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Environmental Impacts of disposable PET plastic bottles: The case of Water Bottling Companies in Addis Ababa

A Research paper submitted to the department of management in the partial fulfillment of requirements for the degree of Executive Masters of Business Administration

By: TesfayeTemesgen

Advisor: Dr. Ethiopia Legesse

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Declaration

I, TesfayeTemesgen, declare that the thesis entitled "***Environmental Impacts of disposable PET plastic bottles: The case Water Bottling Companies in Addis Ababa"*** hereby submitted to Addis Ababa University for the partial fulfillment of the requirements for the Degree of Executive Master of Business Administration in Management is my original work and not submitted earlier for any degree either at this or any other University and all source of material used herein has been duly acknowledged.

Name: **Tesfaye Temesgen** *Advisor Name:* **Dr. Ethiopia Legesse**

*Signature:*_____ *Signature:* _____

Date: _____ *Date:* _____

Statement of Certification

This is to certify that the thesis prepared by TesfayeTemesgen entitled: "***Environmental Impacts of disposable PET plastic bottles: The case of Water Bottling Companies in Addis Ababa"*** and submitted in partial fulfillment of the requirements for the degree of Executive Master of Business Administration in Management compiles with the regulations of the university and meets the accepted standards with respect to originality and quality.

Approved by:

Internal Examiner: _____ Signature _____Date_____

External Examiner:_____ Signature _____Date_____

Advisor: Dr. Ethiopia Legesse Signature _____Date_____

Chair of Department or Graduate Program Coordinator

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Table of Contents

Page

List of Figures

Page

List of Tables

Page

Acronyms

AAEPGDC	Addis Ababa Environment Protection and Green Development Commission
AASWAA	Addis Ababa Solid Waste Administration Agency
BT	Benefit Transfer
CBA	Cost-Benefit Analysis
DRF	Dose-Response Function
ECA	Ethiopia Conformity Assessment
EEPA	Ethiopia Environmental Protection Authority
EFBI	Ethiopia Food and Beverage Institute
EPR	Extended Producer Responsibility
GWP	Global Warming Potential
HPM	Hedonic Pricing Method
IPA	Impact Pathway Analysis
ISO	International Organization for Standardization
LCA	Life-Cycle Assessment
LCC	Life-Cycle Costing
MoFED	Ministry of Finance and Economy Development
PET	Polyethylene Terephthalates
PPW	Packaging and Packaging Waste
RPM	Revealed Preferences Methods
SPM	Stated Preferences Methods
SWRDPO	Solid Waste Recycling Development Program Organization
WCED	The World Commission on Environment and Development
WTP	Willingness to Pay

Abstract

The future of humankind on this planet depends on the sustainability of a complex system involving three interdependent, highly fragile subsystems – the natural environment, the social/political system and the global economy (Sadler, 2003). In most developed and developing countries with increasing population, prosperity and urbanization, one of the major challenges for municipalities is to collect, recycle, treat and dispose of increasing quantities of solid waste and wastewater (Coelho, 2011). ***Hence,*** *the objective of this research proposal entitled as "Environmental impacts of disposable PET plastic bottles: The case of Water bottling companies in Addis Ababa" is to identify the estimated quantity of disposable plastic bottles, their respective treatment methods and estimate value for the environmental impacts of these wastes for Addis Ababa. The valuated impacts are evaluated using benefit transfer methods from other countries study. The study employed a cross-sectional in depth interview in which identical self-administered guiding questionnaires were used for six higher officials and experts in the focus area of the study. The study uses case type, mixed method and purposive sampling for this particular exploratory type research. The quantitative findings shows that the net valuated environmental impact of recycling benefit for the year 2018 was 23.98 USD per ton whereas incineration and land fill costs 14.36 and 19.93 USD per ton respectively. The total disposable pet bottles for the city show that net environmental benefit of* 224,673.74 *USD or* 7,303,719.43 birr *was gained for the cumulative impacts of 69.4% recycled and 30.6% landfilled waste treatment practice of the city respectively. Whereas, the qualitative findings of the study show that the solid waste proclamation lacks proper enactment and strict implementation of recycling laws that specifically target PET bottles. In addition, the country's recycling process of disposable bottles for export market is limited to PET flake as a product. So, the study proposes respective solutions for the above stated gaps. And finally, the research concludes its recommendation by giving directions to do further researches on disposable plastic bottles of the country as a whole.*

Keywords: Plastic, PET bottles, Environmental impact, bottling company.

