscale the activities of reusing and recycling. Yet, the researcher has not found information or data that reveal any intent or effort visibly shown by the responsible authorities or local administrations to implement the 4Rs principles. Hence, the researcher argues that the most effective and efficient waste management approaches have not yet received adequate responses from the decision makers and the respective authorities of the city and the region at large.

It is to be remembered that waste management has no policy on its own. As it has been explained in the previous chapters, waste management does not have its own policy. Unfortunately, there is not waste management policy in the Tigray National Regional State and the country at large despite the rapidly growing quantity and complexity of waste generated in tandem with rapid urbanization, industrialization and economic growth, and thus their overall impacts on the urban areas of the region and the country.

Indeed, the presence of intent to employ integrated waste management approaches in the policy-makers is reflected in different policy documents. Though not directly, there is a statement that reflects the intent to employ integrated (solid) waste management approaches. For instance, the FDRE's Solid Waste Management Proclamation No.513/2007 of EFDRE article 3 shows implicitly the need for reusing, recycling, composting and recovery of waste: it puts the objective of the proclamation as follows: *“Objective of the Proclamation: The objective of this Proclamation is to enhance at all levels capacities to prevent the possible adverse impacts while creating economically and socially beneficial assets out of solid waste”*.

As is stated in the final phrases of this statement, which is ‘... to prevent the possible adverse impacts while creating economically and socially beneficial assets out of ...’ it is explicitly reflected that there is a need to implement waste hierarchy. Likewise, the solid waste management manual prepared by the Ministry of Urban Development and Construction, Urban Planning, Sanitation and Beautification Bureau (MUDC-USBB) in 2012 has also tried to address basic issues pertaining to waste management approach (MUDC-USBB, 2012). Both of these two national documents may indicate that there is intent to employ waste management approach. But bearing in mind the real situation at local level, it is difficult to substantiate the extent to which national commitment is in place by simply observing the reality in local administration though difficult to witness the extent to which national commitment is in place. Despite the fact that implementation guideline and clear, focused directives are vital issues needed to realize the national proclamations and manuals; the researcher has not come across with such documents prepared at the national level.

Possibly due to deficiencies in awareness knowledge and appreciation to the diverse benefits of the approach by the local and regional authorities, waste management approaches like integrated waste management and 4RS have received insufficient responses in the study areas. Surprisingly enough, it is not unusual to come across annual plans and reports containing phrases and statements with regard to integrated waste management and waste hierarchy like sorting, reusing, and composting. In many of the annual plans and reports, the idea of integrated waste management and certain key constituents like sorting, composting and reusing have been inconsistently raised. But the researcher has not found evidence or information that substantiate their implementation except the works of segregation of waste into organic and inorganic items at the sources undertaken in Mekelle and segregation of plastic material (mainly water packing containers) from non-plastic items in the landfill in Adigrat. As it can be understood from the performance reports, it has not been actualized as per the annual plans. Unfortunately, as it has been explained above, currently, the work of separation of wastes at sources which was conducted by the households in Mekelle has been ceased because they could not proceed further to meet the ultimate objectives of segregation. In view of the attention given so far, the researcher also doubts whether or not the work of separation of plastic materials from non-organic sources in the landfill of Adigrat will stay long; he believes that it will be discontinued at some point in the near future.

The works of segregation of waste items (which is the first step for all 4Rs option) into organic and inorganic at sources of generation and in the landfill were occasionally undertaken in Mekelle and Adigrat; but, it has not been possible to implement in the subsequent phases. Neither of the 4Rs options has been implemented. Consequently, the works of segregation have totally been ceased in Mekelle, and it has been staggering on the way to discontinue in Adigrat.

According to some of the key informants, significant number of reasons or factors could have been listed for the non-realization of the waste hierarchy in general and 4Rs principles in particular in the urban areas of the region. Nonetheless, lack of commitment as a result of insufficiency of lack of awareness about and lack of appreciation to the

benefits of this approach of the responsible bodies has been a key constraint to implement effective and sustainable waste management approaches. The implementation of IWM approach in the urban areas has lacked attention by the local as well as the regional authorities in Tigray. The local administrations are focusing only on the costly, and less efficient conventional waste management systems such as collection, transportation and disposal.

Chapter Five: Summary, Conclusion and Recommendations

5.1. Summary

The widely observed nuisance, unsightliness, foul, odour, and so on created by the improperly managed wastes in many of the urban areas of Tigray National Regional State has primarily provoked the researcher's interest to conduct a study on urban environmental problems in general and waste management challenges in particular. The wastes left uncollected are widely seen being scattered in streets, open areas, and river courses in the urban areas of the region. Liquid waste overflowing from septic tanks and pit latrines of residential houses, commercial establishments, institutions, and garages on to the surface, drains, streets etc has been and is a day to day phenomenon particularly in the urban areas. Open toilet practices have not been uncommon phenomena in the urban areas. A significant number of persons are openly urinating and defecating in open areas, streets, river courses. These situations, which could be identified as improperly managed liquid waste and solid wastes, are responsible for the degradation of the region's urban environment.

The researcher has also reviewed the urbanization processes of the region in relation to the country's situation. Likewise, the researcher, after consultation of census reports of different periods, has come to know that there has been rapid urbanization in the region. And it is more likely that urban environmental degradation associated with rapid urbanization process will continue in the future unless it is offset by rigorous responses from the responsible bodies. Then the researcher raised the question "what have been the responses of the regional as well the local governments to combat the negative effects of the inevitable urbanization process on the environment and waste management in the urban areas?"

Subsequently, the researcher plainly stated his key research objective as "to assess the extent to which urban environmental problems in general and waste management problems in particular have received policy responses in the major urban centres of Tigray Regional State". The researcher argued that it would be more logical to examine and evaluate the extent of the policy responses vis-à-vis the nature and extent or strength of

the problems. Hence, as his secondary interest or purpose, the researcher has also retained an objective to assess the nature, and magnitude of the waste management problems in the urban areas.

To this end, the researcher has devised a research methodology that would bring him to his research end. In defining the methodology, the researcher first tried to declare the research philosophical position upon which his research design, approaches and methods are founded or based.

Having informed from the extensive literature backgrounds of the idea of philosophical assumptions or theoretical paradigm and their significance in academic research, the researcher has come up to a position where he could decide his philosophical stance upon which his research work has been founded.

Based on his literature consultation on the arguments and distinctions made between qualitative and quantitative approaches and their philosophical backgrounds, the researcher has been convinced and recognized that neither quantitative nor qualitative approach is superior nor inferior to each other. Moreover, the so called 'better' approach and method depends on the research question(s) the researcher seeks to answer. One approach could be more appropriate to answer a particular research question than the other which means that these two approaches could complement one another.

Hence, the researcher agreed on the idea that neither the quantitative nor the qualitative approach and method is essentially better than the other; the suitability of which needs to be decided by the context, purpose and nature of the research study in question. The philosophical paradigm or theoretical philosophy that backs such belief is Pragmatism.

Hence, it has been obvious that pragmatism suits the philosophical position of the researcher, and thus all approaches, methods of data collection, analysis and interpretation are founded on such position. In brief, the theoretical paradigm underpinning the mixed methods research approach is pragmatism (Creswell, et al., 2003).

In line with his research philosophy or paradigm (that is pragmatism) and corresponding approach (mixed approach), the researcher has defined his methods such as data collection instruments, sampling techniques and procedures, and data analysis techniques he employed. He has used both primary and secondary data sources for this research project. Semi-structured questionnaire and in-depth interview are used as basic data collection instruments where the former is specifically employed to collect information from the community and the latter from the decision makers.

In this research project, two samples are formed wherein one sample is for questionnaire survey and the other for an interview. Both probability and non-probability sampling techniques are used to select respondents and key informants (interviewees), respectively. To select the sample units or subjects that constitute both samples, the researcher has used multi-stage sampling techniques. At the first stage two urban clusters, Mekelle City and Adigrat town, are selected purposively depending on their population size. Then, to select the household heads for the questionnaire survey, the researcher has further selected four sub-cities from Mekelle and four *Kebeles* from Adigrat randomly. And then inner and outer zones of each of the *sub-cities* and *kebeles* were arbitrarily identified. Ultimately, using systematic random sampling techniques, household heads (which are more or less analogous to housing units) were selected. Likewise, purposive sampling technique is used to select the key informants owing to their duty and responsibilities, relevant experience and field of specialization. While selecting the key informants, the intention is to select knowledgeable or well-informed persons about the waste management activities taking place in the respective city or town. Regarding the sample size, 450 households and five key informants are selected for the questionnaire survey and the in-depth interview, respectively.

Different types of quantitative and qualitative data analysis techniques have been used for both data collected through questionnaire survey and in-depth interview. Basically, descriptive techniques for the quantitative data and thematic content analysis techniques for the qualitative data are used. The researcher tried to reduce the size (the dimension of the data) into manageable sizes using a more common technique called Principal Component Analysis (PCA). Using such a technique, the data collected through

questionnaire that mainly focused on waste collection and disposal services were reduced into three components or factors such as liquid waste collection service (component-I), solid waste collection service (Component-II) and services provision disparity (Component-III).

Most of the descriptive techniques of analysis used in this study include ratio, rates and percentiles. But, an effort has also been made to employ a non-parametric test such as Pearson Correlation Coefficient to determine the association between waste collection program cancellation and dropping of wastes in open areas, streets illegally. As far as the qualitative data is concerned, the researcher has used software called Atlas ti version 7 which he received from the UNISA Regional Centre. Finally, after extensive analysis and interpretation of both quantitative and qualitative data with the help of suitable softwares, the researcher has come out with very important findings. Moreover, the researcher has suggested clear, feasible and effective solutions.

5.2. Conclusion

Finally the study has come out with some basic findings which could answer the basic research questions/objectives. The primary objective of the research was to unpack the extent to which waste collection and disposal services are adequately and properly provided in the urban areas. In line with this objective, the researcher has tried to reveal the basic challenges that local administration of the urban areas face in their attempt to manage the wastes generated. With respect to this objective, the researcher has tried to address three issues which are liquid waste collection and disposal services, solid waste collection and disposal services management and disparities in waste collection services among the residents in different neighbourhoods.

Finally the study has come out with some basic findings which could answer the basic research questions/objectives. One of the findings shows that the overarching problem (as indicated by the community as well as by the key informants) is non-existence of actual liquid waste management system in the urban areas. The public sector (the Sanitation and Beautification Department) which is in charge of liquid waste management has not been is

deficient in capacity in many aspects. The SB department staff argue that the SB sector has no manpower specialized in liquid waste management and thus it lacks the expertise to discharge its duties. In fact, though so lately, the regional counsel has recognized the problem and decided the works of liquid waste management to be transferred to the City's Water Supply and Distribution Office. Therefore, except for few activities like administering the dumping site (drying bed), and public toilets (which are totally outsourced to Micro and Small Enterprises), and occasional cleaning of the storm water canals, no major activities or tasks related to liquid waste management are run by the Sanitation and Beautification Departments.

The second issue is related to liquid waste disposal site. Mekelle is probably the only urban centre in the region to have a well defined disposal area called drying bed or lagoon. But due to its improper location and poor management, it has posed serious social, economic and environmental problems on the nearby settlements and the lower catchment areas. It is sited in agriculturally useful rural settlement area and very close to the Romanat River which has multi benefit to the nearby and downstream communities. Whereas, the problem linked with liquid waste disposal is more severe in Adigrat, where no specific disposal site is in place; the septic suction trucks empty their content anywhere outside the urban area proper. Usually, septic suction trucks are dumping the waste in densely settled and agriculturally important areas. Hence, the unregulated liquid waste disposal activities in the town have been creating serious environmental, social and economic problems to the rural community. Moreover, the study has revealed that the free-riding or uncontrolled septic suction trucks, the misusing of storm water drainage canals, and limited or no access to unhygienic private and public toilets are posing major challenges on the urban areas of the region.

