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# Solid Waste Management in Addis Ababa

A new approach to improving the waste management system

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<p>Addis Ababa, the capital city of Ethiopia suffers from poor solid waste management. The inadequate solid waste management system has rendered development, lessened the aesthetic beauty of the city and most importantly endangered the lives of the people. Regardless of the harmfulness of the waste, solid waste management has not been given the amount of attention it requires. The insufficient management and lack of attention to the matter can be observed from the unbearable litter in the rivers, drains and streets in Addis Ababa. It is obvious that immediate action is needed in the solid waste management sector.</p> <p>Therefore, this thesis aimed at studying the solid waste management system in Addis Ababa to find the main causes for the insufficient service delivery. For these reasons, this thesis also aimed to give suggestions on how the current situation can be improved. There are only a handful of researches and projects related to solid waste management; all these works mainly focus on the current situation and future improvements. However, this thesis focused on finding the cause of the problem by investigating the development measures the city took.</p> <p>The primary work of this thesis was to study the current solid waste management system using the limited research papers and project reports. In addition, it aimed at discussing the main causes of the inadequate solid waste management in Addis Ababa. The thesis also analyses three case studies that were thought to be significant to suggest a solution: case for the IGNIS project, case for the Informal waste recovery system in Addis Ababa and case for the solid waste management system in Windhoek, Namibia.</p> <p>On the basis of the results of the thesis, three methods have been suggested to address the urgent and massive need of Addis Ababa's solid waste management system. These are importing the appropriate waste and environmental management education, formalizing the informal waste recovery system and lastly, establishing public-private partnership in all the waste management segments.</p>	
Keywords	

## **Acknowledgement**

I would like to announce hereby that any error or omissions in the following dissertation are solely my own.

*'All things were made by Him; and without Him was not anything made that was made.'* John 1-3

*'And whence is this to me that the mother of my Lord should come to me?'* Luke 1 - 43  
*Because of you; Mom, Dad, Zele and Mule.*

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## List of abbreviations

AA	Addis Ababa
AAEPA	Addis Ababa Environmental Protection Authority
AAIT	Addis Ababa Institute Technology
AT Verband	Association of appropriate Technology
BAuA	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin
EIA	Environmental Impact Assessment
ENDA	Environmental Development action in Ethiopia
EPDRE	The Ethiopian People’s Revolutionary Democratic Front
FDRE	Federal Democratic Republic of Ethiopia
GHG	Green House Gasses
IGNIS	Income generation and climate protection by valorizing municipal solid waste in a sustainable way in emerging mega cities
ILO	International labor Organization
IZES	Institute of Future Energy Systems
RLDS	Addis Ababa University – Regional and Local Development Studies
SBPDA	Sanitation, Beautification and Park Development Authority
SYMKE	Suomen Ympäristöturvallisuuden kehittämiskeskus
TPLF	Tigrayan People’s Liberation Front
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNHCR	United Nations Refugee Agency
UNICEF	United Nations International Children's Emergency Fund
UPE	Urban Political Ecology

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## 1 Introduction

Waste management is a current, complex subject. Almost all human activities create waste; especially since the Industrial revolution in the mid-18th century, the amount of waste created increased dramatically around the world. Not only has it increased in amount but also in type and toxicity. Waste management is an issue to most countries around the world. The waste management in a given country is directly related to the economic, social and political status of the country. The challenge of the management is tougher for middle and lower income countries. According to the World Bank (2016), Ethiopia is a low income Sub-Saharan country with \$550 GDP per capita with a population of 97.1 million.

Addis Ababa, the capital city of Ethiopia, has one of the fastest growing populations in the world. The population has leaped from 15,000 to 4 million since its establishment 100 years ago (IGNIS, 2016). With all the socio-economic problems growing parallel, waste management in the city can take a great portion. Due to the insufficient waste management system in Addis Ababa, the habitants suffer the site and consequences of accumulated waste piles on the streets and drains all around the city. These piles pollute the surrounding vegetation, ground water and soil from the leachate. Due to weather variation and chemical reaction between materials fire ignites. The emission from the smoke pollutes the atmosphere. Moreover, these piles provide a breeding ground for insects and rats who can potentially cause the outbreak of an epidemic. They also cause a nauseating smell and are quite unpleasant to see.

The current solid waste management system mainly relies on the municipality to address it and there are few private participants working on a very small scale compared to the amount of work needed in the sector. The method used by the municipality is crude open dumping after collection from households and institutions at a place called Repi about 15 km from the city centre. The dump has been running for the last 50 years without proper management.

There have been few approaches to solve the problem and no significant changes have occurred. It can easily be seen that the city has expanded out of the government's service capacity and the aid of the private sector is needed. The solution to the waste problem requires the committed participation of both parties with the proper partnership.



As many underdeveloped countries, Ethiopia also suffers a high rate of unemployment. It is quite common to see many young graduates and non-graduates spending their time idly. It is clear how unemployment can directly influence the criminal rates and violence in a city. Employment is essential for a functional urban ecology and the waste sector can be a good means to deal with this problem.

This thesis primarily aims to understand the waste management problem in Addis Ababa. Proceeding, it analyses three case studies; these are case for the IGNIS project, case for the informal waste recovery system in Addis Ababa and case for the solid waste management system in Windhoek, Namibia. Lastly, based on its findings, it proposes a method to improve the waste management system in Addis Ababa, Ethiopia.

## **2 Waste management in Addis Ababa, Ethiopia**

### **2.1 Overview of Addis Ababa, Ethiopia**

#### **2.1.1 Ethiopia**

Ethiopia has a significant world history since the 8th century. The kingdom of Axum, which was then in power, was one of the most influential and powerful trading centres in the world. Since Axum, Ethiopia has gone through a series of civil wars between different ruling dynasties, which has contributed to the huge economic and social decline that the country is suffering from at the moment(Wikipedia,2016).

However, the country was unified by Emperor Tewodros II in 1855. The country continued with the rule of successive emperors and the social system was mainly feudalist. The Imperial rule ended in 1974 when the soviet-backed Marxist-Leninist military dictatorship led by Mengistu Haile Mariam overthrew the Emperor Haile Selassie I. The military administrative council (*Derg*) led the country for the following 17 years until the Tigrayan People's Liberation Front (TPLF) merged with other ethnically based fronts put it aside by forming the Ethiopian People's Revolutionary Democratic Front (EPRDF). The Ethiopian People's Revolutionary Democratic Front (EPRDF) has been in power since the victory over the *Derg* in 1991. The current government has a structure of a federal parliamentary republic where the Prime Minister is the head of Government and has 'The Federal Democratic Republic of Ethiopia' as the country's official name (Wikipedia,2016). The map in figure 1 shows the location of Ethiopia in Africa.



Fig.1 Location of Ethiopia in Africa

Ethiopia is the second most populous landlocked country in the world with an estimated population of 97.1 million with a growth rate of 2.5% in 2014 and with a GDP per capita of 550\$. (World Bank, 2016). Ethiopia is one of the poorest countries in the world; nevertheless, there has been a great economic growth of 10.8% per year between 2003/04 and 2013/14. In the horn of Africa, the regional annual average economic growth is 5.0%. The economic growth has brought about a significant reduction in poverty from 38.7% to 29.6% since 2005. The government planned to reduce this figure to 22.2% by 2015.

The EFDRE has done a great work in infrastructure development and agricultural sectors. The economy highly depends on agriculture, and 80% of the economic activities depend on agricultural products. Ethiopia is one of the leading and highest exporters of coffee and maize in Africa. The country is also well-known for exporting gold, leather and oilseeds around the world. Other export commodities are cereals, cotton, sugar cane and potatoes. Even though agricultural commodities are the bases for the economy in the country, agricultural methods are still undeveloped and depend on unreliable water sources. In addition to agricultural products, the country aims to export energy after the completion of the Grand Ethiopian Renaissance Dam, which is under construction at the moment. The dam aims to produce 6000 MW electricity upon completion(Wikipedia,2016).

The clearly observable change that has occurred in the country since the EFDRE has come to power is the construction and improvement of road networks both in the capital and in the regions. Good transportation networks are backbones for economic development; it was a plausible move from the government to tackle the transportation sector primarily (AllAfrica, 2016).

The improvement in the transportation can easily be attributed to the two-digit economic growth that has occurred. During the first Road Sector Development Program (RSDP, 1997-2002) the government invested 7.3 billion birr on road construction, of which 5.5 billion was on federal roads and 1.7 billion was on regional roads. The program rehabilitated 975 km trunk roads, upgraded 549 km trunk link roads and constructed 928 km new link roads. Overall, paved roads have tremendously increased to 99,522 km from 26,550 km and the regional roads to 33,609 km from 10,680 km between 1996/97 and 2014 (AI-Africa.com, 2016). The first light railway in east Africa was also constructed and has started giving service as of September, 2015.

The Ethiopian Airlines is one of the leading airlines in Africa; it has been in service since 1945 and currently flies to 82 destinations around the world. Ethiopia has quite a diverse terrain with a wide range of altitude. The northern part of the country is covered with chains of highland mountains covering 270,500 sq.km. Contrarily, the eastern and north-eastern part of the country has a desert feature with quite low lands. Dalol, one of the lowest and the most isolated place on earth is located in the eastern part of the region. Again the central and south-western part of the country is covered with tropical forests and has a moderate altitude between 2000 and 2500 m. The southern part of the country is mainly a desert.

Regardless of the great variation in the terrain, the climate in the country is rather uniform throughout. It is dominantly tropical monsoon with terrain-induced variation. For example, the average annual temperature in Addis Ababa is 16 °C and daily maximum temperature varies between 20 °C and 25°C. However, there has been a significant increase in temperature since the establishment of the city. This can be attributed to the rapid deforestation due to population, civil wars and logging(Wikipedia,2016).

Deforestation is high in the regions and the deforestation has adversely affected the wildlife. Ethiopia is home to 31 endemic species of mammals and 856 bird species. Sadly, sixteen of these are critically endangered to be extinct. There have been several

movements to raise awareness to save both the forests and wild animals however, there has not been any significant change

### 2.1.2 Addis Ababa

Addis Ababa was established during reign of Emperor Menelik II in 1887. The Emperor and his wife Empress Taytu discovered Addis Ababa in search for a better military operation site. Since its establishment Addis Ababa has gone through complete transformation. The city has expanded immensely with a current area of 530.14 km<sup>2</sup>. There has been a rapid growth in road construction. The estimated population of the city is 4 million with a growth rate of 6% and population density of 7,545 inhabitants/km<sup>2</sup>. There has been a registered high migration from the rural regions to the city, this can be attributed to the leap in population growth (IGNIS,2016). The following maps show the location of Addis Ababa.



Fig.2 Location of Addis Ababa in Ethiopia and Map of Addis Ababa

Addis Ababa has a status of the capital and a state for the federal government of Ethiopia. The city is further sub-divided into 10 sub-cities, which are responsible for their own municipal and non-municipal services; the sub-cities are further divided into *Kebeles* (the smallest administrative units of the government) and there are 99 *Kebeles* in Addis Ababa. The city is administered by the city government, which has the mayor as its chief executive officer. The mayor will lead in the office for a span of five years and the current major is named Diriba Kuma and was in office since the 9<sup>th</sup> of July, 2013(Wikipedia,2016).

Addis Ababa is also a diplomatic center in the horn of Africa as the Organization of the African Unity and the United Nations Economic Committee for Africa has their headquarters in the city. Furthermore, the regional headquarters UNDP, UNICEF and UNHCR are all located in there. Addis Ababa is the trade centre of the country. It is the platform for all traders in the city from the regions to meet. As most of the government international affairs offices are located in the city; all export activities pass through the city. The economic activities are mainly trade and commerce. In general, Industrialization is not rapid in Ethiopia; nonetheless, industrial activities are relatively high in the city. There is also fast road and building constructions. For a visitor it might seem as if the whole city is under construction (Africa-business, 2016). The following figure shows the map of Addis Ababa.

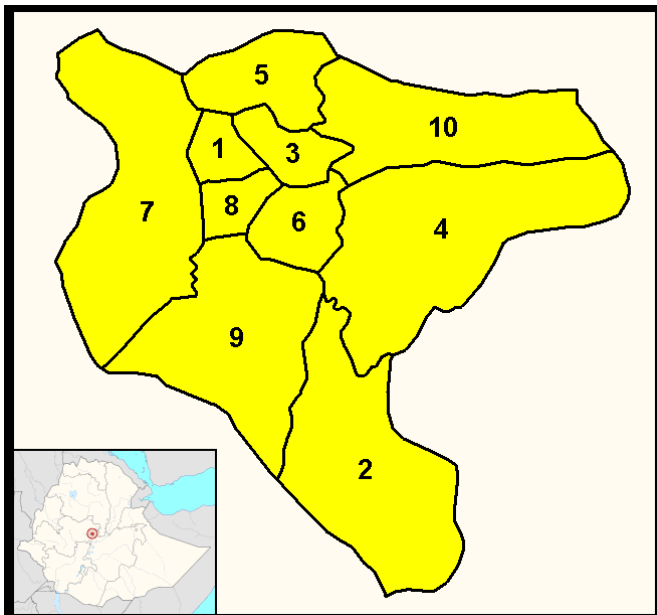


Fig. 3 Map of Addis Ababa

Due to Addis Ababa's position close to the equator, the city has relatively constant temperature. As stated above the annual average temperature ranges between 16 °C and 20 °C. The climate is characterized by Subtropical Highland Climate (Köppen, 2016). Ethiopia is actually known as the country of 13 months of sunshine. There are two main seasons: sunny season between September and June and a Rainy season between Mid-June and August. The terrain is relatively uniform specially the southern part of the city except scattered hills; the city has an overall altitude of 2100-3000 m above sea level. Both the weather and terrain is excellent for work and residence.

Addis Ababa, in addition, is the social center of Ethiopia where people from 80 different ethnic groups live in harmony. There are several museums and cultural centers in the city. The National museum, the National palace (formerly known as jubilee palace) and the African Hall (the permanent seat of UNECA) are all located on Addis Ababa. All embassies and International cultural centers are also found in Addis Ababa. It is also the center for the government's transportation and communication agencies; all the radio and television station agencies have their head offices in the city.

Transportation is mainly provided by privately-owned minibuses and government-owned public buses. There are also the very old Lada taxis, which mainly work late at night. Recently, a light electrical train service has been introduced. Transportation in Addis is social, entertaining and unique but in terms service and at times of urgency, it could be frustrating and tiring. The available transport is not sufficient for the habitants and the vehicles in the public service are usually in a very poor condition; in addition, having the jagged roads, it can be uncomfortable to go around the city. Though there has been rapid development on the road networks, there are still strong traffic jams in the city. Due to the population increase and the vehicle boom on the roads, moving from one place to the other in Addis has become challenging. Nonetheless, If the current work on improvement on transportation services continues, the problem could be solved soon.