1. INTRODUCTION

1.1. Background of the study

The production of plastic materials started to flourish on an industrial scale in the 1940s and 1950s. Recently exhibited in the last 15 years back from 2013, the global annual production of plastics has doubled, and reaching approximately 299 million tons in 2013. (Hahladakisa , 2018)**.**It is projected that if the world consumptions for plastic continues with same patterns as today's , 12,000Mt of plastic waste will be expected to be discarded in landfills or the natural environment by 2050, which is more than double the estimated 5,800Mt of plastic waste ever generated from primary plastics up to 2015(Dunmade, 2017).

In fact, Plastic products play a major role in our modern society due to their many useful attributes such as durability, light-weight, flexibility, electrical and thermal insulation, water and air impermeability and low costs (Kouloumpis, 2018)**.**The majority of us consumes drinks in plastic bottles and also uses plastic bottles in every day household goods, such as bleach, shampoo, conditioner, bathroom cleaners and hand soap dispenser bottles (Bhunjun, 2018). Plastic packaging is widely used everywhere in the world. One of the most common plastic used for packaging is polyethylene terephthalate abbreviated PET. This plastic is strong and durable, chemically and thermally stable. It has low gas permeability and is easily processed and handled. This almost unique combination of properties makes PET a very desirable material for a wide range of applications including food and beverage packaging; especially water bottles at a very cost effective price (Caroline , 2017)**.**

In this day and age, bottling water is one of the most common ways of making potable water available for people on a journey, at various ceremonies and work sites. It is often used on occasions such as wedding ceremony, birthday celebration, burial ceremony, and many other situations when large numbers of people are gathered for entertainment. Bottled water offers good taste, good quality and convenience. Though the bottled water consumption rate varies from one region to another, the global average bottled water consumption per person is about 50L/yr. and in 2014, the global bottled water market volume was about 290 billion liters and the market value was about USD170 billion. The market value is expected to reach USD 280 billion in 2020 (Dunmade, 2017)**.** And

according to Forbes sited from Sandra (2017), estimated that more than 480 billion plastic drinking bottles were sold in 2016 across the globe, which increased exponentially from around 300 billion bottles a decade ago. It is estimated that over half a trillion plastic bottles will be sold in 2020. By 2021 the figure will also become a staple in modern day society with a million plastic bottles bought around the world every minute – and the number promises to jump another 20%.

With reference to the higher figure of PET bottles, the changing human culture replaced glass bottles by plastic bottles and thereby, plastic bottles become one of the most disposable materials in the modern world (Caroline, 2017)**.**This increasing trend of plastic demand for bottled water shows continued growth following the living standards of the population around the world. However, the waste management becomes a problem for all. In the developed countries, this issue has reached a crisis situation; it is affecting the ecosystems of the individual countries and the global community as whole. The waste is just as serious problem in the big cities of the developing countries, and is intricately interwoven with the problems of hygiene and public health (Harris, 2018)**.** Studies on waste management explains that disposal of non-bio-degradable substance is a major challenge for the present era as it makes up much of the street side litter in urban and rural areas. It is rapidly filling up landfills and choking water bodies. Plastic bottles make up approximately 11% of the content landfills, causing serious environmental consequences. Plastic bottle, an urban junk, has many sustainability characteristics. Plastics are produced from the oil that is considered as a nonrenewable resource. Plastic, an environmental pollutant, has an insolubility of about 300 years in the nature and so it is considered as a sustainable waste (Caroline, 2017)**.**