With respect to solid waste management, door to door solid waste collection activities are totally covered by MSEs in both Mekelle and Adigrat. This is one of the strengths of the local governments. But most of the findings reveal that the overall solid waste management condition is poor. The poor waste management in the study area, as the study revealed, has been manifested in different ways. One of the key indicators to the poor waste management of the study areas is the low waste collection coverage recorded

in both towns. The researcher has computed the waste collection coverage of both urban centres; in Mekelle for the years 2004 to in 2008 EFY (2014-2016), waste collection coverage ranged between 63% in 2007 EFY and 83 % in 2005 EFY. Owing to the large magnitude of waste left uncollected every year, the municipality has been forced to collect huge volume of waste using mass sanitation campaign and formal collection system in 2009 E.C., wherein over 162% of the annual plan has been executed in Mekelle. Likewise, in Adigrat, though better than the situation in Mekelle, low waste collection coverage was also computed for the last six years (2004 EFY-2009 EFY) in Adigrat which ranges between nearly 71% and about 85% in 2006 EFY and 2004 EFY, respectively. Generally, owing to the low waste collection coverage, the wastes left uncollected litters the urban areas wherein wastes are found widely scattered in open areas, river courses and streets.

The second major issue raised in relation to solid waste management is the quality of services provided to residents. Not only that the waste collection coverage is very low but also it has been found that the quality of collection service provided to beneficiaries in the study areas is very poor. The basic problems detected through this study are the frequently cancellation of collection programs, inconvenient collection schedules (usually the time when beneficiaries are out of home), and misbehaviour of the collection crews (noticeable in many ways). Besides, lack of formal and consistent monitoring and regulating and inspecting works conducted by the responsible bodies has worsened the problem of waste management in general and waste collection and disposal service delivery in particular.

The location and management of the transfer stations is also another cause of the poor waste management of Mekelle. The study has revealed that not only the location of the transfer stations is inappropriate but also they are poorly managed, unhygienic and create unsightliness scene. Because they are sited near natural drains, they have been the main sources of water pollution. In fact, mainly due to lack of appropriate site and poor handling system, a number of transfer stations are recently closed up and are being continually closed. On the one hand, since the transfer stations are practically used as only transfer centres, and the distance from almost all directions of the city to the landfill is immaterial,

the detriment, as measured in terms of social, economic and environmental costs, outweighs the benefits of establishing transfer stations in Mekelle.

The third issue which determines the status of the waste management system is the disposal system. The disposal system is basically landfill. The landfill location and management system are the two vital issues which should be examined thoroughly to determine the status of waste management in a particular city or town. The researcher has tried to examine the landfills based on primarily field observation and interview of the experts and landfill managers. Fortunately, both cities' landfills are the only landfills established with the assumption to have the status of sanitary landfill. The structural design of both cities' landfills comprises most of the basic qualities of a sanitary landfill. Nevertheless, though it is more likely to detect certain structural defects, the problem of managing the landfill is more serious. The status of the landfill of Mekelle is particularly worse because it is relatively older than that of Adigrat's. It is uncontrolled, aesthetically unpleasant, full of nuisance, and continuously exposed to the break out of fire for the last three years. Thus, the status of the landfill of Mekelle is very poor, and it hardly resembles an engineered landfill. It is also important to bear in mind here that the Mekelle landfill has been and still is suffering from lack of the requisite machineries and basic facilities like water and light.

When it comes to the management condition of the landfill of Adigrat, even though it is a newly established facility, its layering of soil is not regularly done. It has neither proper nor adequate machineries. It lacks proper fencing to prevent litters like plastic materials blowing out to the surrounding settlements and farming lands. Moreover, basic facilities like electricity and water pipes are not extended to the landfill. The key informants have also doubt in the quality of the structural design of the landfill of Adigrat. In view of disposal sites, one of the most serious problems found in Adigrat is the prevailing status and fate of the old open dump. It is located within a river course and in the centre of settlement and has as such been abandoned without proper closure. As a result, it has been a basic source of social and environmental problems for the town and particularly to settlements and institutions found around it.

Finally, the problem of disparities among the beneficiaries in the waste collection services provided has been found to be significant. The outer parts of towns, the underdeveloped settlements, nebbar tihizto areas, are disfavoured when it comes to their access to public services, including waste management services.

Hitherto, the key failures in waste collection and disposal services observed on the part of the (local) government and responsible institutions have been discussed. The waste management (specifically waste collection and disposal services) problems prevailing in urban centres are mainly attributed to failures observed in the key actors, such as the government and the community.

The role of the community to maintain the cleanliness of one's city or town is of paramount importance. And yet, the research reveals that most of the practices of the community have been the sources of the problems and/or have aggravated the problems. Most of the problems created by the community could be generalized into two aspects: on-site mishandling of waste and open toilet practices. The use of improper storage for waste at home (receptacles or a liquid waste container that is septic tanks) have created significant problems of sanitation at household, neighbourhood and even community levels. For different reasons, solid wastes are kept at home unnecessarily for a long time waiting for collection in improper materials which are worn, useless, and torn materials. With increasing time before collection (usually due to breakage of collection service programs) and sub-standard condition of the receptacles, the wastes stored at home create unpleasant condition to households and when it becomes unbearable, the owners of the waste (waste generators) are forced to throw them outside of their home.

Many of the septic tanks either have defected structural design or their volume is not proportional to the size of beneficiaries. As a result, mainly because of these reasons, seepages and spilling over (overflowing) of liquid waste from private individual houses, condominiums, commercial houses, public and private institutions and so on to the surface, drains, streets, etc. have been frequent phenomena in the study areas. Moreover, connecting private septic tanks to and dumping solid wastes and liquid waste into the

storm water canal have been identified as part of the serious challenges of the study areas.

The last but not least issue addressed in the study in relation to the residents' practices is the condition of open toilet in the urban areas. Though it is believed that there is a declining trend in the prevalence rate of open toilet practices, considerable proportion of population is still practising urinating and/or defecating in open areas, drains and streets. The main reason for open toilet practices in the study areas have has identified as lack of access to toilets.

The researcher argues that to maintain proper waste management including waste collection service and on-site waste handling practices, it needs to be supported by stringent controlling, monitoring and inspecting endeavours. Nonetheless, this study has revealed that lack of controlling, inspecting and monitoring system has been part of the main problems which contributed to the existing poor waste management in the urban areas. For reasons which are mainly attributed to implementation and organizational problems, regular and effective controlling system enforced by effective fines is missing in the study areas.

In view of the third objective of the research, and of course as one of the basic measure of responses to the waste management problems, the researcher has tried to examine the policy and legal documents and associated provisions in place which are currently in use to manage the waste generated in the urban areas. As indicated previously, it is evident that the quantity and composition of waste produced and thus the complexity to manage is rapidly growing due to the socio-economic and environmental changes mainly in the urban areas. The huge volumes of waste generated in the urban areas are posing serious challenge to the local administration bodies. As increasing growth in quantity, diversity (composition) and complexity of waste becomes a typical feature of most urban areas of the country. It has been a necessity to have comprehensive and effective urban waste management policy. And yet, it has been evident that there is no 'Waste Management Policy' as such at all administration levels (neither at national, regional nor local level). It has been the Environment Policy of the country which serves as a primary official

document, subsequent to the constitutional document, and serves as generic document to be sources of the variety of provisions and proclamations and regulations published so far by federal government, regional states or local administrations.

Following the national solid waste management proclamation no 513/2007, the Council of Tigray National Regional State has published two key documents such as Waste Management proclamation no 81/2011 and regulation no 191/2013. Unlike the National Waste Proclamation which focuses on only solid waste, the Tigray Regional State Proclamation and Regulation covers both solid and liquid waste management. Many of the necessary directives, guiding lines, procedures or action plans as prescribed or suggested in the proclamation and regulations have not yet been published and implemented. Moreover, certain articles and sub-articles have been found difficult to implement by the responsible bodies and the residents. For instance, Article 4 (3) of the Waste Management Regulation of the Tigray Regional State is one of those which have not been simple to implement. Similarly, the 20 meter radius principle has toughened the duties of the households, though the responsible bodies are claiming that it is the most effective means to maintain the cleanliness of the residential areas in the urban centres of the region including the study areas. It has also been found that the workforce which is accountable to the realization of the rules and regulations of waste management has not yet been established as stipulated in the legislation. Owing to the strong challenges they are posing on the environmental and human health and safety and waste management endeavours, certain wastes like construction wastes, agricultural wastes, e-wastes, or special wastes (identified as hazardous wastes), which need their own effective and detailed rules and regulations, action plans and management procedures, etc are overlooked by the responsible bodies. They have not received enough attention.

Nevertheless, despite all these problems described above, the overarching problem of waste management in the urban areas is not linked with or associated with defected and/or lack of policy and legal documents. The existing policy documents could be bases to instigate satisfactory waste management systems. Rather, it is the implementation weakness that owes more to the poor cleanliness of the urban environments and poor waste management of the urban areas. Most of the rules and regulations stipulated in the

waste management regulation No.191/2011 have not also been implemented fully and satisfactorily.

The second indicator employed to examine the extent to which waste management problems have received policy responses is institutional capacity. Institutional capacity is the function of three aspects such as structural organization, human, and financial and material resources. Based on the meagre information available in records and the in-depth interview of the key informants, the researcher has tried to reveal the extent to which the institutional capacity of the Beautification Sanitation and Department of the municipalities measures up to the breadth and depth of the problem of waste management of the urban areas of the region.

In view of its function and its demographic and socio-economic characteristics, the department level organization of the Sanitation and Beautification sector in Mekelle explicitly witnesses inadequacy of responses of the decision makers to waste management problems. Fortunately, recently, the structure of the department has been extended to *Tabia* level, but the link among the different level of administration up to the regional level is loose and indirect. However, a department level organization of the SB sector clearly shows the insufficiency of response to waste management of the city. Sanitation and Beautification activities organized at the department level does not match with the vastness and complexity of the tasks of managing waste generated in Mekelle. On the other hand, in the cases of Adigrat town, which is smaller than Mekelle, department level organization could be sufficient for the purpose.

When evaluated, the response of the responsible body or decision makers in terms of the second measure of capacity, that is the manpower size and quality, the researcher has found that it has been one of the most weakness of the decision makers. First of all, it is only 68% of the manpower demand of the sanitation and beautification sector of the region that has been fulfilled. Similarly, in Mekelle, it is nearly the regional average manpower size that is fulfilled. Besides, turnover of employees is a serious problem in this sector which is attributed to various factors among which salary and remunerations, which are not fixed in consideration to the nature and complexity of the tasks or works of the

department, stands first. The maladministration of the local administrators and their being inconsiderate to the duties and contribution of the cleanliness workers has also enhanced the rate of turnover of the employees. Lack of employees in relevant profession in the market has forced the office to recruit workers with related fields of specialization. But the worst thing that is prevailing in the region is the system of assigning bureau heads mainly based on their political affiliations, irrespective of their profession or field of specialization. This has also been a serious challenge for the sanitation and beautification sector.