Another major activity in Addis Ababa is construction. The real-estate business has been popular in the past two decades. New residential areas are vast in the south eastern part of the city. The center has an old European look mainly due to the Italian occupation between 1936 and 1939. The northern part of the city is still comparatively rural. Besides residential buildings; the main buildings in Addis Ababa are shopping malls, hotels and recreational centers and government buildings.

Addis Ababa holds the key to access Ethiopia. Advances made here can easily be transferred throughout the country. A model to improve the administration, education, infrastructure and governmental service in Addis Ababa, can straightforwardly be expanded to the regions and there hence, bring about a holistic change and improvement in the country's status. As diplomatic center in the horn of Africa, developments made in Addis can also significantly influence the whole of Africa.

## 2.2 Waste management history in Addis Ababa

Addis Ababa started as a small settlement near a spring water located at the centre of the city named Filweha about 100 years ago. The Emperor Minilik and his wife Taytu built their palace near the spring water, and all the warlords and their followers settled around them. The settlement continued expanding, and Addis Ababa has become one of the largest cities in Africa; the physical area has leaped from 33 km<sup>2</sup> in 1920 to 527 km<sup>2</sup> in 2003(CSA,2009; Camilla,2012).

Construction and settlement in Addis Ababa has continued in a random order since its establishment. There have been six master plans prepared, none of which were implemented (Yirga-lem,2008; Camilla,2012). Therefore, there are no sufficient paved roads, sewer systems and water distribution infrastructures.

There has never been a sufficient waste management system capable of addressing the multidirectional waste problem in the city. There are many reasons for the poor urban infrastructure and service in Addis Ababa. For many years, the need for a waste management system has not been recognized by the administrators. Neither has there been any waste management know-how. In the beginning, the administrators were not concerned with the matter as the number of habitants was relatively low and the waste generated was not grave in both amount and type. Therefore, disposing of waste at a far site was an easy tactic. However, with the fast expansion of the city, the far site has become somebody's back yard.

All the rulers have not given waste management the amount of attention it needs. Waste management was never considered a pressing matter as the country has been going through numerous international and civil wars and there were always more important matters to address. Disregarding the waste issue can also be observed among the people. Getting the waste out of site has been a well-embedded approach for long. The waste has been piling and causing damage silently. Unfortunately, when the true magnitude of the problem was recognized the damage has already been done.

The locales have been accustomed to simply dumping waste on streets, open fields and rivers. There are still squatter settlements taking place, and the government has not been able to control it. Enormous constructions are in progress before the proper infrastructure is in place.

After FDRE came to power, the first organization that took responsibility for waste management was the City Health Bureau under the department of Environmental Health Care. As there were already sufficient responsibilities for the bureau, a proper waste service was not achieved. This problem was solved when the FDRE introduced structural reform to delegate responsibilities to lower units in 2003. When the decentralization was implemented, the waste management responsibility came under Sanitation, Beautification and Park Development Authority (SBPDA). As part of the reform, waste management departments have been founded on sub-city and *Kebele* (the smallest administrative unit in the FDRE) level. The following figure shows the structure of the Sanitation, Beautification and Park Development Authority.

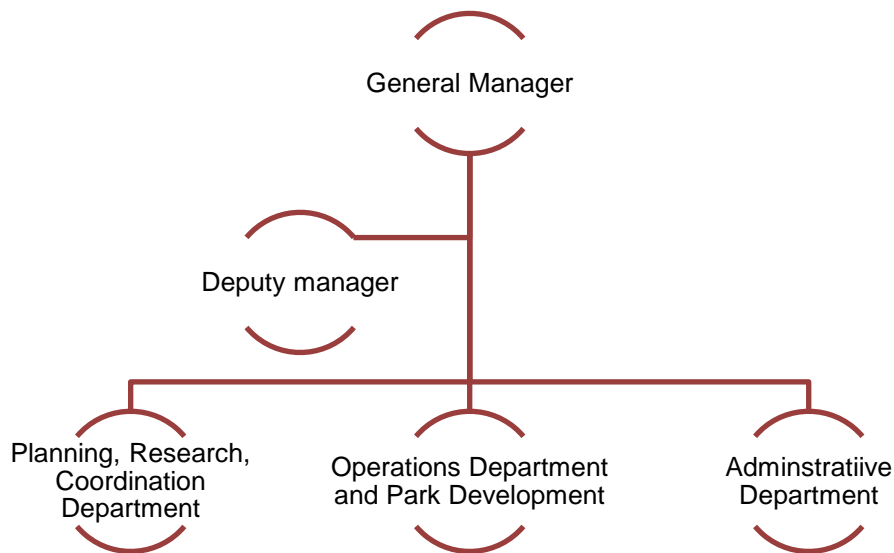


Fig. 4 Sanitation, Beautification and Park Development Authority Structure

The main responsibilities of the SBPDA was organizing and administering waste management in sub-cities and regulating polices concerning solid waste. The sub-cities were responsible for collecting and transporting waste within their area. Lastly, reporting daily waste operations and primary collection fell under the responsibility of the *Kebeles*. The structure of the authority was slightly changed when the business process reengineering program was introduced to all the government offices to enhance service delivery.

The SBPDA was renamed as Solid Waste Management Agency and Landfill Project Office. The change that took place in the operation was that the Department of Park and Cemetery was separated from SBPDA as an independent agency as a result the responsibility scope of the agency was narrowed.



The operation of waste management has two major parts. The first stage of the process is where individuals and informal workers collect waste and deliver it to the collection tank at a common collection site. The second stage is where the government trucks come to empty the tanks and dump the waste at a dump site. This has been the process for many years. However, in 2003, the Addis Ababa city administration has adopted and implemented the micro-and small-scale enterprises program to alleviate unemployment and poverty with micro-credit loans and business training.

As a result, the task for primary collection of waste from households and industrial institutions has been assigned to enterprises working under the sector. When the government implemented this program, it did not recruit the already existing informal collectors.

For reasons unclear, implementation took place disregarding the existing actors. The task was simply taken from the informal actors to employees organized under micro-and small-scale enterprises by the government. Letters were given out from the *Kebeles* to the households and industrial institutions instructing them not to pay the informal collectors. This has created more unemployment than alleviating the problem.

After the election in 2005, the activities of the micro-and small-scale enterprises have been decreasing. The micro-and small-scale enterprises constructed for the pre-collection have again been collected under the administration of the *Kebele*. The MSSEs were no longer independent to function on their own and the manner of payment has been changed so that the households and institutions pay service charges with water bills directly to the *Kebeles*. Hence, the system has gone back to its former centralized trend.

Most of the development projects implemented in Ethiopia have been following a trend where a new idea or method is acted on only when it is introduced and then abandoned and presumably going back to the old method.

To support the above claim, a situation in the solid waste sector can be mentioned; Seleshi Demissie (Gash Abera Molla) is an artist and one of the very few environmental activists in the county. In 2001, he set up a project to engage the unemployed youth to work on disposal of solid waste and beautification of the city's natural areas. The project was quite influential that almost all the youngsters at every corner of the city was collaborating for its implementation. The whole city was mobilized towards proper management

of solid waste. The phenomenon was vast enough to attract international media. However, after sometime, the mobilized society has completely abandoned the project objectives and gone back to the old ways.

Overall, the solid waste management problem in Addis Ababa has its roots in the way the city was established and the course of the developmental route it took. The random settlements that have been established make efficient solid waste management unattainable.

The disregard to the effect of solid waste on the society by both the government and the people also plays a significant role. Looking at the history of the government approach, one can see virtuous strategy; nevertheless, the implementation should be with research to match the real circumstances of the city. Moreover, in order to reap the benefits of changes implemented, the changes enforced should be sustained.

### 2.3 Laws and Legislation relating to waste management in Addis Ababa

The process of implementing regulations in the Federal Democratic Republic of Ethiopia (FDRE) goes as follows: a proclamation is first passed by the president; according to the proclamation the council of minister issue regulations for effective implementation, and the authorities issue directives.

Girma Wolde Giorgis (President 2001-2013) passed the first proclamation regarding specifically to solid waste in 2007. The proclamation may be cited as Solid Waste Management Proclamation No.513/2007. On the third article of the proclamation, the objective reads as follows: "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."

The Proclamation has five parts. The first part of the proclamation defines the terms in use and declares the title and objective. Part two is mainly about responsibilities of urban administrators. Responsibilities of actors in handling different type of waste are declared in part three and guidelines for transporting solid waste and management of solid waste disposal sites in part four.

The last part of the proclamation declares penalties when these guidelines are trespassed. There are two other proclamations relating to waste management and to environmental policy. The proclamations are 'Environmental Impact Assessment Proclamation No.299/2002' and 'Environmental Pollution Control Proclamation No.300/2002'. The content of these proclamations is such that it sets the responsibilities of the authorities and actors concerned in the matter and declared penalties when the bodies fail to meet their responsibilities. The Environmental Policy of Ethiopia consists of general attitudes to protect and preserve all natural resources in the country.

The laws and regulations are well prepared; nevertheless, there is a huge gap between what is written in the papers and what is done practically. It has been more than ten years since all the proclamations have been passed but there has not been any significant change. The regulations are also considerably non pragmatic. The effort required to implement the regulations has somehow been missed.

Despite all the regulations being good in theory, a few of them are adopted by the city administration and citizens and very little is done to enforce them. In most cases, it is also difficult for the citizens to follow the regulation because they do not have access to a proper solid waste system that allows them to manage their waste in line with the regulations. The claim that households should sort their waste seems meaningless when the city administration has not established any formal system for the collection of sorted waste.

It is meaningless to argue that every person is obliged to dispose their waste in a sustainable way when someone has to walk 1 km to do so and even then often arrive to find that the container is already overloaded. Hence, there is a big gap between the requirements of the regulations and the reality on the ground, and this makes it difficult for the city administration and citizens to follow the regulations (Camilla, 2012, p. 59-60).

As stated above, the regulations stated by the government should be in tune with the realities of the city. There is also a need for proper research for a strategy to implement regulations, policies and declarations and on how to embed the values in the society.

## 2.4 Waste management system in Addis Ababa

Addis Ababa is going through a rapid change. The government has recognized the significant role transportation plays in development. A quarter of each year's infrastructure budget has been spent on road construction and ameliorating the connection networks. The government has allocated \$4 billion to repair and build roads over the next ten years (EGP,2012). The first light electric rail way in Sub-Saharan Africa was also built in Addis Ababa in 2015. Since the real estate business has boomed in the last 20 years, several new, expensive residential areas have been constructed. The government have also introduced the construction of condominiums to alleviate the housing problem in the city. All this has completely changed the appearance of Addis Ababa.

The construction boom in Addis Ababa in the last two decades along with the real estate business has created several new, relatively quality residential areas. Mostly, these residential areas are found in Bole sub-city, Akaky Kaliti sub-city and Nefas Silke Lafto sub-city. Most of the government built new road networks are found in these areas. Moreover, many new shopping malls has been opened along these roads. These areas are well constructed, facilitated and relatively modern than the other areas.

However, the remaining seven sub-cities are mainly made of poorly built, rundown and overcrowded neighbourhoods. In addition to poor infrastructure, the city also suffers from poor waste management services. Most of the riverbeds and fields are used as dumpsites. It is common to see piles of waste in the middle of the streets and along the roads. The public areas are quite littered. In most neighborhoods, it is common to see over flown garbage tanks with a nauseating smell.

### 2.4.1 Main sources of waste

The only proper practical research done on the amount and composition of waste in Addis Ababa was by a company named Norconsult A.S in 1982 from Norway. All the researches and papers have been published based on these data. However, seeing the changes the city has gone through in the last 30 years, it may be reasonable not to put too much emphasis on these values. However, there are estimations by Sanitation, Beautification and Park Development Agency (SBPDA) based on both these data and

the realities of the city that could be significant; the estimated amount of waste generated per day is 0.221kg per capita, and the main sources of the waste are given in Table 1.

Table 1 Amount of waste generation in Addis Ababa

House-holds	Hotels	Commer- cial institu- tions	Industries	Hospitals	Disposed on the streets
71%	3%	9%	6%	1%	10%

#### 2.4.2 Composition of waste

As the households generate the highest amount of waste, it can be deduced that the content would mostly be organic. This can be supported by the very few available research data. To observe the waste composition in Addis Ababa, two research data are added below, one from a research from Norconsult in 1982(Figure 5) and the second from the IGNIS project between 2008 and 2014 which surveyed only households (Figure 6). The following two graphs show the waste composition of Addis Ababa according to Norconsult and the IGNIS project respectively.

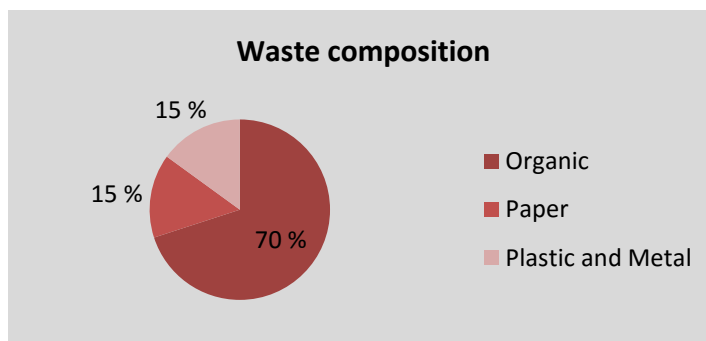


Fig. 5 Composition of waste in Addis Ababa by Norconsult 1982

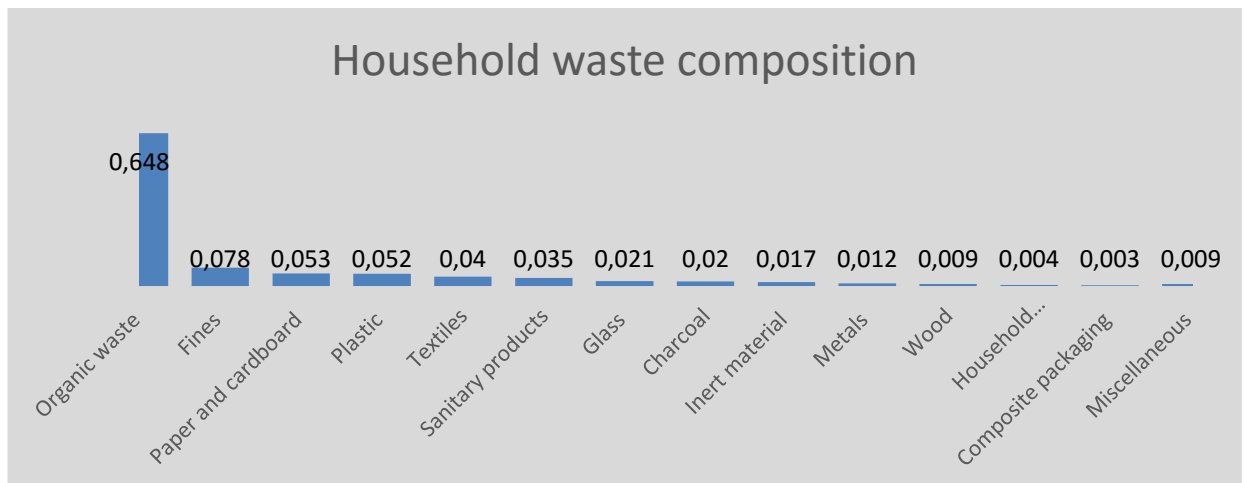


Fig. 6 Waste composition by survey on households by the IGNIS project 2012

The first data cannot be representative of the current waste composition in Addis Ababa. As stated at the beginning of this section, there has been a great change in the real-estate and road construction sector in the city. This will cause an increased amount of construction waste. Since this data has been collected by Norconsult, many industries has been established and electronic gadgets has grown popular. Again, it can be assumed that in the current waste composition there will be high amount of industrial and electronic waste. The second data is only representative of composition of waste from households. To conclude, there is no data that can give a clear figure of the current waste composition in Addis Ababa.