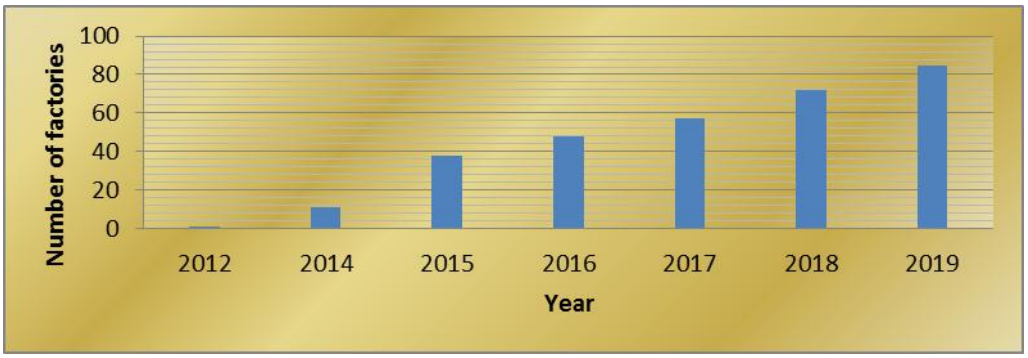
Despite the higher consumptions and usage rate of bottled water, globally, the PET used in beverage bottles has a higher recycling rate than any other type of plastic, "but unexpectedly, almost 50% of these containers are not collected for recycling and only 7% is recycled in a closed loop of bottle-to-bottle"; this represents a great opportunity. What's more, the same study shows that "72% of plastic packaging is not recovered at all". Forty per cent goes to landfill, most often in deplorable conditions of pollution, health and environmental care; and 32% leaks out of the collection system and mostly goes to illegal dumping and/or mismanaged actions. Finally, 14% of the plastic is sent to an incineration or energy recovering process (Mayenberger, 2019)**.**In support of this fact sited from Nace

(2017), the National geographic studies show 91% of all plastic is not recycled**.** Therefore, it is necessary to develop an integrated waste management system at global as well as a regional perspective including technological, social, economic and political factors (Harris, 2018).

To challenge this problem, Gopalakrishna (2019) stated that**,** several rules and regulations have been enacted in many developed countries. Unfortunately, regulations on recycling and reuse of PET are not prevalent in many countries even today. Although Germany was one of the leading countries in terms of recycling PET, developing countries such as India are recently reporting recycling rates as high as 90%. South Africa has also shown a rapid increase in the rate of recycling PET bottles which reached to 58 % in 2017. Part of this increase in recycling rates is due to the enactment and strict implementation of recycling laws that specifically target PET bottles. In addition, major beverage companies such as Coca-Cola and Evian have pledged to use at least 50% of bottles from recycled PET. Recent reports suggest that Evian has pledged to use 100% recycled PET bottles.

Regarding the issues of PET water bottles in Ethiopia, the introduction of plastic bottled water to the country began through the Highland Springs brand by Apex Bottling Company in 1999, and now, the sector has seen tremendous growth (Mekonen, 2013).According to the information obtained from Ethiopia conformity Assessment Agency certification office, the following fig1 clearly shows the growth trend of licensed water companies in Ethiopia.

Fig1. Trend of licensed water companies in Ethiopia (Source: ECA certification office)



During 2016, there were 63 bottled water producing plants (Assessment, 2017) and as per information from ECA 15 companies were unlicensed. And in the year 2018, the number of bottling companies reached to 72 and within a year period (2019) these figure has

arrived at 85.In effect, this number amplifies the volume of plastic bottled water and disposal of the same at increasing rate. Though it is difficult to get actual data for the waste recycling rate of disposable PET bottles, the estimated recycling solid waste management experience of Addis Ababa is below the world average figure of 91% for study shows that 95% of Addis Ababa recyclable wastes are not collected for recycles (SWRDPO, 2012).