The last capacity issue considered in this study is the material and financial resources of the sector. Still based on the scanty information available, the researcher has found that the sanitation and beautification sector has suffered from materials, machineries and financial deficiency. Key machineries like skip loaders, dozers, bulldozers, compactors, and basic facilities are among the most deficient materials. Likewise, despite the fact that the proportion as well as the total magnitude of budget allocated to Sanitation and Beautification sector has been increasing from time to time, the budget allocated to the sector does not measure up to the actual magnitude of the work load of the sector.

The last criteria used to evaluate the extent to which waste management problems of the urban areas have received response from the responsible bodies (decision makers) are waste management approaches employed in the urban areas. The 4Rs principle is among the most important approaches in waste management. For various reasons, minimization, reusing, recycling, and recovering of waste needs to be the ultimate goal of waste management so as to ensure sustainable waste management. However, the findings of this research have revealed that 4Rs principle has generally received inconsiderable attention from the responsible bodies. Despite the scanty trials to sort the waste into biodegradable and non-biodegradable items and into plastic and non-plastic items at household level and in the landfill (for instance in Adigrat), and the private investment involvement in semi-recycling (chopping of plastic materials), there has not been major practices of sorting and reducing, reusing, recycling or composting and recovery of waste initiated by government bodies (the local as well as regional governments). In general, though the volume and nature (composition) of waste generated in the urban areas of the

region has been significantly changing, so far, the local administration bodies have overlooked the 4Rs principles.

The second approach which enjoys relatively a better attention and well recognized as a useful means to ensure sustainable waste management is the participation of the stakeholders. One of the successes of the local administration or the Regional Government of Tigray is the involvement of micro and small scale enterprises (MSEs) in waste collection activities. Almost throughout the region, the primary waste collection work is covered by MSEs. However, the involvement of the MSEs or stakeholders in general is limited to only collection works; they also had to be involved in other waste management activities like composting, reusing or recycling of wastes.

5.3. Recommendations

From this study it has been revealed that the response to urban environmental problems is insignificant. The multitude problems facing the urban centres of the region are principally attributed to the negligible response from the decision makers/ policy makers. More often than not, urban environments are overlooked by the decision/policy makers. But, this research area needs further research to identify the main causes: On the one hand, whether the growth-first strategy has been an overwhelming conception particularly of the less developed countries. In fact, this could be linked with the public demand for such strategy from their administrators. On the other hand, whether the appreciation to clean and safe environment despite it is boldly written in their constitution, is negligible. Despite the key role it could play in environmental management, the issue of sufficiency of environmental awareness and commitment of the decision/policy makers has not been a research area that adequately and properly addressed by academic researchers.

In line with the research objectives in general and based on the key findings of the study in particular, the researcher has forwarded the following recommendations with the anticipation that they would considerably contribute towards the formulation and implementation of plausible and workable municipal solid waste as well as waste water management policies:

- In order to make informed decisions and planning, the municipalities should conduct survey to precisely understand (the nature, composition, magnitude of waste generated (waste characteristics) and estimate the nature and magnitude of the problem related with urban waste management of their respective administrative unit boundary.
- In order to ensure regular, convenient and full coverage collection services to the beneficiaries, municipalities of the respective urban centres should be able to involve as many competent MSEs as possible in waste collection services accompanied by effective inspecting, regulating and monitoring activities.
- Bearing in mind the size and function of the city, the organization of the Sanitation and Beautification sector of Mekelle does not measure up to its status. Hence, the responsible body should upgrade the organizational structure of the sector of Mekelle from department to an agency level.
- The decision maker should recognize the risks, difficulties and complexities of waste management and the role of the waste management sector staff and thus reconsider the salary and remuneration of the employees to reduce dissatisfaction on their job and, thereby, the commitment of the staff could be raised and turnover of the employees could be minimized significantly.
- A fully mandated and empowered office of liquid waste (liquid waste) management which stands on its own should be established in the urban centres including Mekelle city and Adigrat town to manage all aspects of liquid waste problems in the respective urban centres.
- Mekelle municipality as well as the regional government should introduce a standard sewerage system particularly in the inner neighbourhoods which do have large concentration of population and economic activities. Likewise, more feasible, efficient and proper treatment plants should be established for the liquid waste collected through both sewer line and septic suction trucks.

- The state of the art and multifunction public toilets (which are commonly identified as green toilets) should be established in the needy areas of both Mekelle and Adigrat. The old and substandard public toilets of both urban centres should be upgraded so as to significantly minimize the incidences of urination or defecation in public spaces.
- The whole operational system of septic suction trucks needs strict controlling and regulating system. To this effect, a fully responsible and accountable office or body should be identified and/or established to manage them accordingly.
- The local administration of Adigrat should have a properly selected liquid waste dumping site(s) and should establish appropriate management system.
- To implement the waste management rules and regulations, the responsible body should devise a system and set up special section or group exclusively and fully responsible and committed to prevent improper and illegal waste handling systems and ensure proper operation of MSEs involved in waste management such as collection, transportation, disposal, recycling, and composting.
- The local administration of the respective urban centre should upgrade its landfills. The landfills should be upgraded to full-fledged sanitary landfills and should be able to be properly managed and equipped with the necessary equipment, machineries and facilities.
- At least the regional government should have a waste management policy that takes into consideration the extent and complexity of the current and future waste management problems of the urban centres of the region.
- The decision makers should make efforts to ensure full implementation of the existing waste management proclamation and regulations and publish detailed regulations, guidelines and directives, as stipulated in the documents, particularly to those waste types that lack attention from the responsible bodies such as plastic wastes, construction wastes, e-wastes, agricultural wastes, hazardous wastes, and so on.

- The regional as well as the local administration should strive to develop and strengthen the overall institutional capacity (in human power, material, financial and managerial) of waste management sectors.
- The decision makers at all administration levels should internalize the policy statement, as stipulated in the FDRE Constitution and Environmental Policy, 'every citizen has the right to live in clean and safe environment', and thus act accordingly to that end.
- The responsible bodies and particularly the local governors and the heads of the sanitation and beautification sectors need adequate knowledge about the environment and its link with socio-economic development so that they could develop appreciation to clean and safe environment, and its contribution to the overall urban development and, thus, would have commitment to create clean and healthy environment in the urban areas.
- To make the waste management endeavour more efficient and sustainable, the decision makers should focus more on strategic waste management approaches such as reducing, reusing, recycling, composting, and recovery of waste.
- Implementation of strategic waste management approaches such as 4Rs, and participation needs their own detailed rules and regulations, directives, and guidelines. Therefore, the responsible bodies should strive more to issue all these provisions.
- Involving households and micro and small enterprises in sorting activities should be target oriented and successful. Otherwise, it would be monotonous and backbreaking to residents involved in such activities. Therefore, the responsible bodies should strive hard to keep on succeeding phases of 4Rs like reusing, composting, recycling, recovering of wastes
- The informal activity of the *liwach* and *koralyo* should be organized and given supports to enhance their activity.

- The local administration (municipality) should scale up the participation of the MSEs and private investors in various aspects of waste management such as in the collection, transportation, 4Rs activities, and public toilet administration and so on.

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Annex I: Questionnaire

A. English Version

Household Survey

Dear participants

This questionnaire is designed to collect data pertaining to urban environmental management in general and solid and liquid waste management in particular of Major Urban Centres of Tigray National Regional State. The data collected through this instrument will be used solely for writing my doctoral dissertation. What is more, the outcome of this study will be helpful to improve the efforts that are being made to protect the urban environment and in so doing create healthy, beautiful and attractive urban centres. I would also like to assure you that your identity and all the information that you provide in response to the questions in this questionnaire will be kept strictly confidential.

I am confident that having read what I have stated above you will kindly take a few minutes to fill this questionnaire with the assistance of the enumerator. Thank you very much in advance for your cooperation

Part I. Bio-data (General Background information of Household)

1. City/Town: _____
2. Sub-city: _____
3. *Tabia/Kebeles* _____
4. Location: Inner _____ Outer _____
5. Gender: Female: _____ Male _____
6. Family size: Female _____ Male _____
7. Number of people living in one house unit: _____
8. Function of the house unit: Residential _____ Mixed _____
9. Educational status of the household head
Cannot read or write _____ secondary school _____ College Degree and above _____
Reading and writing only _____ Preparatory school _____
Primary school _____ Diploma/certificate _____

Part II. Household head's Perception and Practices pertaining to liquid and solid waste management in her/his city/town:

10. Cleanliness status of your city/town?
Very good _____ poor _____
Good _____ very poor _____
Fairly good _____
11. Low statuses of solid waste management in your city or town?
Strongly disagree _____ Agree _____
Disagree _____ Strongly Agree _____
Neutral _____
12. Sub-standard solid waste collection and disposal system (management) in your city/town.
Strongly Disagree _____ Agree _____
Disagree _____ Strongly agree _____
Neutral _____
13. How frequent have you ever come across any amount of solid waste that was dumped illegally at the wrong place in your city/town?

6						
3/2 7	Collection centres/points are far from your home					
4/2 8	Collection Touring line far from your house/home					
5/2 9	Collecting crew does not properly and adequately whistle to notify their coming for collection					
6/3 0	Misbehaviour of the collecting crew					
7/3 1	Unnecessarily Rushing (too short time to stay at a collection centre)					
8/3 2	Dissatisfaction /disinterestedness of the members of the collection crew					

33. Is there a system of complaint hearing through which the community could express their concerns about waste collection services to the appropriate authorities?
Yes No I don't know
34. If your response to question number 33 is 'yes' to what extent does it (the hearing) bring a solution?
Always Rarely
Often Never
Sometimes
35. What option do you use when the collection crew missed for long time?
Dumping in nearby open area
Burning
Ever Storing
Mention if any other _____
36. What options do other people use when collection crew missed for long time?
Dumping in nearby open area
Burning
Ever Storing
Mention if any other _____
37. How long have the collection crew disappeared consistently in your neighbourhood?

38. How frequent do the collection service provider crew visit your neighbourhood? 1. Twice per week 2. Once per week 3. Once in two weeks 4. Once in three weeks 5. Twice in three weeks 6. Once in a month 7. Indefinite
39. There is inadequate supervision, controlling and regulating activities with respect to sanitation in your neighbourhood?
Strongly disagree Agree
Disagree Strongly Agree
Neutral
40. Do you observe disparities among neighbourhoods in the quality of the solid waste collection services they obtain?
Yes No I don't know
41. If your answer for question number 40 is 'Yes' how high is the disparity you observed in the quality and coverage of services provided among the different areas?

No.	High disparities in service delivery	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/41	Between the inner and the outer residential areas/neighbourhoods/ Part of the city					
2/42	Between the wealthy and the poor people's residence areas					
3/43	Between people in authority and the common folks residence areas					
4/44	Between business centres and residential areas					
5/45	Between areas with many public institutions and those without					

46. How severe is the problem created by each of the waste streams in your city or town?

No.	Solid waste stream which created high problem	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/46	Detached Residential houses					
2/47	Communal houses (condominiums, hostels, camps etc) wastes					
3/48	Commercial areas /business establishments					
4/49	Public and private institutions (hospitals, colleges, etc)					
5/50	Manufacturing industries and other producing establishments					
6/51	Construction and demolition					
7/52	Agricultural waste					

53. How severe is the problem created by each of the solid waste streams in your neighbourhood?

	The Types of Solid waste stream which created high problem	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/53	Detached Residential houses					
2/54	Communal houses (condominiums, hostels, camps etc) wastes					
3/55	Commercial areas /business establishments					

71. What shortcomings have you observed in aspects of the rules and regulations of waste handling, collection and disposal systems that you know?