#### 2.4.3 Waste disposal process in Addis Ababa

There are 10 sub-cities in Addis Ababa. In each sub-city there are about 10 *Kebeles* (smallest administrative unit in FDRE). And in each *Kebele*, there may be 7500-8500 households. The waste disposal process has a formal and an informal segment. The formal part of the process involves two levels of collection and disposal at a dumpsite named Repi about 15 km from the city centre and is completely government work. The informal segment has several actors working on self-initiatives to collect different types of waste and to sell it at a place called 'Menallesh Tera' in the biggest open market in country called Merkato. People and different industrial actors come to Menallesh Tera to buy materials they need.

#### 2.4.4 Formal waste management process

In each *Kebele*, containers are placed at common place near the main roads. The distance to these containers may be different for different households. For some it may be next door and for others a kilometre or more away. On the basis of schedules from the *Kebele*, employees carry bags of waste to the containers with a trolley. This is the primary stage of collection. Those who can't afford to pay the waste collection fees and those who live far away from the containers have to then carry their waste to the common place by themselves. The containers are yellow and have sizes of 8 m<sup>3</sup>. There are only 512 containers for the whole city of Addis Ababa; most of these containers are in a very bad condition. Figure 7 and 8 below show push-carts used to collect waste from households in Addis Ababa and the formal waste management process respectively.



Fig. 7 Waste collection push-cart

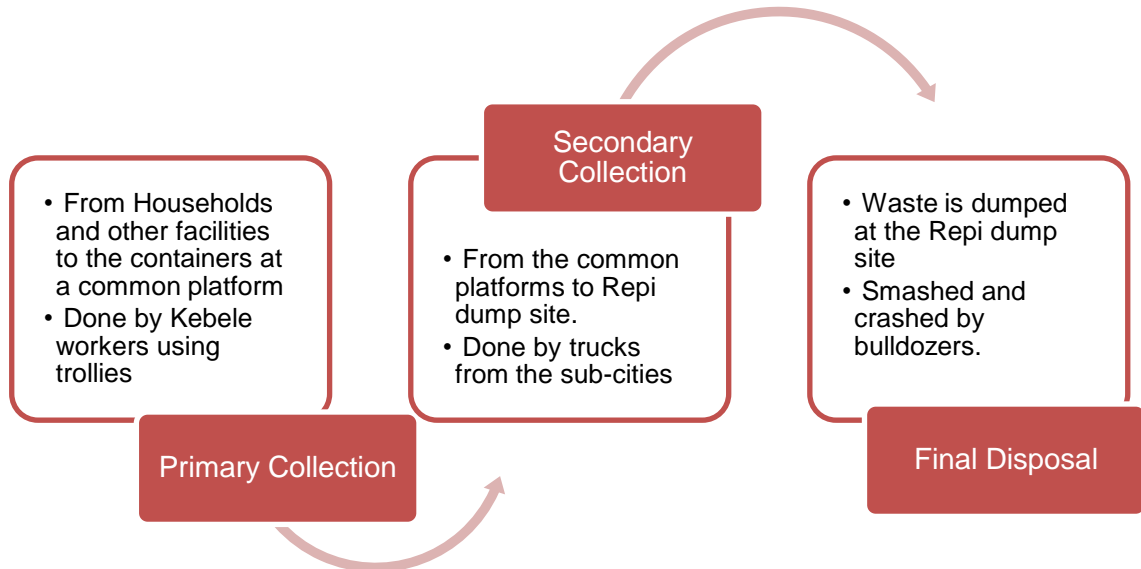


Fig. 8 Formal waste management process

The containers are then emptied at Repi and placed back by the government trucks. According to the International Labour Organization (ILO) in 2009, the waste management agency had 77 trucks in 2003. Due frequent breakdowns, there were 60 trucks in proper function by 2006. In accordance with the business process reengineering program in 2009, the agency bought 44 more trucks. Their daily service hours have also changed from two shifts a day to three shifts a day (Camila, 2012, p. 56).

Finally, the waste is dumped at Repi. When Repi was established in 1964, it was considered far enough not to be anybody's problem; however, with the fast expansion of the city, now the dumpsite has been surrounded by settlements. The dumpsite does not have any proper gas or leachate collection system. The boundaries of the dumpsite are not exactly known as it does not even have a proper fence, however the waste at the site covers an area of 25 ha (Camilla, 2012, p. 57). The waste is not covered with soil nor is there anything on top to cover it. It is exposed to heavy rains in the summer for two months and intense sunlight throughout the year. There are thousands of vultures and hundreds of scavengers working at the site.

There were 4 bulldozers in function to fit and level the waste, in 2003 there was only one in function (SBPDA, 2003; Camilla 2012). The dump site needs to be shut as soon as possible.



As there has not been any proper record of the amount of waste being dumped at the site (Yirgalem, 2001; Camilla, 2013, p. 58) and there has not been any leachate or emission collection system; therefore, the amount of damage it has caused cannot be estimated. The nauseating smell of the dumpsite calls at a very far distance. It is also quite unpleasant to see. The dumpsite is causing a serious damage to the environment and is a significant threat to the health and lives of many living around the area. The government's immediate action is needed.

#### 2.4.5 Informal waste recovery process

The key role in the informal waste recycling process is played by a market place named Minalesh Tera. Minalesh Tera is located in Merkato in Addis Ababa; one of the biggest open markets in Africa. In Merkato, the same kinds of materials are sold on the same block called '*tera*' in Amharic; which translates to queue in English. Thus, people would go to the block of the material they are looking for and find different types of that material. For example, in the spice block one can find all kinds of spices, and the place would be called '*Kimem Tera*' which directly translates as spice queue. Menaleshe tera is the block where all the useful waste comes to be sold and recycled again. Usable waste is collected by waste workers and brought to Menalesh. The details of the waste workers are discussed in the case study of the informal waste recovery system in Addis Ababa in the case studies section of this dissertation. The informal waste recovery process can be seen in figure 9.



Fig. 9 Informal waste recovery process

At Menalsh, there are the whole sellers and middlemen who buy materials from waste workers and sell them to industrial actors. The materials are mostly small glass bottles,

plastic containers of different sizes and car tires. Then, there are the crafts men who make different kinds of equipment in Menalesh from the waste they buy; and sell their products there in the market. The most common products made are sandals, ropes, chairs, washing container and metal stoves for charcoal.

The informal sector contributes significantly in waste reduction and raw material production. It has also created job opportunities for many. Nevertheless, it is disregarded and unsupported by the government and its contribution is not recognized. All the informal actors are seen by the government as vermin and all the informal actors see the government as their potential enemy.

### **3 Main causes for the inadequate waste management system in Addis Ababa**

The first step towards solving a problem is to carefully identify the source. If the source is identified and studied a great portion of the problem is solved. The following section aims at pointing out the main possible causes of waste problem in Addis Ababa.

#### **3.1 Attitude**

An attitude can briefly be defined as one's regard to a given matter; how a person approaches a matter shows the attitude of that person, for example, does the person regard the matter as important or unimportant, urgent or unurgent, useful or non-useful etc. can be terms to show the mind set or attitude of that person. The attitude towards a problem is the key to solving a problem. In order to solve a problem; the problem needs to be seen as a problem. Moreover, in order to arrive at a lasting solution to a challenging matter such as waste management, which requires the relentless cooperation of both the people and the government, there needs to be the right mind set and attitude.

The primary mind set required is to regard the matter as a problem. The second attitude required is willingness and earnestness to solve it. One may identify and understand the effects of the problem, however, may not be willing to deal with problem. Therefore, it requires willingness to face and solve a given problem.

Thirdly, problem solving is not an easy task; it requires persistent commitment. There should be an attitude determined to see the problem solved and the solution implemented. For example, there has been several local and international sanitation and waste related projects in Addis Ababa; however, there has not been none that persevered to see the problem resolved.

Lastly, as we inhabit the world that is ever changing; there cannot be a fixed solution. Continuous improvement parallel to changes is required. Sustainability and constant improvement are not familiar strategies in Ethiopia. Most projects and methods are abandoned soon after implementation before there is a chance to evaluate if they were effective or not.

Within the willingness to solve a problem, there is also a proper mindset for work. A sincere care for the success of the work is required. When dealing with waste management in a given city; there needs to be an earnest care from both the government and the people for the tidiness and cleanness of the environment. In other words, both parties must be intolerant of the current circumstance. The people who have taken the responsibility of waste management and the environment must have earnestness to protect and deliver proper out comes to the mass. Therefore, the right attitude is the primary necessity to solve any given problem.

When expanding the above idea to the whole society, the people have to be conscious of and irritated by the existing problem; and as society along with the government, the people should have a striving attitude to search for a solution to their problem. Execution and perseverance until the problem is solved are vital responsibilities.

With respect to waste management, there is an easily observable erroneous attitude towards waste by both the government and the people in Addis Ababa. The wrong attitude of 'if it is not on my lawn or back yard, it is no longer my problem' is well embedded in the society. Waste is usually seen as a government problem that does not really concern the people. Therefore, people simply use getting the waste out of their site and far away as a solution.

The fact that the city is their bigger living room and far away is someone else's back yard has not yet been recognized. That is why most people use the rivers to dump their waste as it will wash it away. The people have not realized that it will wash it away to dump it

at someone else's doorsteps and what remains will stay to cause disease. Other common dump areas are open fields, drains and streets. Nonetheless, there has not been any significant work from the government to raise awareness or introduce a proper method to the people to dispose of their waste.

This trend of disposing waste can easily be linked to lack of awareness and regarding the matter as a government work. Not only is it regarded as a government matter but also as a matter not issue enough for discussion. Only recently have there been media discussions concerning environmental matters. The society has no to minute awareness about waste and the environment. For instance, many have difficulties to accept waste related studies as proper subjects and to accept waste related work as proper professions. Waste related issues are in general underestimated and the profession is considered inglorious.

On the other hand, the government has a wrong attitude towards waste by regarding it as a matter to get to later. It is clear that there are more pressing matters at hand; however, waste is not a matter that can be postponed as improperly disposed waste can cause severe damages in a short period of time and these damages once done are usually irreversible.

The waste issue cannot be procrastinated as it can affect all the social, political and economic activities. It should be seen that it could be a serious barrier to all the development activities the government is to carry out. By the time the government gets to the matter, the damage will be too expensive and time consuming to fix or will be impossible to solve.

It should be noted that the waste matter can block and render other urgent matters the government is working on at the moment. A tidy and proper work place can boost work efficiency and littered work place can render work. Waste can be an obstacle to governmental development activities such as road and residential area constructions, hydro-power generation and sewage and drain developments.

Piles of waste can be a breeding ground for pests and a potential source for an outbreak of an epidemic disease. In addition, emissions from dumpsites will contaminate the entire natural environment. Dumpsites usually ignite; the smoke and methane gas from their

decomposition will pollute the atmosphere. Air pollution causes several lung and respiratory truck dieses. Uncontrolled leachate will pollute the ground water and soil. Exposure to the contaminated soil and water will damage vegetation and harm human health depending on what kind of chemical is contained.

All this damage will eventually result in the expense of the government and will cause delay of work as the people will not be able to work. Dumped waste will also be a tripping stone for all the infrastructure building work the government considers more urgent.

The tidiness and sanitation of the environment has significant influence on peoples' regard to themselves and especially children. There is a negative psychological influence improper environment will have on the mentality of the inhabitants. It will adversely affect the self-esteem of the people. The influence is stronger on children as they are not yet conscious of altering how they see themselves. In order to develop a well-functioning society, self-confident and efficient citizens are needed; these are people who have been raised and worked in a proper work environment.

The city's consumption and production of goods is growing rapidly; the amount and quality of natural resources are deteriorating likewise. It is no longer an option to throw away waste while having such a high demand of raw materials in most industries. Waste, when treated wisely, is a potential source of raw materials and therefore is at the heart of the economy. Using waste as an option for a source of raw materials can alleviate the dependency on natural resources.

There needs to be an immediate work to raise awareness on understanding waste as a potential resource and that it is well needed. However, if waste is not handled well it is quite problematic.

Lastly and most importantly, the waste matter cannot be left for later as waste improperly dumped will immediately commence its damage to the surrounding natural environment. As stated above, leakages and emissions from dumped waste are not controlled and the amounts are unknown. The damages these leakages and emissions cause are usually irreversible. And if there are methods to reverse such damages, they are much more expensive than the cost that would be needed if it was handled beforehand.

### 3.2 Awareness and Education

Awareness about the environment is quite low in Ethiopia. Both the benefit of taking care of the environment and the harm of neglecting the environment are not known. The people have fallen into the habit of dumping waste in the rivers, fields, drains and ditches; this is known to be the only approach possible to deal with waste. The harmful impact of such disposal has not been apparent. To take responsibility for the city as they take care of their homes is missing in the society.