1.2. **Statement of the problem**

The future of humankind on this planet depends on the sustainability of a complex system involving three interdependent, highly fragile subsystems – the natural environment, the social/political system and the global economy. It is axiomatic that a catastrophic event in any one of these would result in severe consequences for the others (Sadler, 2003)**.** And environmental consideration is no longer regarded as a trend but a way of life for industry. For many companies over the past few decades, there has been a shift in addressing environmental issues. Actions that were taken at the operational level due to regulative demands are now being discussed at the strategic level. The idea of sustainability must consider the interplay of social, economic and environmental aspects with integrated and long-term perspectives. In most developed and developing countries with increasing population, prosperity and urbanization, one of the major challenges for municipalities is to collect, recycle, treat and dispose of increasing quantities of solid waste and wastewater(Coelho, 2011)**.** A cornerstone of sustainable development is the establishment of affordable, effective and truly sustainable waste management. For all these reasons, there is an increasing interest in the several options for management of resources and waste in order to design strategies for integrated, sustainable resource and waste management policies (Cherubini, 2009)**.**

Nowadays, the recycling of PET bottles is a common environmentally friendly procedure, and is used to reduce plastic waste and to reprocess plastics for other applications. PET bottle to bottle recycling processes have been established worldwide due to their huge potential (Bach, 2012). On the other hand, Solid waste management in developing countries is threatened by several negative externalities, the society's poor sustainable culture, the deficient infrastructures, the informal economy where the scavengers operate, their low levels of human development, non-operable or lack of public policies, the astronomical volume of residues generated and unmanaged by the public services, the

huge loss of value by burying the residues in landfills and the inability to contain the leakage to natural ecosystems, contaminating soil and water(Mayenberger, 2019).

These facts can be common reasons for Ethiopia as it is among the least developing country in the world and according to SWRDPO (2012), the recycling data that shows the 5% collection experience of solid wastes for the capital city clears that the waste management practice of the country is not different from the developing countries' experience. In addition, the growing trend of the country's PET bottle water business if it is not managed properly, will affect the environment in both waste volume and value of these disposable at the rate greater than ever.

Though managing of these wastes in its proper treatment alternatives has an opportunity for sustainability of plastic packaging business in general and bottled water business in particular, convincing governmental authorities for their non-operable or lack of public policies is not an easy task. Because, as per Kaggwa (2014),environmental impacts are hardly appreciated by policy and decision makers unless supported by a strong economic case and economic analysis therefore puts environmental impacts in an economic perspective and helps to influence policy and decision making. So far, it is difficult to get economically valuated environmental impacts of packaging wastes of the country. For this reason, this study reveals case type research of Economical Valuated environmental impacts of packaging waste specific to disposable PET water bottles in Addis Ababa.

1.3. Research questions

The study basically aims to answer the following major research questions.

1. What volumes of disposable PET plastic bottles are rejected in Addis Ababa?
2. How much is the valuated environmental impacts of each treatment options for packaging wastes in general and disposable plastic bottles in particular?
3. What are the main problems of existing environmental policy and regulatory frameworks of the country that challenges for the management of disposable PET wastes?
4. What strategic alternatives are proposed to alleviate the problems regarding to management of disposable PET bottles?

1.4. Objectives of the study

1.4.1. General Objective

The main objective of the study is to model economically valuated environmental impacts of plastic packaging wastes in monetary terms for different treatment options of the country in general and Addis Ababa in particular.

1.4.2. Specific Objectives

Moreover, the following are specific objectives of the study:

1. To quantify the estimated amount of disposable PET water bottles in Addis Ababa,
2. To estimate the percentage figure and per unit valuated impact of each treatment options for the same waste.
3. To model and calculate the total environmental valuated impacts of disposable bottles for actual data and alternative waste treatment scenarios.
4. Based on the findings of the study, conclusion and recommendation is proposed.

1.5. Scope and Limitation of the study

The study is conduct for economically valuated environmental impacts of plastic packaging waste specific to disposable PET bottles from Water Companies in Addis Ababa. The valuation model is developed based on BT (Benefit Transfer) techniques and Cost Benefit Analysis (CBA) methodology from landfill, incineration and recycles waste treatment options of other countries study.