S.N	Constraints of rules and regulations pertaining to waste handling, collection and disposal systems	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/71	They are too weak either to stop or deter violators					
2/72	They lack clarity					
3/73	They are not properly implemented					
4/74	They are not known by many of the residents					
5/75	Stakeholders have not participated in their development					
6/76	Are not accepted by many of the residents					

77. Are there persons/workers responsible to the task of waste management controlling and regulating in your neighbourhoods?

Yes there No there are not I do not know

78. How do you evaluate the controlling and monitoring activities with respect to solid waste management in your town?

Very strong weak
 Strong Very weak
 Medium There is no control whatsoever

79. Significant discrepancies in the ways in which the responsible bodies treat or handle waste management rules and regulations violators in your city or town.

Strongly Disagree Agree
 Disagree Strongly Agree
 Neutral

80. What could be the reason why waste generators are not properly handling (collecting, and disposing) their wastes?

S.N	Possible reasons for mishandling of waste by generators	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/80	Lack of better options					
2/81	Lack of proper mechanisms for law enforcement and commitment					
3/82	Weak fines and charges					
4/83	Illegal dealing with violators					
5/8	Others (Lack of awareness, commitment					

1/96	Problems related to sewerage line					
2/97	Problems related to private toilets and number of people using of open toilets					
3/98	Problems related to storm drainage					
4/99	Problems related to public vacuum tracks services					
5/100	Problems related to public toilets					
6/101	Problems related to business establishments' liquid waste management					
7/102	Problems related to public and private institutions					
8/103	Problems related to communal houses liquid waste management					

104. What types of problems are there connected with storm drainage?

	Problems connected with storm drainage	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/104	problems of connecting private toilets to drainage canals					
2/105	problems of dumping wastes into the drainage canal					
3/106	problems of using drainages as open toilets					
4/107	problem of the bad effluent coming out of the drainage canals					
5/108	problems of clogging of the drainage canals and overflowing of flood					

109. What are the problems connected with private or communal toilet facilities in your city/town?

	Basic Problems connected with private toilet facilities	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/109	Lack of access to private toilet facilities					
2/110	Increasing number of people using open toilets					
3/111	Unhygienic and substandard toilet facilities					
4/112	Frequently filled septic tanks					
5/113	Many toilets have never been sucked					
6/114	Frequently seeping out of septic tanks/toilets					
7/115	Frequently spillover/ exploding of sewage from septic tanks and toilets					

I strongly disagree
I disagree
Neutral

I agree
I strongly agree

144. If you believe the number of people discharging their waste water out of their septic tanks (compound) is significant, what could be the possible reason?

S.N	Possible reason for people to let out discharges out of their home	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/144	Lack of proper toilets or/ and/septic tanks					
2/145	Lack of awareness about its environmental consequences					
3/146	Fear that their septic tank or toilet will be full soon and then minimize cost for vacuum truck					
4/147	No or poor controlling and regulating mechanisms					
5/148	The enforcements/charges are too weak to prevent illegal acts or give lesson to violators					

149. There is low commitments and efforts made by the responsible bodies to make the city/town clean, beauty and attractive? (efcmtrsbdcback)

I strongly disagree
I disagree
Neutral

I agree
I strongly agree

150. How do you rate the sanitation problem in your city/town created by the different liquid waste streams?

	Waste stream that created high problems in liquid waste management	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1/15 1	Liquid waste generated from residential areas					
2/15 2	Liquid wastes generated from communal residential areas (condominium, apartments, camps, etc.)					
3/15 3	Liquid wastes generated from manufacturing industries, workshops, garages, etc					
4/15 4	Liquid wastes generated from public and private institutions(Hospitals, colleges, hostels, religious centres,)					
5/15 5	Liquid wastes generated from business establishments (hotels, bars & restaurants, tea rooms, local drinks, beauty salons, fuel station, etc)					
6/15 6	Liquid wastes generated from agricultural activities					

7/15 7	Liquid wastes generated from car wash and garages					
-----------	---	--	--	--	--	--

158. Little or no commitment and concern of the residents to maintain the cleanliness of their city/town?

- | | |
|---------------------|------------------|
| I strongly disagree | I agree |
| I disagree | I strongly agree |
| Neutral | |

159. The rivers or water courses passing through the centre or near the city are serving as waste dumping sites and as open toilets.

- | | |
|---------------------|------------------|
| I strongly disagree | I agree |
| I disagree | I strongly agree |
| Neutral | |

160. Washing automobiles in any area including in and/or near rivers is a usual phenomena.

- | | |
|---------------------|------------------|
| I strongly disagree | I agree |
| I disagree | I strongly agree |
| Neutral | |

161. Do you have a practice of reusing or treating of wastes generated by one self.

- | | |
|----------|------------|
| Yes I do | No I don't |
|----------|------------|

162. If your answer to question number 188 is 'Yes I do' which type? For what purpose?

_____.

Thank you in advance for your cooperation!!

B. Tigrigna (local language) Version

ብመራሕቲ ስድራ ዝምለእ መጠይቕ

ዝኸበርኩም/ከን ነባራይ/ነባሪት እዛ ኸተማ

እዚ መጠይቕ ወረቐት እዚ ሓለዎን ክንክንን ከባቢ ኸተማ (Urban Environmental Management) ብሓፈሻ ኣተሓሕዛን ኣተሓላልዎን ደረቕ ጉሓፍን ፈሳሲ ርስሓትን (Solid and Liquid waste management) ብፍላይ ንምፅናዕ ተባሂሉ ዝተዳለወ እንትኹን ብዝተመረፀ መራሕቲ ስድራ እዛ ኸተማ ተመሊኡ ዝምለስ እዩ።

እቲ በዚ መጠይቕ ወረቐት ዝእኩብ መረዳእታ ቀንዲ ዓላማኡ ንናይ 3ይ ዲግሪ ትምህርቲ ፅንዓት ፅሑፍ ንምድላው ኮይኑ ካብዚ ብተወሳኺ ግን ናይቲ መፅናዕቲ ውፅኢት ናይ ከተማታት ኣከባቢየዊ ፀገም ንምፍታሕ ኣብዝገበር 9ዕሪ ሓጋዚ እታዎት ኮይኑ ከገልግል ይኸእል እዩ።

ናይ እዚ መፅናዕቲ ተሳተፍቲ ማንነትን ዝተውሃበ መልሲን/ መረዳእታን ምሉእ ንምሉእ ብሚስጢር ዝትሓዝ ኮይኑ እቲ መፅናዕቲን መፅነዳይን ብናይ ስነምግባር ደንቢ ፅንዓትን ምርምርን ዝተቐየደ እዩ።

ስለዚ ክቡራት ተሳተፍቲ እንታይነትን ረብሓን እዚ መፅናዕቲ ብውሳኔ ብምግንዛብ ብመሉእ እምነትን ሓቃዊነትን ኣብዚ መጠይቕ ወረቐት ዝለዎ ሕድሕድ ሕቶ መልሲ ሂቡኩም ንክትምልሱላይ ብኣኸብርት እላቦ ። ንትሕብብርኩም ድማ ኣቐዲመ ከመስግን እፎቱ።

ክፍሊ 1 ሓፈሻዊ መግለጺ መራሕታት ስድራ

1. ከተማ _____
2. ክፍለ ከተማ _____
3. ጣቢያ _____ /ቀጠና _____
4. መርክብ: ማእከል ወሰን
5. መራሒ ስድራ ያታ: ተባዕታይ ለ. አነስታይ
6. አብ ሓደ ገዛ ዝነበሩ በዝሒ አባላት ስድራ ተባ _____ አነ _____ ድምር _____
7. አብ ሓደ ግቢ ዝነበሩ በዝሒ አባላት _____
8. ተጠያቂ መራሒ/ሓት ስድራ ሀዚ ዘለዉሉ/ዋሉ ገዛ ግልጋሎቱ
 - ሀ) መንበሪ ገዛ ሹቕ፣ ዎርክሻፕ፣ ጋራጅ፣ አብያተ ንግዲ ደብዳቤ ብልዕን መስተን ናይ ቁንጅና ሳሎን
 - መ) ናይ ቤት እንሰጥ ምርባሕ (ሰ) ዝተሓዋወሰ
9. ናይ መራሒ ስድራ ደረጃ ትምህርቲ
 - ሀ. ምንባብን ምፅሓፍን ዘይክእሉ ሰ. ዲፕሎማ/ሰርተፊኬት
 - ለ. ምንባብን ምፅሓፍን ዝክእሉ ሸ. ድግሪን ካብኡ ንላዕልን
 - ሐ. 1^ይ ብርኪ (1ይ- 8ይ ክፍለ)
 - መ. 2^ይ ብርኪ /9ይ-12)

ክፍለ 2 መራሕቲ ስድራ አብ ሓለዎን ክንክንን ከባቢ ከተማ (urban environmental management) ብሓፈሻ አተሓሕዝን አተኣላልያን ደረጃ ጉሓፍ (Solid waste management) ብፍላይ /አመልኪቱ/ ዘለዎም ተመኩርን ትዕዛብቲን

10. ፅርዮት ከተማኹም ከመይትግምግምዎ?
 - ሀ. ብጠዕሚ ልዑል መ. ትሑት
 - ለ. ልዑል ሰ. ብጣዕሚ ትሑት
 - ሐ. ማእከላይ
11. ትሑት ደረጃ አተሓሕዝን አተኣላልያን ደረጃን ፈሳስን ርስሓት ከተማኹም?
 - ሀ. ብጠዕሚ አይስማዕምን መ. ይስማዕም
 - ለ. አይስማዕምን ሰ. ብጣዕሚ ይስማዕም
 - ሐ. አይስማዕምን አይቃወምን
12. ንዛ ኸተማ ዝበፅሖ ዕብዮት ብርኪ ዝምጥን ስርዓት ዓተሓሕዝን አተኣላልያን ደረጃ ጉሓፍ ዓለን?
 - ሀ. ሀ. ብጠዕሚ አይስማዕምን መ. ይስማዕም
 - ለ. አይስማዕምን ሰ. ብጣዕሚ ይስማዕም
 - ሐ. አይስማዕምን አይቃወምን
13. ደረጃ ጉሓፍ ብዘይ አግባብ ማለት ካብሕገ ወጻኢ አብ ክፍቲ ቦታታት ሩባታት መንገዲታት ወዘተ ዝተደብሪ ክንደይ ጊዜ የጋጥመኩም?
 - ሀ. ኩሉ ጊዜ መ. ሳሕቲ
 - ለ. ብዙሕ ጊዜ ሰ. ምንም አየጋጥመንን
 - ሐ. ሓድ ሓደ ጊዜ
14. አብዛ ኸተማ ካበይ ዝምንጭው ጉሓፍት እዮም ብዙሕ ጊዜ ብሰብ ዋና ብአግባቡ ዘይታሓዙን/ ዝተሓዙን/ (አብ አተሓሕዝ ደረጃ ጉሓፍ ብበዓል ዋናታት/ ጉሓፍ መምንጨውቲ አካላት/ ዝገበር ጥንቃቄ ክንደይ ዝአክል እዮ

ተ.ቐ.	ዓይነታት ፍልፍል/ መምንጨውቲ አካላት	ደረጃ አተሓሕዝን አተኣላልያን ደረጃ ጉሓፍ								
		ብጣዕሚ	ፅርዮት	ፅርዮት	ማእከላይ	ትሑት	ብጣዕሚ	ትሑት	መልሲ	የብላይን
1/14	ካብ ናይ ግሊ መንበሪ አባይቲ ዝወፁ ጉሓፍት									
2/15	ካብ ናይ ሓባር መንበሪ አባይቲ ዝወፁ ጉሓፍት									
3/16	ካብ ንግዲ ቤታት ዝወፁ ጉሓፍት									

4/17	ካብ ናይ መንግስታዊን ዘይመንግስታዊን ትካላት/ ጥዲና ትካላት ከም ጥዲና ጣብያ፣ሆስፒታል/ዘበሉ፣ት/ቲ ትካላት ከም ቤት ት/ቲታት፣መሰልጠኒ ማእኸላት፣ ኮሌጅን ዩኒቨርሲቲታትን ዝመሰሉሉ/ ዝወፁ ጉሓፋት						
5/18	ካብ መፍረይቲ ትካላት/ ኢንዱስትሪ፣ ዎርክሾፓት፣ጋራጃት/ ዝወፁ ጉሓፋት						
6/19	ካብ ህንፃታት ፍርስራሽን መንገዲ ስራሕን ዝወፁ ጉሓፋት						
7/20	ካብ ሕርሻን ምርባሕ እንስሳታትን ዝወፁ ጉሓፍ						

21. ቤት መዘጋጃ ካብዛ ከተማ ገዳማ ጉሓፍ ብኣግባቡን ምሉእ ንሙሉእን ክስብዕዎን ክልዕልን ኣይከኣለን.