The society has not yet perceived the holistic image of the city and the country. It is not understood that each individual is a stakeholder in the wellbeing of one another and the country as a whole. Both correct and incorrect actions of a given individual will affect everyone else since the environment is a system where everyone is connected in a chain. Moreover, the idea of using waste as potential resource is not a familiar idea. Waste is known to be rubbish and useless. The well-imbedded approach is to get it out of site. Winning over such habit to be responsible to dispose waste properly and to come to see waste as a resource is going to be challenging since, as any habit is hard to break.

The awareness level is low mainly because of the low distribution of proper education in the country. The number of available educational institutions is not sufficient for population. In all elementary and high school education before joining the university; a profound education about the environment is not given. There is no independent environment-based degree program on the Bachelor's degree level in the whole country.

There are only 33 governmentally recognized universities. Out of these universities, only one institution offers Environmental Engineering on master's level. This Master's degree program is found in Addis Ababa Institute of Technology; in the department Schools of Civil and Environmental Engineering which was upgraded from the Department of Civil Engineering in 2012.

People behave and act as they know. Lack of knowledge about the environment, the use and harmfulness of waste has caused such irresponsible disposal habit. Usually, people who are involved in the waste collection and recycling business are engaged in the business because they do not have any other option to earn their living. Mostly, people who work in the waste business are poor. The overall regard of the society to people engaged in waste collection and disposal and professions related to waste is low.

According to the reports from the waste related projects that took place in Addis Ababa, there are only a few professionals in the field and the qualification of the ones that are available is low. In Addition, those that are in the administration office to waste related matters are employed based on political allegiance to the ruling party not on qualification to be in that position (Camilla, 2005, p. 89 -103).

This has created a tripping stone to any improvement in the waste management. In general, there are only a few professionals in the Environment related subjects. There is no particular organization to collect waste related data and to carry out research on environmental issues. There has been only four significant research works done on waste. All of them are foreign organization initiated. The first research work was done by NOR consults in 1982.

In addition to this study, there are Master's and PhD thesis papers by Camilla Lousie Bjerkli from a Norwegian UAS in 2005 and 2013 respectively. Finally, there is the IGNIS (Income generation by valorizing municipal solid waste and climate protection) project, which took place between 2008-2014 in Addis Ababa. There has been a mention of another research by a man named Gordon in 1994 and 1995; however, the material has been available for the public.

All of these research works had to generate their own data or use secondary data collected for other purposes. This wastes time which could otherwise be used to solve the actual problem. The IGNIS project had to develop their data collection method to understand and characterize waste. As the city does not have a master plan and suffers from squatter settlements; it is only wise to come up with a data collection method that fits the circumstance of the city.

There have been several local and international projects implemented in Addis Ababa on sanitation and toilette development. There have been several government resolutions to improve its service and to transform the country. However, they all seem to fail. Projects and work methods have a route of forth and back pattern in Ethiopia where they are exercised at the beginning and then abandoned. International projects come and implement projects and leave; people participate and contribute in the beginning however, they abandon it and go back the old way as the projects leave. This is because

implementation of projects and methods are not based on good research and reliable data.

Addis Ababa City Administration operates with data on waste generation and composition that were compiled by Norconsult in 1982. Given that the data are 30 years old, they are no longer representative for the current situation (Camilla, 2013, p. 47). 'When dealing with a problem that needs the cooperation of a mass like the society; it is essential that the participants understand the problem and are sincerely engaged in the implementation of the solution. If they do not understand, they will not care whether the implementation is successful or not. As their contribution is needed for the success and sustainability of the solution, the plan will be doomed to fail. However, if all the stakeholders understand and are consulted as to what is to be implemented; the chances will be higher for the implementation to successful.

It is suggested here that the primary work towards improving the waste situation in Ethiopia is to raise awareness about the environment and waste. This can be done through education. An environment-related subjects should be added in the curriculum. In addition, to create professionals in the environment and waste management sector, the government has to import the education to its higher institutions. Though awareness is raised among the society waste and the environment, it will be futile if the method and know-how is missing.

Lastly, Reliable data is the foundation for a good research. A clear understanding of the situation and the problem is the foundation for a solution. Therefore, there should be a statistics agency assigned particularly to collect and analyze all the required data for waste and environmental research. Following, the research has to consult and put into consideration the people involved. This will enhance the government-people relationship. If there will be a project or system implementation, enough time and resource should be invested to get the people to understand and accept the project as their own. This will guarantee the success and sustainability of the project.

### 3.3 Economy

Ethiopia's GDP per capita as of the World Bank is \$550. The population has dramatically increased in the last few decades; the current population is estimated to be 97.1 million;



which was 74,264,000 in 2005 (UN World population prospect, 2010). This radical population increase has caused all kind of social, economic and political problems. Solid waste management in a given city is directly influenced by the economic status of that given country. The quality of the management is highly dependent on what the country can afford. One of the main reasons for the poor waste management in Addis Ababa is the low economic status of the country.

The way the capital city has come to develop is in a manner of expanding squatter settlements. Since, emperor Menelik and his wife have decided to move and settle in an area named 'Filweha' in Addis Ababa, the warlords and worriers have started to build their houses around them; the expansion of the city have followed the same manner since then. Addis Ababa still suffers from squatter settlements by random incomers from the rural areas. The expansion manner such that houses built following the needed infrastructure such as sewer, water pipelines and electric grids; has given Addis Ababa the current unstructured figure (Yirgalem, 2008; Camilla, 2012). This manner of building infrastructure is quite expensive and can be held as a reason for the low quality the infrastructure has in the city.

Addis Ababa at the moment does not have any master plan. Between 1936 and 1941, there has been six mater plans prepared; nevertheless, none of them were implemented. Over all, the city has poor public services. About 95% of the population does not have any proper sewer or drainage and 47% of the households does not have potable water supply. Due to the poor distribution line, there is the possibility that the water which has entered the system may not reach the intended destination; this is estimated to be 47% (Camilla, 2012). The sanitation in Addis Ababa is quite below the level that is needed for any heathy livable environment.

There is high unemployment in the city and increasing at a fast rate. The high unemployment which is estimated to be 31.4% has caused the development of a widespread informal employment of 69% (Camilla, 2012). The informal employment is mostly labor work where the informally employed people are underpaid and abused.

Moreover, due to the devaluation of the Ethiopian birr, the cost of living has soared since 2004. This has caused the prices of most of the daily supplies to double (UN-Habitat, 2008b; Fransen & Dijk 2008; Camilla, 2012). All the above stated problems pertaining to

the low economic status of the country contribute to the poor solid waste management in Addis Ababa.

The fact that the city does not have any master plan makes solid waste management planning difficult and any service delivery insufficient. The way the expansion goes in the city does not prepare any route for waste collection prior to building the residential area; therefore, will make both liquid and solid waste collection challenging.

As to the current waste management system, there were only 60 collection trucks for the whole city in 2006 which were 77 in 2003. The number of collection trucks has decreased due to lack of maintenance, poor condition of roads and lack of paved roads in the city. In the year 2004, there were only 36 trucks in service out the 72 available trucks (Camila, 2012). In addition, there are only 587 (8 m<sup>3</sup>) containers for the entire city; The area of Addis Ababa is 530.14 km<sup>2</sup>.

A wise solid waste management can root a strong economy and a strong economy can afford a good solid waste management. The solid waste management system in a city is highly reliant on the economic status of the country.

To improve the solid waste management system, the economic status of the country has to improve. In order to make the needed improvements in the waste management system, the economic status of the country has to improve. Meanwhile, a keen solid waste management could be used to strengthen the economy.

### 3.4 Governance

In the following section, the influence of governance on solid waste management is discussed based on the PhD dissertation by Camilla Louise Bjerkli in 2012 titled 'Urban Services and Governance: The case for Solid Waste Management in Addis Ababa, Ethiopia'. This dissertation aimed to evaluate the solid waste management in Addis Ababa from the urban political ecology (UPE) and governance frame of reference. Beyond all the above-discussed problems, governance is the most important matter when it comes to solid waste management. Sound governance can cover issues coming from different directions. These problems maybe attitudinal, educational or economical; all these matters can be covered with good governance. If there is good governance in a given city, efficient work can be done with limited resources.

Since the Ethiopian People's Revolutionary Democratic Front (EPRDF) came to power in 1991; two major structural changes have taken place to improve the governance and administration. The first one was the District-Level Decentralization Program which was started in 2003 as part of the Sustainable Development and Poverty Reduction Program (SDPRP). The aim of the decentralization was to give more power to lower level administrative units to improve the urban services.

The second major structural change was in 2004 with the implementation of the Business Process Re-Engineering Program. The program was led by the Ministry of Capacity Building. The program aimed to improve service delivery and capacity within state institutions by reducing the bureaucratic structures and procedures, removing non-performing civil servants, and increasing the capacity of the remaining civil servants. In line with the decentralization and the business process re-engineering, the government has also adapted the principles of good governance to all the administrative units. However, the Ethiopian good governance package has more values than the common eight principles.

The Ethiopian good governance principles are: Integrity, Loyalty, Transparency, Confidentiality, Honesty, Accountability, Serving the Public Interest, Exercising Legitimate Authority, Impartiality, Respecting the Law, Responsiveness and Exercising Leadership.

Good governance is important for the successful delivery of all urban services. For the successful delivery of urban services in this case, solid waste management, the implementation of the principles is vital. There should also be a cooperative and trusting relationship between the government and the people. The government should be considerate of the needs of the people by consulting them on decision making and the people should be cooperative in the government's quest for development. The quest for development should be sustained; persistent commitment is required from both sides for success. As stated by Camila 'Only with recognition of and commitment to existing actors and competent people - employed –on a long- term basis in order to have continuity in the management of urban services - will a good basis for improving solid waste management in the city be provided'.

Though the measures taken by the government to decentralize power to lower level, to implement business process re-engineering and good governance are good; none of them has brought about any significant change in the city's urban service delivery. This

is mainly due to the disagreeable relationship the government has with the people. The people do not trust the government and they are unwilling to cooperate with the developmental measures the government takes on. Again, the government is not transparent and does not involve the people in its decision making process.

The Ethiopian government is highly politicized. The government is more concerned in sustaining its power than the actual needs of the people. There are frequent shifts within the government; lack of continuity highly renders any ongoing development works. There is also lack of communication within the government bodies where they work independently on the same matter (Camilla, 2005, 89-90). The relationship between the government and people can be held as one of the major reasons for the poor solid waste management in Addis Ababa. Again, the government's ineffectiveness to execute its good governance values has caused the solid waste management situation. In conclusion, prior to any developmental works the relationship between government and the people has to be mended; then all else will follow.

#### **4 Analysis of significant works related to waste management**

##### **4.1 IGNIS (Income generation and climate protection by valorizing municipal solid waste in a sustainable way in emerging mega cities)**

IGNIS was a multifaceted waste management project which took place in Addis Ababa between 2008 and 2014. The project was done in collaboration between German and Ethiopian partners. The German stakeholders were as follows Association of appropriate Technology (AT Verband), Institute of Future Energy Systems (IZES), Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA) and the Ethiopians were: Addis Ababa Institute of Technology (AAIT), Addis Ababa Environmental Protection Authority (AAEPA), Addis Ababa University – Regional and Local Development Studies (RLDS) and Environmental Development Action in Ethiopia (ENDA, Ethiopia).

The aim of the project was to develop individual waste recycling projects that could put value to municipal solid waste and create employment and generate income.

Based on these individual projects, the project intended to create a sustainable material flow system that can improve the waste management and decrease greenhouse gasses (GHG) emitted. In addition, if successful, the system could be used as a model for other emerging mega cities.

The IGNIS project was a pioneer in introducing several waste management and treatment methods. It was also the longest and the most expensive waste related project in the city. It had both research and practical pilot projects. The research part of the project developed a systematic method to collect data and analyze the waste dynamics in the city and also it has envisaged plans for the sectors of waste which have not yet been studied. The pilot projects introduced waste treatments methods that were not yet familiar in Ethiopia such as biogas production, composting, fuel generation. And also Occupational Safety and Health of employees was introduced which is not yet an implemented knowledge in Ethiopia specially in the waste management sector. For the above reasons and to learn from the loss and gain of the project; it is clear that it is quite beneficial to study the project.

For any successful research reliable data is essential. The first challenge for the project was to collect data with Addis Ababa's current urban situation. Addis Ababa does not have a proper master plan and suffers from still ongoing squatter settlements. Having the urban infrastructure and limited paved roads, it is challenging to collect data. In addition, the vast majority of the people are ignorant or reluctant towards research therefore, cooperation is rare. The data collection to characterize the waste focused on households as they are the highest generators of waste in the city.

The IGNIS project developed a systematic method to collect data based on socio-economic classification of areas based on building structures. This method was developed from the theory that socio-economic classes correlate with building structures as people normally live in the kind of house that they can afford. People with similar socio-economic background are likely to show similar life style. Therefore, people who live in similar building structures are likely to produce relatively the same type and amount of waste.

First, secondary data was collected on socio-economic status from the Central Statistical Agency in Ethiopia. These data were collected for other purposes. Second, the building structures were evaluated and the residential areas were classified into eight categories. Thirdly, sample testing areas (sub-cities) were selected. Lastly, the building classes were mapped using satellite images and studied using GIS applications. This was a keen method to approach the data collection when having the circumstance of the city and the time limit. The data collection method developed can also be used for other research work.

The project had nine pilot projects and six conceptual projects. The pilot projects aim was to implement small-scale waste treatment and management projects and observe their feasibility and so forth expand the projects to a larger scale. Practical pilot projects are quite useful to save time and resource. By running the small scale project, one can easily see if the project will be successful and identify the possible problems that will arise and hence, will be prepared when expanding the project.

The first two projects were composting projects, one in Gerji, a rather new and modern residential area east of Addis Ababa and the second near Tewedros roundabout, close to the center of the city. Composting, in general, is a feasible waste treatment method in Addis Ababa since 60% of the waste is organic. The Gerji composting pilot project collected organic waste from the surrounding households. The collection was done by distributing collection bins to the residences. Waste bins are not common in Addis Ababa. The distributed bins were then emptied once a week by pre-collectors.

The organic waste collected was sorted again to avoid other inorganic materials that may contaminate the compost. After composting, a sample was taken to the laboratory to check the quality of the input material to form compost and the following results were obtained: the moisture content of the compost was 72-77% (ideal moisture 50-60%), phosphorous 0.13-0.21% and for potassium was 0.24-0.25 % (both are lower than average values from German compost analyses, (IGNIS, 2014)). At the Gerji compost site a person was hired to stir the compost every other 4-5 days since the composting was done manually. When the compost was ready, it was sieved with a self-made sieve to separate the mature compost.