1.6. Significance of the study

This economic valuation of environmental impacts has become increasingly important in the evaluation of investment projects, government measures and policies and international trade (Marques, 2013). At the forefront, the findings and suggestions of this research will benefit Environmental Protection Authority (EEPA), Addis Ababa Environment Protection and Green Development Commission (AAEPGDC), Addis Ababa Solid Waste Administration Agency (AASWAA), Ministry of Finance and Economy Development (MoFED), Solid waste collector associations of the city, water bottling companies and Packaging industries. In addition, findings from this research paper can help as supporting document during the preparation of plastic packaging waste related policies and operational strategies,. Moreover:

1. It is, believed that this research paper can be used as a source document for those who want to make further study on the area of environmental impact evaluation approaches for municipal solid waste treatment options.
2. This research identifies the estimated quantity of disposable PET water bottles in Addis Ababa. And also, it estimates the environmental impacts of these wastes based on alternative waste treatment approaches for selecting of the safest treatment option.
3. Lastly, the remedies are proposed for sustainable development opportunities of water business and related stakeholder accordingly.

1.7. Organization of the study

The study is organized in five chapters. The first chapter covers the introduction part of the paper and in this chapter background of the study, statement of the problem, objectives, significance, scope and limitation of the study are described in detail. The second chapter deals with literature reviews based on theoretical, imperial and conceptual framework. The third chapter discusses the research methodology of the study. Data analysis and interpretation part of the research is presented in chapter four. And finally, Conclusion and recommendation part of the research has presented in chapter five.

2. LITRATURE REVIEW

Literature review provides a framework for establishing the importance of the study as well as benchmark for comparing the result with other findings. Therefore, the theoretical review part of this chapter discusses major concepts of sustainable development, ethics, environmental friendly design and legal framework of a particular product. Under empirical review part related studies of previous work from articles, journals and other sources are assessed and presented and finally, conceptual frame work of the thesis is included.

2.1. Theoretical Review

2.1.1. Sustainable Development

During the 1960s and 1970s the environmental impacts of various development processes were increasingly recognized by a range of groups. In 1983 the United Nations set up an independent organization called The World Commission on Environment and Development (WCED). The aim of the WCED was to examine the problems of environment and development facing the world and to consider possible solutions. These solutions should be considered not just for current generations, but with an awareness of long-term issues (Willis, 2005).

Of course, the future of humankind on this planet depends on the sustainability of a complex system involving three interdependent, highly fragile subsystems – the natural environment, the social/political system and the global economy. It is axiomatic that a catastrophic event in any one of these would result in severe consequences for the others(Sadler, 2003).And, the notion of "sustainable development" linked ideas of equity between generations, the balance between economic and environmental needs to conserve nonrenewable resources, and the idea of reducing industrialization's waste and pollution(Peet, 2009).

Sustainability reflects the need for careful balance between economic growth and environmental preservation (Torado, 2011). Development on the other hand refers thought of an increase in well-being across the members of a society between two points in time. Welfare is formally defined as the benefit an individual derives from consuming goods and services over time. It is equal to the discounted present value of future utility. If consumption is measured for all members of a society, then this discounted present value is termed social welfare(UNECE, 2009).

According to the WCED, 'sustainable **development**' is: 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs and in the same manner. Similarly Torado (2011) defines **Sustainable development as** a pattern of development that permits future generations to live at least as well as the current generation, generally requiring at least a minimum environmental protection. And Sadler (2003) relates sustainable development and environmental issues that over the past decade, the need to pursue ''sustainable development'' has been at the center of discussion of environmental issues and economic development. According to Worldbank (2006) having committed themselves to achieving sustainable development, governments face a number of challenges beyond the traditional concerns of their natural resources and environmental agencies. One of the most important of these is integrating economic policies with policies for the management of natural resources and the environment.

The issue of development and environment gets high concern by The United Nation (UN) and it is included among the Eight UN Millennium Development Goals and 18 Time-Bound Targets called Goal 7(Ensure environmental sustainability) and Target 9 (Integrate the principles of sustainable development into country policies and programs; reverse the loss of environmental resources)(Peet, 2009).