- ሀ. ብ. ይስምዕምዕ መ. ኣይስምዕምዕን
 ለ. ይስምዕምዕ ሰ. ብ. ኣይስምዕምዕን
 ሐ. ብመጠኑ ይስምዕምዕ ሸ. መልሲ የብለይን

22. ኣብ ሰፈርኩም ናይ ደረጃ ጉሓፍ ምእስብሳብን ምልዓልን ግልጋሎት ትረኽቡ ዶ

- ሀ. ኡወ ንረክብን ለ. ኣይንረክብን

23. ንጥያቄ ቁፅሪ 22 መልሲኹም ዝዛንዝ ዝብል እንተኾይኑ ካብእዞም ዝስዕቡ በይናይ ዓይነት?

- ሀ. ብናይ ፈረስ ጋሪ መ. ብተሸካማይ
 ለ. ብኢድ ዝድፈእ ጋሪ ሰ. ካሊእ

እንተሃሊዩ ጥቕሱ

ሐ. ብናይ ፅዕነት መኪና

24. በቲ ዝ ንገዛ ዝወሃብ ናይ ጉሓፍ ምስብዕባሳ ግልጋሎት ርኽብ/ሕገስ ኢኹም?

- ሀ. ብጠዕሚ ኣይስማዕምዕንል መ. ይስማዕምዕ
 ለ. ኣይስማዕምዕን ሰ. ብጣዕሚ ይስማዕምዕ
 ሐ. ኣይስማዕምዕን ኣይቃወምን

25. ኣብቲ ዝ ንገዛ እናዘሩ ናይ ጉሓፍ ምእካብ ግልጋሎት ዝህቡ ትካላት/ማሕበራት ዝረኣዩ ዓበይቲ ፀገማት እንታይ እዮም?

ተ.ቐ	ዓይነት ዝተርኣዩ ፀገማት	ብጣዕሚ ኣይስማዕምዕን	ኣይስማዕምዕን	ኣይስማዕምዕን ኣይቃወምን	ይስማዕምዕ	ብጣዕሚ ይስማዕምዕ
1/25	ብፕሮግራምካ ዘይምምዓእ					
2/26	ኣብዝምቹ ሰዓት ዘይምምዓእ					
3/27	ጠጠው ዝብልሉ ማእኸል ቦታ ካብ ዝኹም ኣዚዩ ዝረኣቐ እዩ					
4/28	እቲ ዝዘሩሉ መስመር ኣዚዩ ካብ ዝውትኹም ዝረኣቐ እዩ					
5/29	ምምፀእም ኣዚዮም ኣየቃልሉት?					
6/30	ናይ ባህሪ ፀገም ኣለዎም					
7/31	ጠጠው ኣብ ዝብልሉ ማእኸል ቦታ እኹል ጊዜ ዘይምዕናሕ/ ምሸጋል/					
8/32	ድልዮት ምንኣስን ዘይሕገስ ምኻንን					

33. ምስ ኣወሃህባ ግልጋሎት ምእካብን ምእላይን ደረጃ ጉሓፍ ተተሓሒም ዝረኣዩ ፀገማት ብዝምልከት ዘለኩም ቅሬታን ሓበሬታን ብቐሊሉ ንምቕራብ ዘኸእል ስርዓት ኣሰራርሐ ኣሎ ዶ?

46. ብኸተማ ደረጃ እንትረአ ኣብ ፅርዮትን መልክዕን እታ ኸተማ ዝግበዩ ፀገም ዝፈጥሩ ዘለዉ ጉሓፋት ካበይ ዝወፁ እዮም?

	ፀገም ዘለዎም ዓይነት ደረጃ ጉሓፋት	ብጣዕሚ ኣይሰማይምን	ኣይሰማይምን	ኣይሰማይምን	ኣይ.ቃወምን	ይሰማይም	ብጣዕሚ	ይሰማይም
1/46	ካብ ናይ ግሊ መንበሪ ኣባይቲ ዝወፁ ጉሓፋት							
2/47	ካብ ናይ ሓባር መንበሪ ኣባይቲ ዝወፁ ጉሓፋት							
3/48	ካብ ንግዲ ቤታት ዝወፁ ጉሓፋት							
4/49	ካብ ናይ መንግስታዊን ዘይመንግስታዊን ትካላት/ ጥዲና ትካላት ከም ጥዲና ጣብያ፣ ሆስፒታል ዝበሉ፣ ትካላት ከም ቤት ት/ቲታት፣ መሰልጠኒ ማእኸላት፣ ኮሌጅን ዩኒቨርሲቲታትን ዝመሰሰሉ/ ዝወፁ ጉሓፋት							
5/50	ካብ መፍረይቲ ትካላት/ ኢንዱስትሪ፣ ዎርክሾፓት፣ ጋራጃት/ ዝወፁ ጉሓፋት							
6/51	ካብ ህንፃታት ፍርስራሲን መንገዲ ስራሕን ዝወፁ ጉሓፋት							
7/52	ካብ ሕርሻን ምርባሕ እንስሳታትን ዝወፁ ጉሓፍ							

53. ብአንፃር ፅርዮትን መልክዕን ኣብሰፈርኩም ዝግበዩ ፀገም ዝፈጥሩ ዘለዉ ጉሓፋት ካበይ ዝወፁ እዮም?

ተ.ቐ.	ፀገም ዘለዎም ዓይነት ደረጃ ጉሓፍ ብአንፃር ኣመንጨውቲ ኣካላት	ብጣዕሚ ኣይሰማይምን	ኣይሰማይምን	ኣይሰማይምን	ኣይ.ቃወምን	ይሰማይም	ብጣዕሚ	ይሰማይም
1/53	ካብ ናይ ግሊ መንበሪ ኣባይቲ ዝወፁ ጉሓፋት							
2/54	ካብ ናይ ሓባር መንበሪ ኣባይቲ ዝወፁ ጉሓፋት							
3/55	ካብ ንግዲ ቤታት ዝወፁ ጉሓፋት							
4/56	ካብ ናይ ግሊን ናይ መንግስትን ትካላት/ከም ሆስፒታል ኮሌጅ/ ዝወፁ ጉሓፋት							
5/57	ናይ መፍረይቲ ትካላት/ ኢንዱስትሪ ዝወፁ ጉሓፋት							
6/58	ካብ ውልቁን መንግስቲን ቢሮታትን ዝወፁ ጉሓፋት							
7/59	ካብ ዝወፁ ህንፃታት ፍርስራሲን መንገዲ ስራሕን ዝወፁ ጉሓፋት							
8/60	ካብ ሕርሻን ምርባሕ እንስሳታትን ዝወፁ ጉሓፍ							

61. ኣብ ኣተሓሕዝን ኣተሓላልያን ደረጃ ጉሓፍ ኣመልኪቱ ብወገን ነበርቲ ዝረአ ፀገም እንታይ እዮም?

ተ.ቐ.	ኣብ ነበርቲ ዝረአ ፀገም	ብጣዕሚ ኣይሰማይምን	ኣይሰማይምን	ኣይሰማይምን	ኣይ.ቃወምን	ይሰማይም	ብጣዕሚ	ይሰማይም
1/61	ተሓቢእኻ ናብ ደገ ምድፋእ							

3/62	አብ ዝዘኣም ውሽጢ ዝጥቀሙሉ ጉሓፍ መጠራቕሚ ኣቕሓ መብዛሕቱ ጊዜ ዝኣረገን /ብላይ/ ንመትሓዚ ዘይምቹ/ ደረጃኡ ዘይሓለወን ኣቕሓ እዩ					
4/63	ጉሓፍ አብ ዝተጠራቑሙ/ተዋህሊሉ/ ንነዊሕ እዋን እዩ ዝፀንሕ					
5/64	ጉሓፍ ናይ ምስብሳብን/ምእካብን/ ምድፋእ ስራሕን ሓላፍነትን ናይ ቆሎዕትን ናይ ዝሰራሕተኛታትን እዩ					
6/65	ንጉሓፍ ምስብሳብ ግልጋሎት ዝህቡ ሰባት ዘይግባእ ባህሪ ምርኣይ/ምንእእስ/					
7/66	ጉሓፍካ ፈሊኽ ንምጥርቓም ድልዩት ምንእስ					

67. ናይ እዛ ኸተማ ነባሪ ሕብረተሰብ አብ ንቑፅ ይኹን ፈሳሲ ርስሓት ምስብሳብን ምእላይን ስራሕን ኣቡኡ ዝተዋፈሩ ሰራሕተኛታትን ዘለዎ ኣረኣእይ እንታይ እዩ ዝመስል?
 ሀ. ብ.ፅቡቕ ለ. ፅቡቕ ሐ. ማእኸላይ መ. ሕማቕ ሰ. ብ. ሕማቕ
68. ንስኹም/ንስኹን አብ ንቑፅ ይኹን ፈሳሲ ርስሓት ምስብሳብን ምእላይን ስራሕን ኣቡኡ ዝተዋፈሩ ሰራሕተኛታትን ዘለዎም ማሕበራዊ ክብሪ እንታይ እዩ ዝመስል?
 ሀ. ብ. ልዑል ለ. ልዑል ሐ. ማእኸላይ መ. ትሑት ሰ. ብ. ትሑት
69. ምስካሊእ ዓይነት ስራሕ እንትነፃፀር ናይ ንቑፅን ፈሳሲን ርስሓት ምስብሳብን ምእላይን ስራሕ ዘለዎም ማሕበራዊ ክብሪ ከመይ ተነፃፀርዎ/ረኣ?
 ሀ. ብ. ዝሓሸ ለ. ዝሓሸ ሐ. ሓደ መ. ዝሓመቕሰ ሓመቕ
70. አብ ኸተማኹም ዘሎ ደንቢን ስራሕን ኣተሓሕዝን ኣተኣላልዎን ጉሓፍ/ርስሓት (ደረቕን/ራዕዳን) ክንደይ ዝኣክል ትፈልጥዎም?
 ሀ. ኩሉ እፈልጦ እዩ መ. ሓድ ሓደ እፈልጦ እዩ
 ለ. መብዛሕቱኡ እፈልጦ እዩ ሰ. ምንም ኣይፈልጥን
 ሐ. ዝተወሰነ እፈልጦ እዩ
71. ኣፍቶም እትፈልጥዎም ሕጊታትን ደንቢታትን ኣተሓሕዝን ኣተኣላልዎን ደረቕ ጉሓፍን ፈሳሲ ርስሓትን ዝተዓዘብኩሙዎም ፀገማት እንታይ ኣለዉ?