As of the report on the IGNIS project, the Gerji compost pilot project faced several problems. The main problem was that the idea of composting or waste recycling was not at all known among the people working on the project. Significant time was spent explaining how and what to sort to the house maids working at the residential houses. And usually they were reluctant to bother to sort as there was no need for them to do so or perhaps they did not understand the benefit of the project. There was also a problem to find people who understood the composting process well enough to do the manual work well. The IGNIS project was working with the Addis Ababa Environmental protection agency (AAEPA) on this project however, it was stated that the head of the office had to change and that this too has rendered the project.

The second composting project aimed to collect organic waste from the city's biggest vegetable and fruit market place called Ataklet tera near the city center. The aimed method to compost was open windrow composting with manual operation.

For the manual work, a youth group called Birhan, already working in the area on waste related work, were selected and trained. The Arada sub-city was generous enough to give the group 300 m<sup>2</sup> of land for work south of the market place. However, due to unclear reasons, the *kebele* of the area assigned other youth group for the work disregarding the contact. The previous group was upset of the situation that they claimed ownership of the work areas at the law enforcement agency. Due to this incident, the second composting project only went as far as preparing an area to compost on.

The IGNIS project had two biogas pilot projects. Both plants operated near the city center around the area named Sidest Kilo. The first biogas plant was implemented at the Addis Ababa Institute of Technology in the compound of the student's dormitory. The aim of the project was to collect the food leftovers from the cafeteria of the institute and to generate heat. The generated heat was provided to cafeteria to boil water for dish washing. The plant was in use in Turkey before it was imported to Addis Ababa. Then it was revised by a German company named Gicon before arrival. The following figure shows the IGNIS project biogas plant found in the Addis Ababa Institute of Technology dormitory compound.



Fig. 10 Ignis project biogas plant at the Addis Ababa Institute of Technology

The main compartments of the biogas plant were: fermenter, delivery tank, heating system, agitator and gas storage tank. The fermenter had the capacity for daily input of 200

kg of solid organic waste and 400 l of waste water for operation. The capacity of the biogas plant are shown below in table 2.

Table 2 Biogas plant capacity

Substrate	Weight (kg/d)	Biogas(Nm <sup>3</sup> )
Wastewater	400	2.7
Solid waste	200	26
Total	600	28.7

The Biogas plant had the capacity to produce 28.7 m<sup>3</sup> of biogas per day with an expected amount of methane of 65%. The produce biogas the caloric value of  $H_i = 6.5 \text{ MJ/m}^3$  and had the energy of 183.3 kWh/d. Accordingly, the amount of hot water needed by the cafeteria was 780.2 l twice a day and the calculated amount of energy needed to heat the water was 30,2879.3 J/d. The amount of food waste that was available from the cafeteria was on average 228 kg. It was assessed that the biogas plant was capable to provide the required amount of energy to heat the water and there was sufficient waste to feed the tank.

On the basis of the final report of the IGNIS project, the biogas plant at the AAIT had the following challenges. The qualification of the technical staff of the university and electricians called for implementation and repair of the plan was poor. Basic replacements and repair was problematic. The plant did not have spare parts in case of malfunctions upon arrival. As the technology was new in the country any replacement for the plant had to be ordered and imported from abroad, which was expensive and time consuming.

Following, the amount of food waste coming from the cafeteria was not as much as expected. This was mainly because the university staff gave the edible left overs for needy people living in the university area. Therefore, the biogas plant input was quite low and the energy produced was low respectively. Again, the personnel assigned for the feeding work did not understand the overall concept the biogas and function of the machine so they were not cautious on what to put and what not to put in the machine. Several times the granulation pump was clogged with stones and bones. As for the future for the plant on valorizing waste, the produced gas to substitute for the electrical energy used to heat water was too small to be relevant for the university; however, it is an excellent example for practical work for the university students.



The second biogas plant was implemented at Menelik II preparatory School in Arat Kilo (close the city center). The biogas dome was connected to the female toilette outlet; the female toilet was selected due to its convenience on elevation of its location to install the plant. The bio-latrine plant was to provide energy to the canteen and laboratory.

However, due to poor condition of the toilet, there were not many students using the toilette therefore, the project needed to rehabilitate the toilette in order to get enough latrine waste. After rehabilitation, the toilet was expected to be used by 1,200 female students per day and it was directly connected to the underground 28 m<sup>3</sup> biogas fermenter which had the capacity to produce 9 m<sup>3</sup> biogas per day. This amount was enough to cook meals for 60 persons in the canteen, which would otherwise be provided by 45 kg of wood fuel.

The latrine biogas plant was rather more successful than the one in AAIT as it was functioning properly and giving service until the end of the project. Nonetheless, this does not prove that the challenges of the plant in AAIT are solved here. If the bio-latrine plant malfunctions, repair and replacement of malfunctioning parts will be an obstacle too for the same reason stated above. Regardless, the school staff had a plan to use the biogas-latrine sludge with tree cuttings for compost production. For this purpose, an inlet is required although the implementation of the proposal lays in the hands of the head of the high school.

The IGNIS project had two Occupational Safety and Health related projects. In general, Occupational Safety and Health as a concept is not well known in the country especially, in the waste management sector. There are little measures taken for the safety of the waste workers. Gloves and dust masks are provided to the secondary collectors by the respective sub-city only twice a year. Having the load of work and the kind of material they are dealing with this is exceedingly insufficient. The costs of protective equipment are high relative to the waste worker's income; therefore, most of them work with no protective clothing.

People who work in the informal sector to collect and sell different materials work with no protective clothing and they are highly exposed to danger. The pre-collectors have better protective clothing but still not adequate. Almost all waste workers do not wear dust masks. They are exposed to inhale whatever waste material they come in contact with; this causes several lung and respiratory truck diseases.

Most informal collectors collect materials with bare hands. The contents of the materials they come in contact with may be toxic; this will cause several skin diseases and irritation. In addition, informal collectors specifically *Korales* collect their collected material in a sack. They walk long distances collecting materials from door-to-door. The load they carry is quite heavy; this can cause serious back injury.

Moreover, the collection sacks they use are of poor quality; thus, they are vulnerable to cuts and bruises if the materials they carry break or if they are sharp. To solve this problem, the IGNIS project developed a backpack in a hiking backpack style for the *Korales* to collect waste material with. A sample group was selected and the backpacks were distributed. After interviews, it was proved that the backpacks were safer and easier to use. The structure of the backpacks reduced the load on the back; therefore, they were highly useful when carrying heavy weights. They were also safer by reducing exposure to sharp things since they are made of a stronger material.

The sample group for this project had fourteen *Korales*, out of which only six of them were still working in the business when the evaluation was done. Three of them were interviewed and they all agreed on the usefulness of the backpacks however, they also mentioned that they did not use the backpacks as often. This was because people were suspicious of the big bags they carried. Hiking backpacks are not familiar in the city and the *Korales* were afraid that the people will not sell them materials.

The second project aimed to produce personal protective equipment from waste leather and other textile waste materials for waste collectors and small-scale recyclers. Due to the unavailability of free leather and textile materials and the high cost of these materials on the market, it was realized that it will not be beneficial to produce the protective materials. The project for the backpack for the *Korales* will continue with ENDA, and the idea of manufacturing protective equipment from waste materials is promising and can be well be developed by the government to enhance the safety of the waste workers. In conclusion, the project did a pioneering work by introducing the idea and importance of safety of the waste workers to the concerned government bodies.

The additional two pilot projects were a paper recycling and waste-to-fuel pilot projects which were done in partnership with associates already working in the business. The waste to fuel project was working on a charcoal production business. The aim of the

IGNIS project here was to introduce the replacement of input wood logs for charcoal production with organic waste materials suitable for the process such as e.g. *Khat*, flower cuttings. The project was done in partnership with a women group named WISE(women in self-employment) who have been working in the charcoal production business.

The WISE group operated at the outskirts of the city; their production was primitive and quite manual. The pyrolysis of their process was with partial combustion; this means that the thermal process was under strong deficiency of air. The pyrolysis is known as sub-stoichiometric combustion. It is important to point that all the gaseous, liquid and solid residue of this process is toxic.

The aim of the IGNIS project was to improve the charcoal production of the WISE group by providing improved pyrolysis reactor and reduce smoke emission. Improved pyrolysis reactors were designed and tested in Germany at the University of Stuttgart. The reactors were installed at a location called Debre Zeit near a flower farm. For the charcoal production, discarded cuttings from the flower farm were used. The cuttings from the flower farm were rather wet; it took three to four days to get them dry enough for the process. The owners of the flower farm were also interested in the charcoal production as they too will find a way to get rid of masses of flower cuttings after their production.

This project was successful by introducing the idea to replace wood logs with suitable organic waste for charcoal production, which will decrease deforestation and the amount of disposed waste. Secondly, it was successful by introducing improved design for the pyrolysis reactor to the WISE women group. If invested on, this pyrolysis reactor could improve production for all people working in the charcoal production and reduce emission to the environment.

The paper recycling pilot project was done in partnership with an entrepreneur named Tesfaye Mekonnen who had prior education in paper recycling. In the small scale business Tesfaye uses used paper, banana fibers and pineapple fibers in his paper production with two employees. As to improve the paper recycling business, the first improvement made was a three weeks training for the operator in India on handmade paper production.

Subsequently, the operator made noteworthy changes to the recycling project. According to the training, a beater is required to crush the banana fibers; the operator decided to use a traditional mallet mainly used for kitchen work in Ethiopia as a beater. The beater available is imported from Holland and is quite expensive. The second improvement was the introduction of the bleaching step with caustic soda. Caustic soda is used in the cooking process to break the structures of the banana fibers. The following improvement has brought about significant ameliorations to the recycling pilot project.

In addition to the waste recycling pilot projects, the IGNIS project had a project to prevent erosion and rehabilitate soil with *Jatropha curcas* linn plantation. *Jatropha curcas* linn is a flowering plant capable of growing with small amount of nutrients and is ideal for soil amendment as it has a natural ability to catch Nitrogen. It is also ideal for erosion prevention as it can easily grow on marginal soils, and the oil from the seeds of a *Jatropha* plant is a good source of biodiesel.

The *Jatropha curcas* linn plantation pilot project was implemented in Bati, a location in North Ethiopia. The *Jatropha* seeds could not be found in Addis Ababa. The pilot project developed the plantation in Bati to observe the behavior of the plant. It was observed that the plant required a lot more water than expected to grow. Only two of the months in year are rainy in Ethiopia, which will make it difficult to grow these plants. Lastly, the plants did not grow seeds by the time the IGNIS project ended; therefore, it was not possible to observe their potential as source of biodiesel.

The conceptual part of the IGNIS project envisaged plans for dumpsite improvement, electrical and electronic waste treatment, plastic recycling, metal recycling, collection point improvement and feasibility of Terra Preta in Addis Ababa. The envisaged projected aimed to evaluate and identify methods that will fit the circumstance of Addis Ababa.

In conclusion, the IGNIS project did a revolutionary work in the waste management sector in Addis Ababa. The findings and observations are dependable because they are made from reliable data and practical implementation of projects. The data collection method developed for this project can be used in the future and for other related projects. Since organic waste holds the highest percentage in the waste generated in Addis Ababa; composting and biogas production are the paramount waste treatment methods. The IGNIS project did a great work by introducing and evaluating their applicability in

Addis Ababa. In addition, the introduction of the Occupational Safety and Health in the waste sector and invention of improved work equipment for workers was quite beneficial. The envisioned plans also brought into attention aspects of the waste sector that had not yet been studied.

Observing from the experience of the pilot projects, the first work that needs to be done when planning to expand the pilot projects or implement the envisaged projects is planning and offering trainings to personnel. Before implementing a project, there needs to be enough workers that are trained in the subject and technique of the intended project. There should also be recruits with adequate knowledge to maintain the prospect plant or machine.

As these projects are the foundation for the improvement of the waste management in Ethiopia, the government should invest to expand the pilot projects after making the proper corrections. To summarize, this project can be a stepping stone to improving the overall waste management and environmental situation in Addis Ababa, Ethiopia.

#### 4.2 Case for the informal plastic recovery system in Addis Ababa, Ethiopia

The information about the informal recycling system in Ethiopia was discovered from a master's thesis paper by Camilla Lousie Bjerkli from Norwegian UAS written in July, 2005. The thesis was titled 'The Cycle of Plastic Waste: An analysis on the informal plastic recovery system in Addis Ababa, Ethiopia'. Based on the report from the IGNIS project and the above-mentioned Master's paper the amount of material recovered by the informal sector was high. The number of employment was also quite high therefore, it was found reasonable to have a closer look into it.

According to Camilla's research, the informal sector has a significant contribution to the waste management in Addis Ababa. The government is the main body responsible for handling waste in the city. Unfortunately, the government does not have any recovery system. The current approach is simple crude dumping after collection. This system is harmful to the environment and wasteful of valuable resources. To protect the environment and to wisely use resources, recycling and reuse should be encouraged in the city.

Most of the beverage companies in Addis Ababa have their own method to collect used glass bottles from the shops at their own expense. In addition to the beverage companies, the only recycling or reuse system in Addis Ababa exists in the informal sector. Figure 11 shows recovery cycle in the informal system.

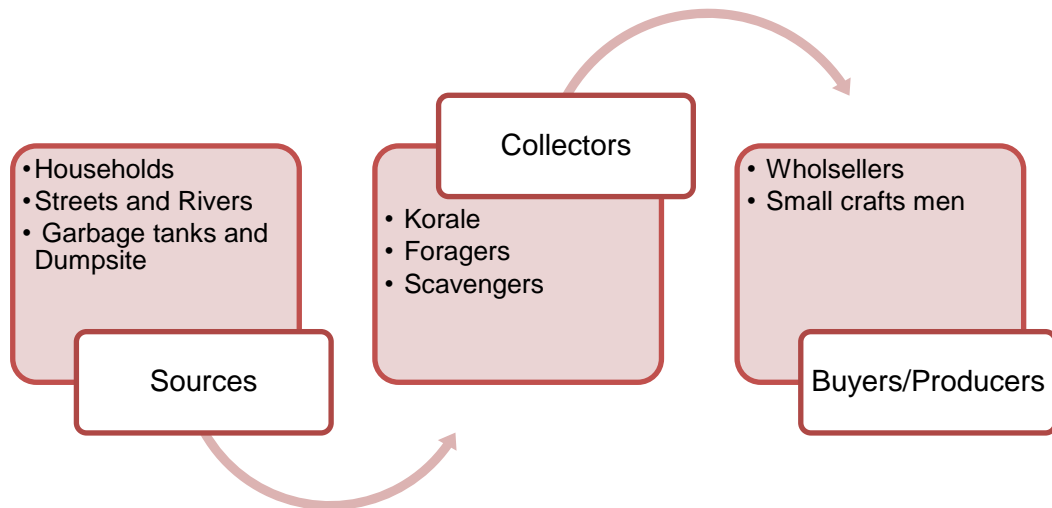


Fig. 11 Informal waste recovery cycle

There are three main actors in the informal sector and the process goes as demonstrated in Figure 11. The informal cycle goes as follows: The collectors collect all kinds of discarded materials mainly plastic and glass bottles from households, rivers, streets, garbage tanks and from the Repi dump site that they think is sellable or could be used again. Then, they bring all these materials to Mennalesh Tera in Markato. Merkato is the biggest market place in Ethiopia and is found quite close to the city centre in Addis Ababa.