ተ.ቐ	ፀገማት ሕጊታትን ደንቢታትን ኣተሓሕዝን ኣተኣላልዎን ደረቕን ፈሳሲን ርስሓት	ብግዕሚ ኣይሰግዎምን	ኣይሰግዎምን	ኣይሰግዎምን ኣይቃወምን	ይሰግዎም	ብግዕሚ ይሰግዎም
1/71	ከምህሩ/ ከከላሽሉ ዘይኸእሉ ድኹማት/ ልሕሉሓት/ እዮም					
2/72	ዝተኣላለኹን ዘይንፁራትን ንትግበራ ዘፀግሙን እዮም					
3/73	ብኣግባቡ ኣይትግበሩን					
4/74	ነበርቲ ይኹኑ መዳርግቲ ኣካላት ኣይፈልጥዎምን					
5/75	እቶም ሕጊታት እንትዳለዉ መዳረግቲ ኣካላት ሕብረተሰብ ኣይተሳተፈሎምን					
6/76	ብህዝቢ ተቀባልነት የብሎምን					

77. አብ ሰፈርኩም ቁፅፅርን ክትትልን ዘይሕጋዊ ኣተሓሕዝን ኣተኣላልዎን ደረቕን ፈሳሲን ርስሓት ዘካይዱ መንግስታዊ ኣካላት ኣለዉዶ?
 ሀ. እወ ኣለዉ ለ. የለዉን ሐ. ኣይፈልጥን

78. ኣብ ከባቢኹም ዝገበር ክትትልን ቁፅፅርን እንታይ ይመስል?
 ሀ. ብ. ጥንኩር ም. ልሕሉሕ
 ለ. ጥንኩር ሰ. ብ. ልሕሉሕ
 ሐ. ማእኸላይ ሸ. ምንም የለን

79. ዝምልከቶም መንግስታዊ ኣካላት ዝግበርው ቁፅፅርን ክትትልን ከምኡውን ዝህብዎ ቅፅዓት ኣብዎንን ዝተፈለለዩ መመንጨውቲ ኣካላት ዝገብርዎ ኣፈላላይ ክንደይ ዝኣክል እዩ?
 ሀ. ብጠዕሚ ኣይስማዕማዕንል ም. ይስማዕማዕ
 ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ
 ሐ. ኣይስማዕማዕን ኣይቃወምን

80. ብዙሕ ጊዜ ጉሓፍ ዘመንጭዉ ኣካላት ብኣግባቡ ጉሓፍም ዘይሕዙን ዘይኣልዩን ንምንታይ ይመስለኩም?

ተ.ቐ	ብኣግባቡ ጉሓፍም ዘይሕዙን ዘይኣልዩን ምክንያት	ብጣዕሚ ኣይስማዕማዕን	ኣይስማዕማዕን	ኣይስማዕማዕን ኣይቃወምን	ይስማዕማዕ	ብጣዕሚ ይስማዕማዕ
1/80	ከሊኦ መማረፂ ምስኣን					
2/81	ዝቆፃፀር ኣካል ስለዘየሎ ወይም ክረኽቦም ስለዘይኽእል					
3/82	እቲ ቅፅዓት ብጣዕሚ ቀሊል ስለዝኾነ					
4/83	ቀፃዕቲ ኣካላት ዋላ እንረኽቡዎምን /እንተፈለጥዎምውን ብቐሊሉ ክደራደሩ ስለዝኽእሉ እዩ					
5/84	ካሊኦ እንተሃሊዩ ጥቕስ (ናይ ግንዛብ ሕፅረት ወዘተ)					

85. ካብ ሕጊ ወፃኢ ኣከባቢኡም ዘበላሸዉ ኣካላት ተኸታታሊ ዝሓኮነ (regularly and continuously) ናይ ምክትታልን ምቕፅፃርን ኢልካውን ናይ ምቕፃፃፅን ምዃን የለን።
 ሀ. ብጠዕሚ ኣይስማዕማዕንል ም. ይስማዕማዕ
 ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ
 ሐ. ኣይስማዕማዕን ኣይቃወምን
86. እዛ ከተማ እትጥቀመሉ መገደዲ ሕጊ ሓለዋ ከባቢ (ብፍላይ ኣተሓሕዛን ኣተኣላልያን ደረቕ ጉሓፍ ዝምልከት) እንታይ ከምዝብል ክንደይ ዝኣክል ትፈልጥዎ?
 ሀ. ኩሉ እፈልጦ እዩ ም. ሓድሓድ እዩ ዝፈልጥ
 ለ. መብዛሕቱ እፈልጦ እዩ ሰ. ምንም ኣይፈልጦን
 ሐ. ዝተወሰነ እዩ ዝፈልጦ
87. መብዛሕቱኡ እቲ ነባራይ እዛ ከተማ እትጥቀመሉ መገደዲ ሕጊ ሓለዋ ከባቢ /ኣተሓሕዛን ኣተኣላልያን ደረቕን ፈሳሲን ርስሓት / እንታይ ከምዝብል ኣፀቢቐ ኣይፈልጦን።
 ሀ. ብጠዕሚ ኣይስማዕማዕን ም. ይስማዕማዕ
 ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ
 ሐ. ኣይስማዕማዕን ኣይቃወምን
88. ሓለዋን ክንክንን ከባቢ (ከም ኣተሓሕዛን ኣተኣላልያን ደረቕ ጉሓፍን ፈሳሲ ርስሓትን) ኣመልኪቱ ዝተውሃበኩም ወይ ዝረኽብኩም-ም ናይ ግንዛብ ምዕባይ ትምህርቲ ወይ ስልጠና እንተሃሊዩ ብኸመይ መንገዲ? (ካብ ሓደ ንላዕሊ መልሲ ምሃብ ይከኣል እዩ)
 ሀ. ኣብ ኣኼባ
 ለ. ብመራኽቢ ሓፋሽ

ሐ. ብብራሪ ወረቆታትን ኣብግድግዳ ዝጥቀሱ ፖስተራትን

መ. ኣብ ጥዲና ኬላታት

ሰ. ምንም ኣይረኽብኩን

89. ኣብ እዚ ህዚ እዋን ዝግበር ናይ ህዝቢ ወፍሪ ፅርዮት ዳርጋ የለን ወይም ዘዕግብ ስራሕ እናተሰርሐ ኣይኮነን ክበሃል ይከኣል እዩ

ሀ. ብጣዕሚ ኣይስማዕማዕን መ. ይስምዕማዕ

ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ

ሐ. ኣይስማዕማዕን ኣይቃወምን

90. ናይ ህዝቢ ወፍሪ ፅርዮት ምክያድ ኣድላይነቱ ሊብራሪ እዩ

ሀ. ብጣዕሚ ኣይስማዕማዕን መ. ይስምዕማዕ

ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ

ሐ. ኣይስማዕማዕን ኣይቃወምን

91. ሙብዛሕቶም ዝገበሩ ዝነበሩ ወይም ዘለዉ ናይ ህዝቢ ወፍሪ ፅርዮት ምስ ዝኸሪ ማሕበራዊን ፖለቲካዊን ፍጻሞታትን ዝተተሓሓዙ ወይም ድጋፍ ንምውሃብ ተበሂሉ እዩ።

ሀ. ብጣዕሚ ኣይስማዕማዕን መ. ይስምዕማዕ

ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ

ሐ. ኣይስማዕማዕን ኣይቃወምን

92. ናይ እዚ ከተማ ፈሳሲ ርስሓት መውረዲ ተባሂሎም ዝተዘርገሑ ዓበይቲ ትቦታት/ ፋኛቶራ ኣለዉ ዶ?

ሀ. እወ ኣለዉ ለ. የለዉን ሐ. ኣነ ኣይፈልጥን

93. ንጥያቄ ቆይሶ 100 መስሰኹም 'እወ ኣለዉ' ዝብል እንተኾይኑ ኣብ ዘላኹሙሉ ሰፈር ኣሎ ዶ?

ሀ. እወ ኣሎ ለ. የለን ሰ. ኣይክእልን

94. ናይ እዚ ከተማ ፈሳሲ ርስሓት መውረዲ ተባሂሎም ዝተዘርገሑ ዓበይቲ ትቦታት/ ፋኛቶራ ብዘይ ምህላው ኣብሰፈር ኩም ዝበፅሑ ፀገም ዓብዩ እዩ

ሀ. ብጣዕሚ ኣይስማዕማዕን መ. ይስምዕማዕ

ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ

ሐ. ኣይስማዕማዕን ኣይቃወምን

95. ኣብዛ ከተማ ፀገም ኣተሓሕዝን ኣተኣላልዎን ፈሳሲ ርስሓት ክንደይ ዝኣክል እዩ?

ሀ. ብጣዕሚ ልዑል መ. ትሑት

ለ. ልዑል ሰ. ብጣዕሚ ትሑት

ሐ. ማእኸላይ ሸ. ምንም ፀገም ኣይበፅሐን

96. ኣብዛ ከተማ ዘሎ ፀገም ፍሳሰ ርስሓት ምስእንታይ ዝተተሓሓዘ እዩ?

ተ.ቐ	ብስፍሓት ዝረኣይ ዓይነት ፀገም	ብጣዕሚ ኣይስማዕማዕን	ኣይስማዕማዕን	ኣይስማዕማዕን ኣይቃወምን	ይስምዕማዕ	ብጣዕሚ ይስማዕማዕ
1/96	ምስ ናይ ፈሳሲ ርስሓት መውረዲ/መክየዲ ትቦ/ ፋኛቶራ /SEWER/ ዘተተሓሓዘ ፀገም					
2/97	ምስ ናይ ውልቁ ሸንት ቤት ተደራሽነትን በዝሒ ኣብ ማእኸል ሜዳ / ኣብ ክፍቲ ቦታታት፣ ወሰን መንገዲታት፣ ሩባታት/ ዝፀዳደ በዝሒ ሰብ ዝተተሓሓዘ ፀገም					
3/98	ምስ ናይ ውሕድ መክየዲ ተባሂሎ ዝተሰርሐ ትቦ/ካናል/ ኣጠቓቕማ ዝተተሓሓዘ ፀገም					
4/99	ምስ ናይ መጠጥቲ መክየዲ ኣቕርቦት ዝተተሓሓዘ ፀገም					

5/100	ምስ ናይ ህዝቢ ሸንትቤት ዝተተሓሓዘ ፀገም					
6/101	ምስ ካብ ንግዲ ቤታት፣ መምረቲ ትካላት (ፋብሪካታ፣ጋራጃት፣ ምረክሻጋት ወዘተ) ዝወፀእ ፈሳሲ ርስሓት ዝተተሓሓዘ ፀገም					
7/102	ምስ ካብ መንግስተዊን ዘይመንግስታዊን ትካላት (ጥዲና ጣብያታት፣ሆስፒታል ኮሌጃት ዩኒቨርሲቲታትን)፣ ዝወፀእ ፈሳሲ ርስሓት ዝተተሓሓዘ ፀገም					
8/103	ምስ ካብ ውልቁን ናይ ሓባርን መንበሪ ኣባይቲ (ከም ኮንዶሚኒየም፣ ካምፕ፣ ወዘተ) ሸንት ቤታትን ሕፃብን ንደገ ዝፈሰሰ ርስሓት ዝተተሓሓዘ ፀገም					

104. ምስ ናይ ዝናብ ውሕጅ መውረዲ ተባሂሎም ዝተሰርሑ ትቦታት ወይም ዲፓት ተተሓሓዙ ዝረከቡ ፀገማት እንታይ እዮም?