The market place is organized in such manner that the same kinds of materials are sold at the same area. Mennalesh Tera is a location specializing in recycled and reused materials. In Mennalesh Tera there are mainly wholesalers and crafts men operating at a small scale. The wholesalers buy materials from the collectors and sell it to factories; and the crafts men buy these materials to make different kinds of materials and sell them.

As further elaborated by Camilla on her second thesis titled 'Urban service and governance, the case of solid waste management in Addis Ababa, Ethiopia, (2013, p. 60-70), the collectors can be categorized based on the quality of the materials they collect Figure 12. The quality of the materials they collect depends on where they collect it from and the collector's financial status. The waste collector's hierarchy is shown in figure 12.

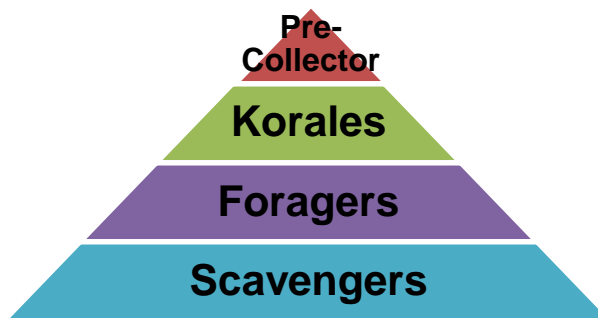


Fig. 12 Waste collector's Hierarchy

At the top of the collectors' hierarchy are found the pre-collectors; who are organized and employed by the *Kebele*. These pre-collectors collect waste from households with a push cart and deliver the waste to the garbage tank. Meanwhile, they collect materials they find sellable and take them to Mennalesh Tera to sell or sell it to a passing by *Korale* (second level waste collectors). The materials they collect are of good quality because they are collected straight from the households. In addition, they are employed by the *Kebele* and have constant income; they are at best economic status in the collectors group.

On the next level, there are the *Korales*. The word '*Korale*' comes from '*Korkoro alleh?*' which translates to 'do you have a metallic roof covering)?' in English. These waste workers travel in all neighbourhoods shouting this phrase. And people who have heard this shout will go outside to sell them used things they do not need. The reason for this particular phrase maybe that the first collected or wanted materials were roof covering metals; because '*Korkoro*' in Amharic is a metallic material mainly used for roof coverings; and also the name of the profession '*Korale*' sound more like *Korkoro* which metallic roof covering.

These collectors are all male and between the age 17-62 years; the average is 28 (Camilla, 2005, p. 66). According to the survey done on Camilla's thesis on the informal sector, most of them come from the countryside, mainly from the Gurage region, mostly they move to Addis Ababa in search of better living conditions. The educational level of these workers is from no to 4-5 years of elementary school.

The *Korales* work with the money they get from the wholesalers in Mennalesh Tera or their own money. They are not employed properly with a contract by the wholesalers rather they work by personal acquaintance and trust with the wholesalers that they will

bring what they bought with their money, and the wholesalers will give them their agreed share when they return.

On average they work 6.6 hours per day; there is no specific start and end time for work for the *Korales* as they work until their bags are full. There are about 3000 *Korales* working in Addis Ababa; the exact number cannot be known as most of them work in this business temporarily until they find a better job. These people are involved in the recovery business only to make a living; 79.4 percent of them work in this business because there is nothing else they can do (Camilla, 2005, p. 75).

On the following level are foragers. These are waste workers who scavenge waste tanks in the neighbourhoods. They sell their valuable materials to travelling *Korales* or straight to the wholesaler in Mennalesh Tera. These waste workers do not have their own money to purchase items with. They collect waste materials for their own need or to make a day's income to survive with. They are at the lower level than the *Korales* because the waste they collect has already been filtered once and it has been dumped in the tank. Therefore, the status of the material will be lower.

At the bottom of the collectors' hierarchy are found the scavengers. These scavengers operate at the Repi dump site. The scavengers at Repi dump site actually live at the dump site and their estimated number is close to 500 -600. They live and work in a group; they have a group leader whom they call their father. They collect all the materials they find that are sellable on the dump site and give it to their father. Their father collects all the material and when it mounts up to a significant amount; they take it to Mennalesh Tera and sell it there. Their father in return buys them food and provides them protection.

The quality of the materials collected by the scavengers is very poor. This is due to the normal routine of the waste system, the materials which are in a better state have already been sorted out at least twice by the time they arrive at the dump site. However, they find good materials when hotels and institutions dump their waste at Repi with their own vehicles and expense.

All the material collected will arrive at Menalesh Tera. There are about 300 wholesalers in Menalesh Tera to receive these materials. Each of these wholesalers have at least has two employees. They buy materials from all kinds of collectors and sell it to factories, small crafts men and small home industries. There are also small crafts men who work



at Mennalesh Tera. They buy materials from the collectors or the wholesalers and they make different products. These crafts men sell their materials to the people in Mennalesh or in other locations in the market. The kind of recycled products that are made in Mennalesh Tera are, for example, traditional Ethiopian cooking stove for charcoal known as '*Lakeche*', chairs, luggage from old brakes, and shoes.

The specialty of Mennalesh Tera is Berbaso. Berbaso is a sandal made from discarded car tyres. These sandals are a commonly worn among people with low income. The discarded tyres are also made into ropes used for horse-drawn carriages in rural areas in Ethiopia.

These are not all the materials that are reused and recycled in Mennalesh. Mennalesh Tera provides several well needed materials to the people. It is also a working place for many crafts men in the city. Nonetheless, there has been several treats from the government that it will be moved or demolished. This change is planned to be implemented without consulting any of the involved actors or doing any research on the possible consequences of the change and use of the location.

The factories that buy materials from the wholesalers are not known or rather prefer to stay veiled about their activities. Considering the amount of material that goes into Mennalesh Tera, it is clear that there are substantial purchasers. The demand for plastic and other recovered materials by factories and small industries has increased in the city; this mainly due to the price of imported materials is getting high. It can be assumed that most of the factories in the city buy used materials from Mennalesh to save money. They prefer not to transparent of their activities because they do not want to pay high taxes. There are complains around the city on the government's imposition of high and unreasonable taxes. These could be the reason why the factories prefer to stay anonymous.

The informal recovery system contributes highly to the overall material flow in the city. The number of employment in sector is also significant. According Camilla, (2005, p. 72) 8395 tons/year of plastic material is recovered and as of the IGNIS final report 8321 tons/year of all kinds material is recovered in the informal sector. The IGNIS project focused on only household to study and characterize waste in Addis Ababa. In the research work of the project the residential houses (buildings) in Addis Ababa were organized into 7 main groups based on their socio economic status. They were High income,

Middle to high income, Middle income, Middle to low income, low income, lowest income and condominiums.

The amount of recovered material by the informal sector are presented according residential building types in Table 3.

Table 3 Recovered valuable materials from households [tons/year] (IGNIS Joint Finale Report, 2014, p. 36)

Materials	Low In- come Housing	Low to Middle Income Housing	Middle Income Housing	Middle to High In- come Housing	Condominiums	Total
Paper and cardboard	1249	109	39	28	21	1446
Plastic	242	238	276	122	0	878
Glass	512	184	86	189	7	977
Metals	1398	548	1431	500	0	3877
Textiles	148	115	53	76	0	391
Household hazardous and special waste	91	216	4	189	136	636
Miscellaneous	59	4	43	0	0	106
Total	3699	1415	1930	1104	165	8312

#### 4.2.1 Benefits of the Informal sector

The IGNIS final report calculated the waste generated by residential buildings to be 242,565 tons/year (2014, p. 38); out of which 8312 tons are recovered yearly. Even though, the amount recovered is only 3.43%, it is still a significant amount having the working environment conditions such as having no proper technology or a responsible body to regulate the system. The recovery system decreases dependence on imported materials. Production with recovered material saves resources and is the base for a stronger economy.

This will aid Ethiopia on the battle of poverty reduction and move to middle income country in the future.

The informal recovery system also contributes to decrease the workload and expense of the government on waste management as the amount of waste that needs to be collected and disposed of will be less. When there is less dumped waste, there will be less pollution. In addition, recovery also decreases dependence on natural resources.

The other significant contribution of the recovery system is employment. According to Camila's thesis, the counted participants are 3000 *Korales*, 600 wholesales personnel, 600 scavengers and this gives the total of 4200 people without the foragers and pre-collectors. The average age of people working in this area is 28. People in this age group are people capable of bringing change to the country. It is clear that engagement of this population reduces poverty and crime rates in the city.

#### 4.2.2 Drawbacks of the Informal sector

There is no government or private body keeping record of the material flow in the informal recovery system. There is no information on vital concerns such as the following: how much goes in and out of Mennalesh? how much is recycled there? what is produced? how much is produced? who buys these materials? And how do the factories recycle the materials they buy? All this crucial information is missing. Especially, not knowing how the plastic materials are recycled in the factories is quite dangerous to the city. Since the method of residue disposal and amount of emission of the recycling process is not known, it can be very harmful to the environment. The quality of the plastic products on the market will also decrease if the process is not done properly. If these plastics are used for food packaging, they will also be carcinogenic to the human health. The recycling process will do more harm than good in this case.

The wholesalers make unreasonable profit whereas the *Korales* do the hardest part of the work. The *Korales* buy different materials from households; the price ranging from 0.35 to 5 birr (1 € is equivalent to 24.96 Ethiopian Birr). They have to walk all day from door to door collecting materials until their bags are full. Then, they usually walk back to Mennalesh Tera and sell the material /kg for 5 birr to the wholesalers. The wholesalers however, sell the materials to factories 3-7 birr depending on the state of the material (Camila, 2005, p. 73).

*'One wholesaler told me that he bought around 200 kg materials each day, and paid about 5 birr per kg, which gave a total expenditure of 1000 birr each day. Further, he sold the materials for 7.5 birr per kg, which generated a profit of 500 birr each day. This was also the case for the other two wholesalers I talked to, though it should be mentioned that this information is not reliable because it is only based on interviews with three out of at least 300 wholesalers operating in the area. However, it is clear that the wholesaler's income was far higher than the daily incomes of the korales.'* (Camila, 2005, p. 74).

The government has not recognized the use or the existence of the informal recovery system. There was a presentation from the Addis Ababa city administration in 2010 to introduce and promote reuse and recycling in the city where such an organized informal recovery system exists.

As of Camilla's research paper on the Informal recovery system, the government has a plan to move and demolish Mennalesh Tera. The government has a negative regard to the whole system and to the waste workers. This is mainly because they do not pay taxes. However, the income of all the parties in the system is not constant and quite low, especially those of the collectors; hence, it is not reasonable to tax them.

There is a negative relationship between the government and the people. The government usually implements changes without consulting the concerned parties and specially without giving proper attention to what the changes will alter and what the possible consequences will be. This approach of enforcing methods and ideas on the people has spoiled the government-people relationship. The people too have a negative regard to the government. They have not yet understood the government to be an organization to bring them service; rather, they see it as an obstacle in their way.

In conclusion, in order to improve the waste management system, the government has to recognize the significant contribution of the informal recovery system and actors. The actors should be considered and consulted on decisions involving them. A proper research should be done before implementing a new idea or change. For any improvement to occur, the relationship between the government and the people has to be mended. Following, a proper research on the waste management system which has studied the matter from all perspectives and has considered all the actors is the key for improvement.

The way forward is, the government has to invest on a research on how to develop the informal sector. Small steps such as organizing the waste workers into a small scale enterprise and improving their working conditions, developing the small crafts men in Mennalesh tera into a factory, developing ways to keep record of the material flow can improve the system. The informal recover system holds the key for Addis Ababa to come out of the 'end of pipe' treatment to reuse and recycling; therefore, it should be given proper attention.

### 4.3 Case for Windhoek, Namibia

Windhoek has one of the best waste management systems in Africa. Its waste management system has earned it the title the cleanest city in Africa (Raili, 2009, p. 14). Based on a PhD dissertation titled 'Municipal Waste Management in Namibia: The Windhoek Case Study' by Raili Hasheela in 2009, Windhoek is already familiar to waste management methods that Addis Ababa aspires to such as sustainable environmental development, waste auditing, sorted waste disposal, landfill technology. Even though, Namibia is a middle income country, Addis Ababa and Windhoek suffers similar urban problems with waste management, unemployment, uncontrolled migration from rural areas and other countries. Therefore, it was found reasonable to study the waste management system in Windhoek to learn methods that could be useful improve the waste management in Addis Ababa.

Namibia is a coastal country located in southwest Africa sharing borders with Angola, Botswana and South Africa. Namibia was occupied by the Germans from 1884 – 1915 and by South Africa from 1915-1988(Gascoigne Bamber, History of Namibia, History world, 2001). It has only been 26 years since the country won its independence. The country covers an area of 825,814 km<sup>2</sup> with an estimated population of 2.1 million (Raili, 2009). Windhoek, located at the heart of the country, is the capital city and center for all the socio-economic and political activities of the country.

Namibia is a natural resource rich country which has its base of economy. The country is classified as a middle income country with a GDP per capita of \$2,000. There are three major economic sectors where Namibia's economy depends; these are the primary sector comprises agriculture, forestry, fishing, mining and quarrying; the second sector comprises manufacturing, electricity, water and construction; and the last sector includes

wholesale and retail trade, hotels, restaurants, health, transport and communication, and education. Diamond mining is a major private business and greatest contributor to GDP. There has been a fluctuation of the economic growth; however, the GDP per capita has increased from 21,328.60 to 34,443.00 Namibian million dollars between 2004 and 2008(Raili, 2009, p. 54 -57).

Similar to many African countries, there is a gap between the poor and the rich in Namibia. On the basis of a household income expenditure survey carried out in 2003 and 2004, two poverty lines of 'poor' and 'severely poor' were created. The household expenditure has estimated the poor households to be 27.6% and severely poor to be 13.8% with consumption levels of 262.45 and 184.56 Namibian dollars per adult per month respectively (CBS, 2008; Raili, 2009). There is also high unemployment of 30% and low formal education opportunities.

The climate of Namibia is mainly characterized by arid to semi-arid with inconstant rain-falls. There are limited water resources; ground and surface waters are the main suppliers. The country cannot afford contamination of its waters with both solid and liquid waste. Again, the economy is highly dependent on natural resources therefore; environmentally sound sustainable development is needed. Fortunately, sustainability and the importance of environmental protection have been recognized and implemented in Namibia.

Development works should be carried out in a way that meets the needs of the present generation without compromising the survival and need of the future generation. Environmentally sound and Sustainable development is promoted in Namibia. It can be observed from the Namibian Environmental Management Act No. 7 of 2007 which promotes sustainable use of resources as an approach to waste management and which encourages participation of interested and affected parties in the management of the environmental issues of concern (Raili, 2009, p. 12, 13, p. 54).

#### 4.3.1 The waste management system in Windhoek

The main government body responsible for handling waste in Windhoek is the division of Solid Waste Management within the city of Windhoek. The Department of Planning, Urbanization and Environment and The department of Infrastructure, Water, and Waste

Management, are other government divisions that play a significant role. Even though, not clearly stated in Raili's PhD thesis dissertation on 'Municipal Waste management in Namibia: The Windhoek Case Study', Windhoek practices a form of public-private partnership in handling its waste. Private companies participate in the entire waste management process: collection, recycling and disposal.

#### 4.3.2 Waste Collection

The main generators of waste in Windhoek are households, business facilities, industrial institutions, open spaces and informal living areas. Informal living areas are those with no proper residential services. Waste from the households is collected by the Solid Waste Management Division which provides these houses with garbage bins of 240L known as 'wheelie bins' beforehand.

These bins are meant for collecting food waste, domestic refuse, commercial waste and all light materials which may not damage the containers. Other materials such as wood, bricks, iron sheets, sand, heavy metals, tree branches and grass are disposed in big containers called '*skips*' found in the residential areas (Raili, 2009, p. 89). It can be concluded that the society is quite familiar with waste separation.

Both the Solid Waste Management Division and private companies collect waste from business facilities. Waste collection from industrial institutions and open spaces is specifically done by private companies. Smaller garbage bins are placed along the streets by the Division of Solid Waste Management. In addition to the wheelie bins, small garbage bins and skips, there are black plastic bags provided by private contractors to the informal residential areas to collect waste in. The waste is collected from both the households and business facilities weekly; upon request both parties can have their waste collected in between if needed. The waste from the skips collected on a daily basis.

### 4.3.3 Waste disposal

There are a total of seven landfill sites in Windhoek. Six out these sites are called '*satellite sites*' and are designed to receive garden refuse and building rubbles. Their locations in Windhoek are Havana, Khomasdal, Pioneerspark, Eros, Olympia and Ludwigsdorf. The remaining landfill is named Kupferberg and it is located 11 km from the city center. This landfill specializes in general waste and hazardous waste which are again stored separately.

For the hazardous waste, the landfill is well lined and has a leachate collection system. All the landfills operate based on the South African Minimum Requirements for landfill sites. Operations at the landfills are done by private companies. Particularly the company named Enviro-Fill Namibia is responsible for the management and operational activities in Kupferberg. All the sites monitor and keep record of the waste disposed using weighbridge. The landfills did their waste audits bi-annual basis; since 2008 this has changed to be carried out in every five years.

On the basis of these records, in the year 2008, approximately 169,915.4 tons of building rubbles, 26,442.23 tons of garden refuse and 119,916 tons of sand were disposed at these sites. On the other hand, 67,925.52 tons of general waste and 4,970.58 tons of hazardous waste were disposed at the Kupferberg landfill. Waste compaction to save space and to avoid litter is practiced in the landfills. The waste is also covered with soil after each day's disposal to reduce unpleasant odor and to improve visual appearance. All the landfills are fenced and secured. Residents can dispose waste at the satellite site with no charge; however, a fee is collected based on waste amount in Kupferberg.

### 4.3.4 Waste generation and composition

Based on the household data collected between 2004 and 2008, the amount of waste generated per capita per day was 0.37 kg - 0.49 kg. The recyclable fraction of the general waste disposed in Kupferberg is 45% and the non-recyclable is 55%; the composition is as shown in table 4.



Table 4 Windhoek waste composition

General Waste	% Weight (based on the GHG inventory)	Estimated weight (in tonnes)
Metal	4	2,717.02
Glass	14	9509.50
Ceramics	0	0
Plastic containers	4	2,717.01
Plastic (soft)	7	4,754.79
Organic food products	15	10,188.83
Wood/timber	1	679.26
Paper (plain)	9	6,113.30
Paper (carton)	6	4,075.53
Garden refuse	32	21,736.17
Others	8	5,434.04
Total	100	67,925.45

#### 4.3.5 Waste treatment

Waste recycling is well-known and practiced in Windhoek. Recyclables are collected at the landfills and the work is done by people properly employed by the private companies. These waste workers are commonly called 'litter pickers', and they work under safe conditions provided with protective wear. The materials collected for recycling are papers, plastics, glasses, and cans. These materials are compacted and semi processed to be sent to South Africa for recycling since there are no recycling plants in South Africa. The major companies involved in recycling are Rent-a-Drum (group of companies), Collect-a-Can, and The Glass Recycling Company.

These companies also recently took on an initiative to collect recyclable materials through establishing separated recyclable waste collection stations at four shopping centers. The above-mentioned companies with other partners also introduced a method to encourage waste separation and recycling through a game at schools where the person who has collected the most recyclable waste will be awarded a prize. The only waste treatment method in Windhoek is incineration of medical waste by the Ministry of Health and Social Services. As the weather in Namibia is a bit dry, waste is a valuable commodity. Therefore, there are three wastewater treatment plants.

In conclusion, the waste management issues of Addis Ababa and Windhoek are at different levels. Addis Ababa is at a point where the city administration is aiming to introduce basic waste management measures such as waste separation, and landfills, whereas the Windhoek's Solid Waste Management Division's following steps will be the latest waste approaches such as Waste Prevention, building waste treatment plant with Best Available Technologies Not Entailing Excessive Costs, and Environmental Impact Assessment (EIA).

There are no garbage bins provided by the government to households in Addis Ababa, and the society is not yet familiar with sorting waste; nonetheless, on a very small scale, there are people who collect sellable materials. In addition, waste is dumped in a mass at one location for the whole city. Contrarily, waste separation and recycling are common trends in Windhoek, and there are seven standard landfills with proper management specializing in different kinds of waste in the city. Waste incineration is also a practiced waste treatment method in Windhoek.

Waste management is mainly the responsibility of government and there is no separate private or government organization assigned for waste auditing and pollution monitoring. Regularly collected and reliable data are the primary steps to understanding the current situation, making suitable decisions and to make workable future plans. Addis Ababa is far behind in this manner. In Windhoek, on the other hand, there is a well-functioning public-private partnership and Waste auditing and regular pollution monitoring is a common practice.

Regardless of the gap, there are several things Addis Ababa can learn from Windhoek. As waste awareness is the primary drawback in Addis; this can be addressed by introducing waste separation, reusing and recycling to elementary and high schools through games, events and campaigns.

As to improve the waste management method in Addis Ababa, the city administration mainly focuses improving collection by buying additional trucks and collection tanks. It is mindless to increase collection without preparing a better disposal site or method. Instead of investing in collection methods the government should invest on building recycling plants and landfills on a scale that is affordable to the country.

Observing the waste situation in Addis Ababa, it is clear that the government has not met the needs of the city. The private sector should be encouraged and invited in the waste management business. There should be a study on a public-private partnership in waste management that works for Addis Ababa prioritizing in the areas the government needs most help. Lastly, the government should establish an organization particularly for waste audits and pollution monitoring; otherwise any improvement may be impossible.

## **5 New approach to solid waste management in Addis Ababa**

Solid waste management is directly related to the social, economic and political status of a given country. It is a team work that requires the persistent cooperation of each stakeholder. To establish a well-functioning solid waste management system in a society, the government and the people have to cooperate fluently. Developments in the government's management system will not alone improve the waste management system; nor will improvements that the people make change the waste management situation. There should be sufficient contribution from both the government and people.

Learning from the past experiences, the government in Ethiopia has invested enormously on building the military, establishing businesses and improving its working systems without investing enough on developing the society as whole. Vital developmental works such as education, transportation and communication, health and sanitation are not prioritized as much as they should be. The government seems to be focused on its own workings. Transformations and development goals seem to be simple government

media talks because the government's approaches for development are usually not practical on the ground.

This is due to not being based on dependable and realistic research. Development methods are usually copy-pasted from another country. Even though there is a great advantage of learning from other country's experiences, methods and approaches should be modified to fit the circumstances of the country with proper research.

Moreover, solid waste management system is not a matter that will be improved by an international organization. The society has to grow into the responsibility of taking care of its environment. International organizations may share their experiences and aid with suggesting ideas for improvements in the country. However, they cannot make the changes for Addis Ababa that Addis Ababa owes herself. A sustainable change is successful only if it comes from the society itself. Changes cannot be put on a society by the government or by an international organization. To create a society capable of growing and improving parallel with the government and the world as whole, the society has to learn and understand its rights and responsibilities for its country; to achieve this, education is the key.

To improve the waste management system in Addis Ababa on the basis of above three case studies namely the IGNIS project, the case for the informal waste recovery system in Addis Ababa, the case for Windhoek, the following ideas have been put forward Figure 13. The main sectors of work are classified in three major categories; development works in awareness and education, development works in waste collection and recycling and development works in the disposal methods; figure 13 shows the summarized sectors.

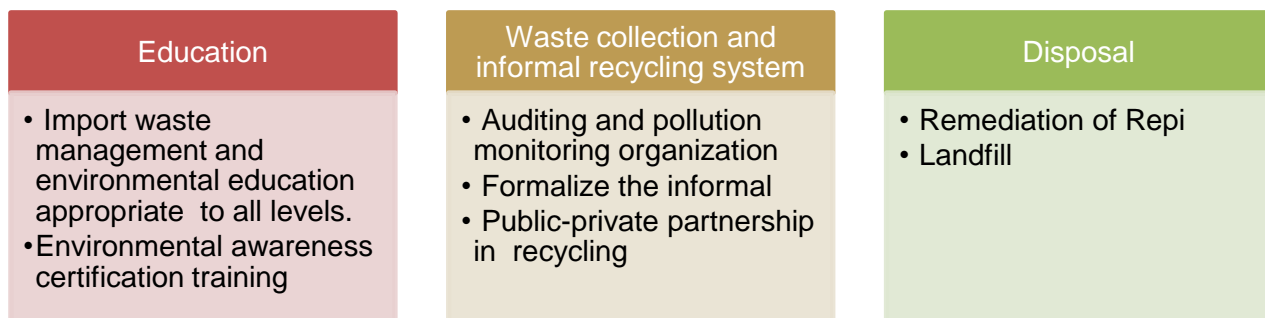


Fig. 13 Improved waste management system for Addis Ababa

In this section, new approaches to improve the solid waste management in Addis Ababa have been suggested. The presented ideas mainly focus on what measures the government should take to improve the waste situation.

## 5.1 Education

The primary investment of the government to improve the waste management system in Addis Ababa should be importing waste and environmental management education. Most of the pilot projects by the IGNIS project failed and took more time than they should because there are no qualified personnel in the area. Again, the pilot projects have not been invested on to be established with their proper corrections because there are no sufficient personnel to continue the work. Both the major waste related works in Addis Ababa: the IGNIS project and Camilla's research papers pointed out that the people in the administration position to manage the waste and the environment are not qualified for the position. This major problem can be solved by importing waste and environmental education from countries with the expertise to generate professionals in the field.

In order to address and make the education available for all citizens, the government can reach the people through organizations. The first method could be reaching to people through already established educational institutions and industrial organizations. The second method could be by establishing waste and environmental management centers at each sub-city. In this way, all classes of people: students, employed and unemployed people will have access to the education.

Educating some of the population does not bring sustainable change; as the environment is shared by all citizens, preservation of it requires the cooperation of all citizens. Hence, all citizens should have the information on how to be environmentally responsible. The organizations to access all citizens can be classified as follows: educational institutions, industrial and commercial institutions and waste and environmental management centers in each sub-city. Figure 14 shows how waste and environmental education can be distributed.

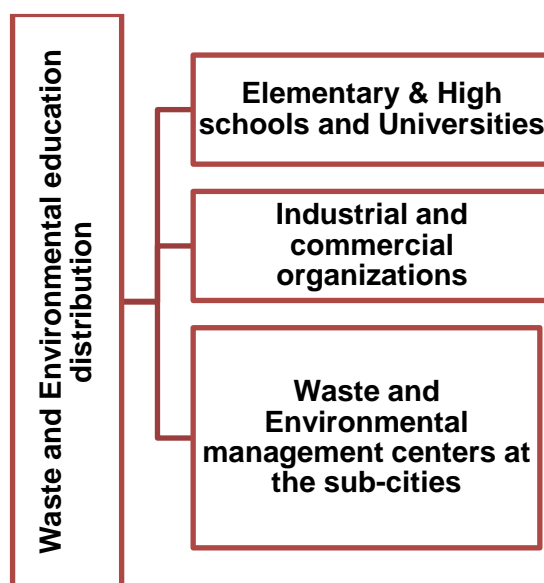


Fig. 14 Waste and Environmental education distribution

Primarily, basic waste management methods such as proper disposal of waste in garbage bins and containers, source separation, reusing and recycling should be thought in elementary and high schools by adding a waste and environmental management subject in the curriculum. The Ethiopian Ministry of Education should take the responsibility of choosing the right education and distribution throughout the levels. Secondly, Environmental engineering at bachelor's degree level should be given at least at the major universities. This can be done in partnership with foreign universities until there are enough educated people in the area. Thirdly, the government should buy or prepare a waste and environmental awareness training for people who are employed and unemployed. To guarantee participation, the government can stress participation by law. This certification can be given to employed people at their respective industrial and commercial organizations.

To address the unemployed people and for the overall environment related awareness work the government should establish 'Waste and Environment management centers' at each sub-city. These organizations will be responsible for raising awareness in their respective sub-city and certification of unemployed people living in the area. They will also be centers for all kinds of projects pertaining to environmental development. For the type of training that should be bought or prepared, the Environmental Safety Card from the company named SYMKE (Suomen Ympäristöturvallisuuden kehittämiskeskus) in Finland could be used as an example.