ተ.ቁ	ምስ መውረዲ ውሕጅ ዝተሰርሑ ትቦታት ተተሓሓዙ ዝረከቡ ዓይነት ፀገም	ብጣዕሚ ኣይሰማዕግዕን	ኣይሰማዕግዕን	ኣይሰማዕግዕን ኣይ.ቃወምን	ይሰማዕግዕ	ብጣዕሚ ይሰማዕግዕ	ብጣዕሚ ኣይሰማዕግዕን
1/104	ናይ መንበሪ ይኹኑ ንግዲ ኣባይቲ ሸንት ቤታት ብትቦ ናብቲ ውሕጅ መውረዲ ትቦ ናይ ምትሕሓዝ ፀገም						
2/105	ናፍቲ ትቦ ሕፃብን ደረቕ ጉሓፍን ናይ ምድፋእ ፀገም						
3/106	ሰባት ኣፍቲ ውሽጢ ትቦ ምዕድዳይ ፀገም						
4/107	ካፍቲ ትቦ ዝወፀእ ሕማቕ ጨና ፀገም						
5/108	እቲ ትቦ ብጉሓፍ ስለዝድፈን ውሕጅ መሊኡ ንደገ ምፍሳስ ፀገም						

109. ምስ ናይ ውልቁ ሸንት ቤት ተተሓሓዙ ዝረከቡ ዝበፀሕ ዓይነት ፀገምን ክብደቱን

ተ.ቁ	ምስናይ ውልቁ ሸንት ቤት ተተሓሓዙ ዝረከቡ ዓይነት ፀገም	ብጣዕሚ ኣይሰማዕግዕን	ኣይሰማዕግዕን	ኣይሰማዕግዕን ኣይ.ቃወምን	ይሰማዕግዕ	ብጣዕሚ ይሰማዕግዕ
1/110	ብብዝሒ ናይ ውልቁ ሸንት ቤት ዘይምህላው ፀገም					
2/111	ፎቆደኡ /ኣብዝረኸቦ/ ዝፀዳደ ሰብ ምብዛሕ ፀገም					
3/112	ፅርዮቶምን ደረጃኦምን ዘይሓለዉ ሸንት ቤታት ምህላው ፀገም					
4/113	ቶሎ ቶሎ ናይምምላእ ፀገም					
5/114	መሊኦም ወይም ተመጢጦም ዘይፈልጡ					

	ሽንትቤታት ምህላው ፀገም					
6/115	ዝነትዑ ወይም ዝፍንድኡ ሽንትቤታት ምህላውን ንደገ (ናብ ፅርግያ) ምፍሳስ ፀገም					
7/116	መሊኦም እናሃለዉ ቶሎ ኢሎም ዘይምጠጡ ሽንትቤታት ምህላው ፀገም					
8/117	ናይ መጠጥቲ መኻይን ኣቕርቦት ፀገም					

118. ግልጋሎት ፈሳሲ ርስተት መጠጥቲ መኻይን ብዝምልከት ዘሎ ፀገም እንታይ እዩ? ፀገሙ ኹ ከንደይ ዝኣክል እዩ?

ተ.ቐ	ምስ ናይ ግልጋሎት ፈሳሲ ርስተት መጠጥቲ መኻይን ተተሓሕዞ ዝረኣ ዓይነት ፀገም	ብጣዕሚ ኣይስማዕምዎን	ኣይስማዕምዎን	ኣይስማዕምዎን ኣይቃወምን	ይስማዕምዎ	ብጣዕሚ ይስማዕምዎ
1/118	ናይ መጠጥቲ መኻይን ኣቕርቦት ዋሕዲ/ዘይምህላው ፀገም					
3/119	ናይ መጠጥቲ መኻይን ግልጋሎት ዘኸፍላኦ ዋጋ ዘይፍትሓዊ ምኻን ፀገም					
4/120	ናይ መጠጥቲ መኻይን ግልጋሎት ወሃብቲ ናይስነምግባር ፀገም (ብደንቢ እንተይመላእኻ ምኻድ፣ ኣብዘይኮነ ሰኣት ብምምጣጥ ብጨና ኣከባቢ ምብካል ወዘተ)					
5/121	ካብ ዝተፈቐደሉን መድፈኢ ቦታ ወፃኢ ምድፋእ ፀገም					

122. ኣብ ከተማኹም ናይ ህዝቢ ሽንት ቤት ኣሎ ዶ?

ሀ. እወ ኣሎ ለ. የለን ሐ. ኣይፈልጥን

123. ኣብ ከተማኹም ናይ ህዝቢ ሽንት ቤት ኣድላዩ እዩ።

ሀ. ብጣዕሚ ኣይስማዕምዎን መ. ይስማዕምዎ
 ለ. ኣይስማዕምዎን ሰ. ብጣዕሚ ይስማዕምዎ
 ሐ. ኣይስማዕምዎን ኣይቃወምን

124. ንጥያቄ ፅቕሪ 129 መልስኹም 'እወ ኣሎ' ዝብል እንተኾይኑ ኣብ ናይ ህዝቢ ሽንት ቤት ተጠቓማይ ዲኹም?

ሀ. እወ ኩሉ ጊዜ መ. እወ ሳሕቲ
 ለ. እወ ብዙሕ ጊዜ ሰ. ምንም ተጠቓማይ ኣይኮንኩን
 ሐ. እወ ሓድሓደ ጊዜ

125. ኣብ ሰፈርኩም ናይ ህዝቢ ሽንት ቤት ኣሎ ዶ?

ሀ. እወ ኣሎ ለ. የለን ሐ. ኣይፈልጥን

126. ንጥያቄ ፅቕሪ 129 መልስኹም 'የለን' ዝብል እንተኾይኑ እንተዝህልዉ ነይሩ ዓቢዩ ጥቕሚ ምሃለዎ ነይሩ።

ሀ. ብጣዕሚ ኣይስማዕምዎን መ. ትሑት
 ለ. ኣይስማዕምዎን ሰ. ብጣዕሚ ትሑት
 ሐ. ኣይስማዕምዎን ኣይቃወምን

127. ንጥያቄ ፅቕሪ 132 መልስኹም 'እወ ኣሎ' ዝብል እንተኾይኑ ምስ ናይ ህዝቢ ሽንት ቤት ተተሓሕዞ ዝረኣ ፀገም ከመይ ትግምግምዎ?

ተ.ቁ	ዓይነታት ፀገም ናይ ህዝቢ ሽንትቤታት (public toilets)	ብጣዕሚ ኣይሰማዕ፡፡	ኣይሰማዕ፡፡	ኣይሰማዕ፡፡ ኣይቃወምን	ይሰማዕ፡፡	ብጣዕሚ ይሰማዕ፡፡
1/127	ኣብዘድሊ ኩሉ ቦታ የለዉን (ዋሕዲ ናይ ህዝቢ ሽንትቤታት ኣሎ)					
2/128	ህዚ ዘለዉ ናይ ህዝቢ ሽንትቤታት ኣብ ምቕደን ዘድሊን ቦታ ኣይኮነን ዘለዉ/ዝተሰርሐ/					
3/129	ናይ ህዝቢ ሽንትቤታት ብፅርየት ኣይተትሓዙን					
4/130	ናይ ህዝቢ ሽንትቤታት ደረጃኦም ዝሓለዉ ህገታት ኣይኮኑን					
5/131	ናይ ህዝቢ ሽንትቤታት ብዙሕ ተጠቓማይ ሰብ የብሎምን					
6/132	ናይ ህዝቢ ሽንትቤታት እኹል ማይ የብሎምን					
7/133	ናይ ህዝቢ ሽንትቤታት ሙብራህቲ የብሎምን					
8/134	ናይ ህዝቢ ሽንትቤታት ኩሉ ጊዜ ኣይኸፈቱን (ደንገጥምይኸፈቱ ፣ብጊዜ ይፅፀዉ ፣ሙሉእ ማዓልቲ ይፅፀዉ፣ ወዘተ)					

135. የትም ቦታ (ኣብ ሩባ፣ ክፍቲ ቦታ፣ ወሰን መንገዲ፣ ኣእዋም ዘለዉሉ ቦታ፣ ወዘተ) ዝፀዳደ (ንፍታን ይኹን ሽንት ማይ ዝጥቀም)

ዝፀዳደ በዝሒ ሰብ ክንደይ ይኸውን?

ሀ. ብሓዕሚ ብዙሕ መ. ውሑድ ጋ የለን
 ለ. ብዙሕ ሰ. ኣዝዩ ውሑድ
 ሐ. መጠነኛ ሸ. ምንም የለን

136. ካብ ሽንት ቤት ወፃኢ ንስኹም ወይም ስድራኹም ኣብ ደገ ክንደይ ጊዜ ትፀዳደዩ?

ሀ. ኹሉ ጊዜ መ. ሳሕቲ
 ለ. ብዙሕ ጊዜ ሰ. ምንም ኣይንፀዳደን
 ሐ. ሓድ ሓደ ጊዜ

137. ኣብ ማእኸል ሜዳ ዝፀዳደ ሰብ ኣሎ እዩ ትብሉ ኣንተኸይንኹም ንምንታይ ይመስለኩም?

ተ.ቁ	ምክኒዶት ምፅድዳይ ኣብ ማእኸል ሜዳ	ብጣዕሚ ኣይሰማዕ፡፡	ኣይሰማዕ፡፡	ኣይሰማዕ፡፡ ኣይቃወምን	ይሰማዕ፡፡	ብጣዕሚ ይሰማዕ፡፡
1/137	መማረፂ ምስኣን (ሽንት ቤታት ስለዝሰእኑ)					
2/138	ዘሰዕቦ ናይ ኣክባቢ ፀገም ብዝምልከት ግንዛብ ስለዝጎድሎም					
3/139	ንሽንትቤት ዝኾን ማይ ኣቐርቦት ዋሕዲ					
4/140	ሽንትቤቶም ቶሎ ቶሎ እናመልኦ ምምጣጥ ስለዝሸገሩ					
5/141	ንብዙሕ እዋን ዝፀንሐ ልምዲ ስለዝኾነ					
6/142	ዝግበር ቁፅፅርን ክትትልን ስለዘየለ ወይም ድኹም ስለዝኾነ					
7/143	እቲ ቆፅዓት ከምህር ወይም ክእርም ዘይኸእል ድኹም ስለዝኾነ					

144. ናይ ዝኹም ረሳሕ ፈሳሲ ንደገ (ካብ ግቢ ወፃኢ) ዝፈሰሱ ኣጋጣሚ ክንደይ ይኸውን?