Through the above stated method, the awareness level in the society about waste and the environment can be improved; the number of qualified personnel in the waste and environmental management sector can be increased and lastly all the residents will be informed about waste and environmental management.

## 5.2 Waste collection and formalizing the informal recycling system

To improve the waste collection and to formalize the informal recycling system; the government needs to pair with private companies. It is apparent that it has not met the needs of the city and that it needs help in all aspects of the process. The government should encourage private companies to invest on waste collection and recycling businesses by offering loans and rewards. A Public-private partnership method should be developed that fits the conditions of the Addis Ababa city administration and the private companies operating in the city. The government should invite private companies in all segments.

Regarding the waste composition of Addis Ababa, organic, plastic and metal waste have the highest amounts. A waste recycling method based on this fact could be useful. Composting and plastic recycling could be the major waste treatment method to take upon since organic waste and plastic waste have the highest percentages.

About 70 percent of the waste generated from households in Addis Ababa is organic waste; this fact makes composting the best waste treatment method for Addis Ababa. Separated waste and composting plants are required for composting. As mentioned earlier in this paper, proper garbage bins or source waste separation are not yet familiar in Addis Ababa. To improve the waste management system, composting plants can be implemented in partnership with interested private companies; in the sub-cities Waste and Environmental Management Centers. The produced compost can be sold to farmers in the country side. This will generate income and create job opportunities for many unemployed people living in the areas.

For collection of separated waste, if affordable, the city administration can aim to provide two garbage bins to households one for organic materials and one for other kinds of waste as tried in the Gerji composting pilot project in the IGNIS project. However, this does not necessarily have to be done with garbage bins. The traditional sacks used in

Addis Ababa can be used, as long as the people are thought to use two different ones. The collection can be by pre-collectors with pushcarts as before. When the pre-collectors collect waste, they can have two different push carts, one for organic waste and one for the remaining types of waste.

The first wise step with respect to recycling is to formalize the informal recycling sector by improving the working conditions of the informal waste workers. Their significant contribution should be recognized. This can be done by forming an 'Organization of Waste Workers' in the city. Ideally it can be established in Mennalehsh Tera as most of the waste workers and wholesalers are found there. There are 300 wholesalers in Mennalehsh Tera and about 3500 waste workers in the city (*Korales* and scavengers added); in addition, there are pre-collectors and foragers. The scavengers and foragers can be developed to work as *Korales*. The idea here is that all waste collectors will be employed by one organization. The city administration can form this organization that will work as a bridge between the waste workers and the wholesalers and households.

The aim of the organization will be to improve the working and living condition of the waste workers and implement fair distribution of profit between the waste workers and wholesalers. All the waste workers can be properly employed by the organization. In this case, the waste workers will have constant income and they will be provided with work equipment's and protective wear. The wholesalers and households will pay the organization for the service they will get from their employed waste workers. In addition, the government will also fund the organization to improve the well-being of its citizens.

In order to improve the working conditions of the waste workers, particularly the *Korales*, a smaller push cart could be provided rather than any bag. All the waste workers usually walk around the neighborhoods and back to Mennalehsh Tera carrying the loads on their backs; improving the bag will not lessen the work load as they have to walk long distances.

Therefore, the hiking bag suggested by the IGNIS project cannot improve their situation as the load will still be carried by them. To reduce the workload, bags with wheels could be a solution. In addition, it is also suggested hereby a bell or a horn to alarm the people in the households to go out to sell them materials instead of shouting. This will protect them from any throat damages they might have from calling out all day. Figure 15 shows the improved method to organize the waste workers.



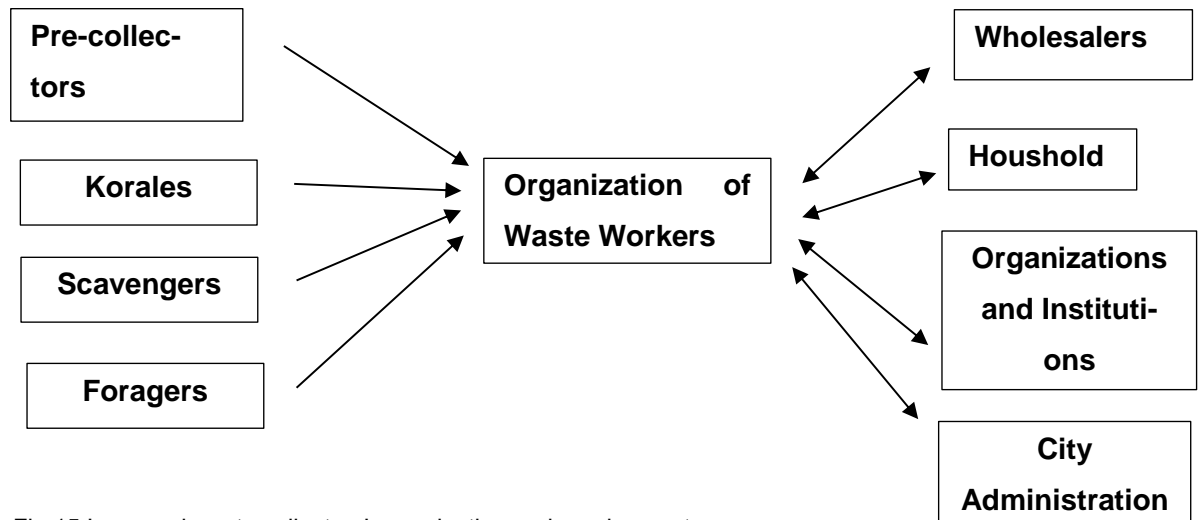


Fig.15 Improved waste collectors' organization and employment

Again on formalizing the informal, the government can invest to organize the small-crafts men in Mennaesh Tera to a proper company that will buy collected materials from the wholesalers and produce goods. The government can benefit from their indigenous skills and in return provide them with proper working conditions; the government can look into ways to develop their works with machineries and mass production. These goods can be sold at a shop preferably in Mennaesh tera since the location is already known among people as to where to buy goods made by these crafts men.

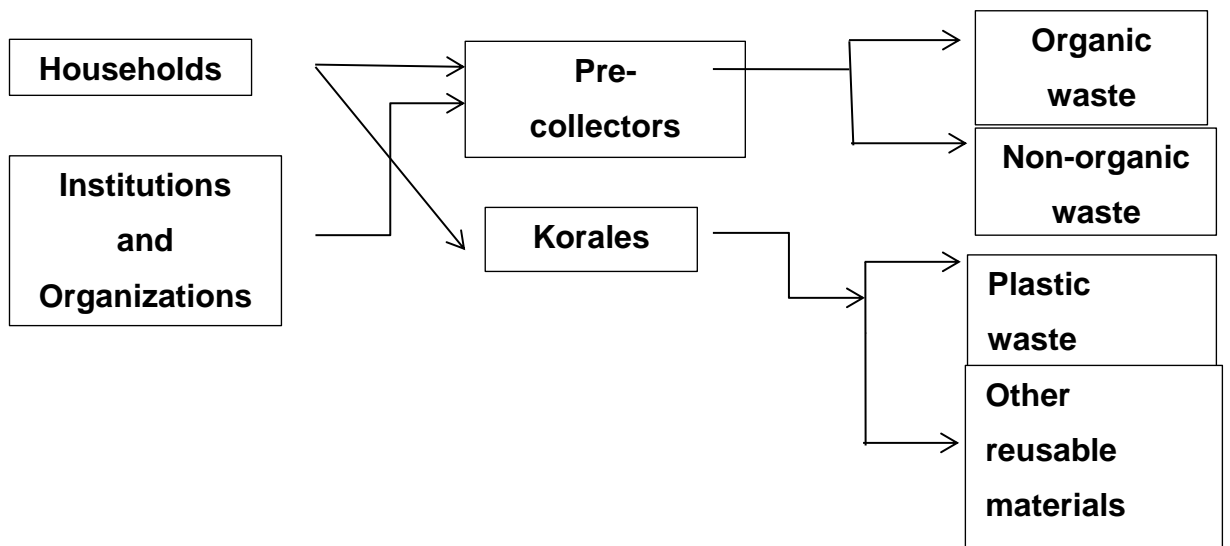
Lastly, the government should establish an organization for waste auditing and pollution monitoring. Both on the IGNIS project and on Camilla's dissertation papers, it was pointed out that unavailability of information about waste and pollution matters was one of the major problems they faced. In addition, to implement sustainable development, the government should keep track of its changes and make wise decisions for the future. Execution of improvements and projects should be based on up- to-date and reliable data. If changes are made based on such data and also with sound research, they will be sustained.

### 5.3 Disposal

There have been records that the government has purchased additional trucks and containers to improve the waste management situation in Addis Ababa. The outcome of this improvement is to increase the amount of waste collected. However, if there is no proper plan or improved method to dispose the collected waste; it is pointless to collect more waste. These investments on collection trucks and containers better are expended on building a proper landfill sites.

The waste management system in Addis Ababa should take an immediate leap to building a new landfill site from dumping waste in 'Repi'. Repi has been a dump site for the last fifty-three years. The dump site has no gas emission or leachate collection system. It is clear that it is doing massive amounts of damage to the environment. In addition, several residential areas have been established around it. This will put the health of many living in the area in danger. The second immediate step to improve the waste disposal segment of the process is to close and remediate the site. This can be done through consulting or in partnership with international companies who have the expertise.

Figure 16 shows the summary of the proposed solid waste management system for Addis Ababa.



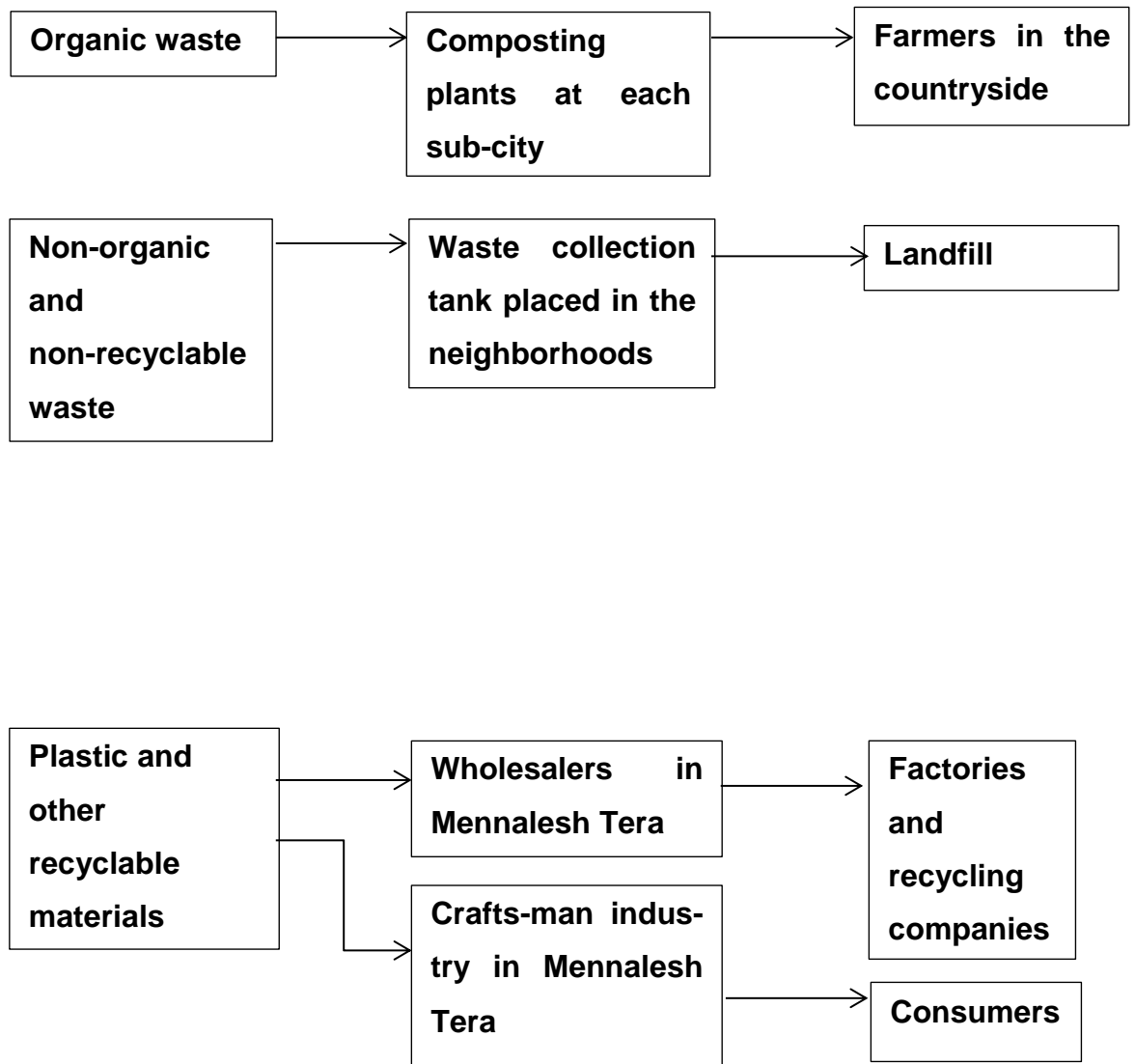


Fig 16. Improved waste management systems in Addis Ababa

## 6 Conclusion

All the above stated improvements can be applicable if the government and the people cooperate with each other. A co-operative relationship between the two is the key for development specially when dealing with a challenging task as solid waste management. As for the case for Addis Ababa, the primary problem in solid waste management is that the knowledge about the importance of the environment and the know-how on how to handle waste is missing. Therefore, the core work in improving the solid waste situation

in Addis Ababa would be to raise awareness about the environment and solid waste management through education. The government owes to invest on importing the needed education and aim to make this knowledge available to all civilians.

The government needs help in the solid waste management sector; it can be easily observed from the solid waste situation in the city. The government should create a strategy on how to work with private companies in all the waste management segments and should invite these companies to invest on reuse and recycling businesses by offering loans and rewards. Accordingly, in partnership with private companies the government needs to establish necessary organizations such as waste auditing and pollution monitoring organization, Waste and Environmental management centers at each sub-city, Waste worker's organization and an industry for the small scale crafts men working in the informal sector.

As pointed out by the few available research papers on solid waste management, the current dumpsite in Addis Ababa should be closed. However, prior to closing the dumpsite, a proper landfill needs to be built. If implemented with a well-aware and cooperative society under good governance, the above stated changes can yield significant improvements in the solid waste management system in Addis Ababa.

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