- ሀ. ብጣዕሚ ብዙሕ ጊዜ መ. ሓድሓደ ጊዜ
- ለ. ብዙሕ ጊዜ ሰ. ሳሕተ
- ሐ. ማእኸላይ ሸ. ምንም ጊዜ ኣይፈሰስን

145. ኣብእዛ ኸተማ ረሳሕ ማዮም ካብ ውሽጢ ዝዘእም(መንበሪኦም/ድርጅቶም) ንደገ ዘፍሰሱ ነበርቲ ብዙሓት እዮም::

- ሀ. ብጣዕሚ ኣይሰማዕማዕን መ. ይሰማዕማዕ
- ለ. ኣይሰማዕማዕን ሰ. ብጣዕሚ ይሰማዕማዕ
- ሐ. ኣይሰማዕማዕን ኣይቃወምን

146. ፈሳሲ ርስተቶም ካብ ዝዘእም ወፃኢ ንደገ ዘፍሰሱ ነበርቲ ኣለዉ ትብሉ እንተኾይንኹም ንምንታይ ይመስለኩም?(ካብ ሓደ ንላዕሊ ምምላስ ይከኣል እዩ)

ተ.ቐ	ምክንያት ኣብ መንበሪ ኣባይቲ ፈሳሲ ርስተት ንደገ ምድፋእ/ምፍሳስ/	ብጣዕሚ ኣይሰማዕማዕን	ኣይሰማዕማዕን	ኣይሰማዕማዕን ኣይቃወምን	ይሰማዕማዕ	ብጣዕሚ ይሰማዕማዕ
1/146	መማረፂ ምስኣን (ሸንት ቤታት ስለዝሰለኑ)					
2/147	ዘስዕቦ ናይ እክባቢ ፀገም ብዝምልከት ግንዛብ ስለዝነድሎም					
3/148	ሸንትቤቶም ቶሎ ቶሎ መሊኡ ምምጣጥ ከይሸገሩ					
4/149	ዝግበር ቁፅፅርን ክትትልን ስለዘየለ ወይም ድኹም ስለዝኾነ					
5/150	እቲ ቅፅዓት ከምህር ወይም ክእርም ዘይኸእል ድኹም ስለዝኾነ					

151. ኣብዛ ከተማኹም ንፅህቲን /ፅሬቲን ምልክዕቲን ንኸትኩን ዝምልከቶም ኩሎም ኣካላትልዑል ፃዕሪ ይገብሩ እዮም::

- ሀ. ብጣዕሚ ኣይሰማዕማዕን መ. ይሰማዕማዕ
- ለ. ኣይሰማዕማዕን ሰ. ብጣዕሚ ይሰማዕማዕ
- ሐ. ኣይሰማዕማዕን ኣይቃወምን

152. ኣብዛ ከተማ ኣብዛ ከተማ ካባይ ዝወፁ ፈሳሲ ርስተት እዮም ዝፃበዩ ፀገም ዝፈጥሩ ዘለዉ?

ተ.ቐ.	ፀገም ዝፈጥሩ ዓይነታት ፈሳሲ ርስተታት ብእንፃር መመንጨውቲ ኣካላት	ብጣዕሚ ኣይሰማዕማዕን	ኣይሰማዕማዕን	ኣይሰማዕማዕን ኣይቃወምን	ይሰማዕማዕ	ብጣዕሚ ይሰማዕማዕ
1/152	ካብ ናይ ውልቂ መንበሪ ኣባይቲ ንደገ ዝወፅእ/ ዝፈሰስ/ ፈሳሲ ርስተት					
2/153	ካብ ናይ ሓባር መንበሪ ኣባይቲ (ካብ ኮንደሚንዮምን ካምፕታትን ሓዊሱ) ንደገ ዝወፅእ/ ዝፈሰስ/ ፈሳሲ ርስተት					
3/154	ካብ ናይ ፋብሪካታት፣ ጋራጃት፣ ምርክ ሾፓት ወዘተ ንደገ ዝወፅእ ፈሳሲ ርስተት					
4/155	ካብ መንግስታዊን ዘይመንግስታዊ ትካላት ከም ጥዒና ትካላት (ጥዒና ጣብዮ፣ሆስፒታላት፣ወዘተ) ትምህርቲ ትካላት (ት/ት ቤታት፣ ስልጠና ማእኸላት፣ኮሌጃት፣ ዩኒቨርስቲታት፣ ወዘተ) ንደገ ዝወፅእ (ዝፈሰስ) ፈሳሲ ርስተት					
5/156	ካብ ንግዲ ቤታትን (ከም ሆቴል ቤት-በልዒ እንዳሻሂ እንዳሰዋ ናይውበትሳሎን መዕደሊ ነዳዲ ገራጃት ወዘተ ንደገ ዝወፅእ ፈሳሲ					

	ርስሐት (ወይም ናብ ውሕጅ መኸየዲ ትቦ ዘፍሰሱ)					
6/157	ካብ ማሕረሰን ጥሪት መፍረይትን ዝወፀእ ፈሳሲ ርስሐት					
7/158	በቢቦተኡ ካብ ዝሕፀቡ ተሸከርካርቲ ዝወፀእ ፈሳሲ ርስሐት					

159. እቲ ሕብረተሰብ ከተመኡ ፅርዮታን ልባቕኣን ንኸትሕሊ ዝገብር ፃዕሪ ልዑል እዩ?
 ሀ. ብጣዕሚ ኣይስማዕማዕን መ. ይስማዕማዕ
 ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ
 ሐ. ኣይስማዕማዕን ኣይቃወምን
160. ብዘ ኸተማ ማእኸል ወይም ብጥቓኣ ዝሓልፉ ናባታት ፅርዮቶም ኣዚዩ ዝተበላሸወ ናይ ጉሓፍ መድፈሊን መፀዳደዩን ቦታታት እዩ ሰብ ዝገብርዎ ዘሎ
 ሀ. ብጣዕሚ ኣይስማዕማዕን መ. ይስማዕማዕ
 ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ
 ሐ. ኣይስማዕማዕን ኣይቃወምን
161. ኣብዘ ከተማ ማኻይንን ባጃጃትን የትም ቦታ ምሕፃብ ኣብሩባ ሓዊሱ ዝተለመደን ካልካሊ ዘይብሉን እዩ
 ሀ. ብጣዕሚ ኣይስማዕማዕን መ. ይስማዕማዕ
 ለ. ኣይስማዕማዕን ሰ. ብጣዕሚ ይስማዕማዕ
 ሐ. ኣይስማዕማዕን ኣይቃወምን
162. ካብቲ ካብ ዝኸም እተውፅእዎ ጉሓፍ ወይከዓ ርስሐት መሊስኩም ናይ ምጥቃም ወይም ምሕካም ስራሕ ትሰርሑ ዶ?
 ሀ. እወ እሰርሕ ለ. ኣይሰርሕን
163. ንጥያቄ ቁፅሪ 188 መልሰኹም 'እወ እሰርሕ' ዝብል እንተኾይኑ እንታይ ዓይነት ጉሓፍ/ርስሐት ንምንታይ ግልጋሎት ከተውዕልዎ?

ንትሕብብርኩም ኣዚየ የመስግን!
የቐንዳላይ!

Annex II: In-depth Interview Questions

Pertaining to Policy Responses to Urban Environmental Problems

- I. Brief personal and your institution’s background information?
- II. Waste Management Practices and problems in the urban areas

A. Solid Waste Management:

1. **Characteristics of waste:** generation rate per capita per day per kg? Generated annually in Kg (2007-2016)? Composition by proportion? Nature (biodegradable Vs non-biodegradable? or Organic Vs inorganic? Carbonic content? Trends in characteristics of waste generated and associated challenges?

2. Collection, transfer station and transportation:

- Basic Role of your institution specifically with respect to collection, transfer station and transportation

- Collection Plan:
 - Collection system: door-to-door? Kerbside?
 - Touring line, collection point, and depot defined?
 - Collection schedule and frequency (for residential, commercial, or else)
 - Complaint hearing system
- Name and number of SMEs involved in collection works?
- Area thought to be covered by each SMEs
- Contract system (permanent or temporary)?
- Duties and responsibilities of SMEs:
- Collection capacity per day/month/year of the Municipality and the SMEs
- Waste collected annually in kg(2007-2016) by types of collection options/SME VS Skip loaders, and Sub-city?
- Controlling (monitoring) system? Who? And how?
- Evaluation/Comment of the performance of EMS: strengths and weaknesses?
- Any observed disparities in collection services among residents (eg inner Vs outer neighbourhoods, residential Vs commercial, wealthiest VS common folk's neighbourhoods etc.
- Any complaint usually heard from residents (related to cancellation of programs, improper schedule, ethicality of the collection crew, distance to collection points, etc)

3. Facilities and equipments available /functional/needed?

- How many machineries (dozer, Roller, skip loader, etc)? Skip loaders, tractors, trailers, public containers, dust bins, etc. if any? On-duty and off-duty, if any? (status)
- Transfer stations, how many if any? Location, Main purposes? Site selection criteria? How far necessary? Operation/management system? Basic challenges and opportunities? (status)

4. Landfill which have been used till 2016:

- Type/status of landfill? Date started to give service?
- Suitability of location? Location criteria?
- Distance from the centre collection point? Is it within the jurisdiction of the city/town Administration?
- Management/Operational system:
 - Selective waste acceptance for land filling
 - Compacting, layering, leachate control system,
 - Access to raga pickers and scavengers
 - Types of machinery and facilities available (dozer, roller, water, electricity, etc)
 - Fenced (access to animals) (both domestic and wild)?
 - Soil availability (if any, for how long it is enough?)
 - Wild or intentional firing problem?

- Capacity of the landfill (for how long and for how much waste)?
- Settlement encroachment (conflict, if any with community)
- Challenges and opportunities?

B. Liquid waste Management

1. Is there formal liquid waste management system in your town or city?
2. What types of liquid waste management system do you use (on-site or off-site: septic tank system or sewer line system)?
3. What is your office's duty and responsibility with respect to liquid waste management? (collection, work permit issuance, disposal site selection and service delivery, controlling and monitoring, etc?)
4. **Domestic /Private toilets:** access to (rate of prevalence)? Type and standard? Sanitation situation? Prevalence of seepage and spill over of effluents? Linking private toilets with storm water drainages/canals and natural drains?
5. **Vacuum truck:** number? Ownership? Adequacy? Fairness of service charge? Collection schedule, if any? Basic challenges related to vacuum truck services?
6. **Public toilets:** number (functional and nonfunctional, if any), and adequacy? Location? Status: new or old? Safety, Sanitation and physical quality? Adequacy of beneficiaries? Service hours (working hours)? Ownership and management system? Demand for public toilet (in quantity)? Basic challenges?
7. **Open toilets/defecation** and urinating in open areas, bushes, streets, storm water canals, etc? How severe? Possible causes? Controlling system in place? How effective?
8. **Dumping system:** Defined site available? Location? How far it is from the centre? What types of dumping system? Controlling system availability? Basic challenges and opportunities

C. On-site waste handling of the waste generators: what are the waste handling practices of the community in urban areas? What types of good and bad waste handling practices are observed in the urban community (urban residents)? What are the causes of the bad practices prevailing at source?

Policy Responses

1. Clear and workable Policy documents of both solid waste and liquid waste management: available? Workable and effective, clear and full coverage? What rules and regulations and enforcements are there? How complete and workable and clear the documents? Any challenges related with policy documents?
2. Policy Measure:
 - Legal framework: rules and regulations, or legislations, enforcements, monitoring and evaluating systems,
 - Institutional issues:
 - institutional arrangement (main challenges and opportunities),
 - institutional capacity

- human resources (quantity, quality/profession, commitment and satisfaction, main challenges and opportunities)
 - material resources (machineries and facilities)(main challenges and opportunities)
 - allocation budget and financial process like procurement, maintenance
3. Focus and implementation of Strategic and Integrated Waste Management System: implementation of 4Rs, community participation/ involvement of stakeholders,
 4. Environmental Commitment/stewardship and knowledge of policy-makers/decision makers
 5. In general, does policy responses measure up to the waste management problem/challenge of the urban areas in general and the study areas in particular?

Thank You!