To incorporate the issues of ethics and environmental friendly design of any product in its entire product life cycle phases of design, operation and final destruction, operation management book Heizer (2007) points the goals for developing safe and more environmentally sound product as follows:-

1) Minimizing waste of raw materials and energy
2) Reduce environmental liabilities
3) Increasing cost effectiveness of complying with environmental regulations
4) Being recognized as a good corporate citizen

And base on these goals**,** the six guide lines that may help operation managers achieve ethical and environmentally friendly design are make product recyclable, use recycled materials, use less harmful ingredients, use lighter components, use less energy and use less materials.

2.1.2. Environmental Impact Evaluation models

Globally, since the 1950s and 1960s, environmental economic analysis has contributed to a better understanding of the causes of environmental problems and alternative ways of addressing them using the analytical tools developed by economists. The goal of environmental economic analysis is to balance the economic activity and the environmental impacts by taking into account and evaluating all the associated project costs and benefits. Environmental economic analysis tools facilitate judgment on the magnitude of harm or loss, ascertaining severity of consequences in human terms based on people's values and preferences. Environmental impacts are hardly appreciated by policy and decision makers unless supported by a strong economic case. Economic analysis provides tools for the assessment of environmental impacts and puts them in a language better understood by decision makers. It is then that their implications on the realization of economic goals are understood and the necessary interventions can be made. Economic analysis therefore puts environmental impacts in an economic perspective and helps to influence policy and decision making (Kaggwa, 2014).

2.1.2.1. Purpose of undertaking economic analysis of environmental impacts

According to Kaggwa (2014), undertaking environmental economic analyses (EEA) provides the following benefits in analysis of environmental impacts and subsequent decision framework, and should start in the earliest stages of environmental impact analysis:

- It improves the analytical process by incorporating the costs and benefits to the environment in addition to other project costs and benefits. By so doing, it helps in making more informed decisions based on a wider analytical base. Environmental costs of economic activities (e.g. costs of pollution) can be detected and information about them provided. Because cost-benefit analysis (CBA) is a fundamental tool and provides decision-makers with objective economic information at all levels, ensuring that CBA has full information is an important step.
- EEA provides the basis for fully internalizing the costs of production and consumption of natural resources and therefore advocates that those that pollute and degrade the environment should be made to pay directly for those costs. We thus have the Polluter Pays Principle (PPP) and the User Pays Principle (UPP) as provided for under the National Environment Act. These inform policy on the imposition of environmental tax, fees and charges on activities that pollute the environment.

- Where feasible, EEA places monetary values on environmental goods and services as a reminder that environmental resources are not free. Values show the growing scarcity of environmental goods and services and the need to moderate their use.
- EEA can improve project design, increase efficiency in the use of resources, minimize adverse impacts, and enhance positive impacts. It provides tools for the analysis of alternatives and the costs and benefits associated with each of them.
- EEA is critical in establishing national priorities and resource management policies. It identifies environmental problems that are severe and requiring urgent attention, as well as the most effective and economically efficient interventions.

2.1.2.2. Environment Valuation Instruments

The environmental valuation emerges as an instrument for measuring the environmental goods and services and the impacts of environmental degradation, in order to obtain direct and indirect costs and benefits resulting from the qualitative and quantitative changes of these goods and services. The economic calculation of environmental goods has become increasingly important in the evaluation of investment projects, government measures and policies and international trade (Matos, 2010) sited from (Marques, 2013).

Regarding municipal solid waste (MSW) management, several studies have been developed to assist policy-makers in the definition and adaptation of the best management strategies for combining the three dimensions of sustainable development - Economy, Environment and Society. In this sense, several methods are used, such as life cycle analysis (LCA), environmental and financial life cycle costing (LCC) and cost-benefit analysis (CBA).

a) **LCA** is commonly used to quantify the environmental impacts of different options for waste collection and treatment, constituting one of the fundamental steps for further environmental valuation (assigning monetary value). The analysis of the life cycle of a given product or service is not an easy task since it involves a lot of information and several assumptions must be considered. However, some databases have been developed regarding the quantification of emissions arising from management operations. Furthermore, different methods and models can be used in order to facilitate the LCA.

b) **LCC** combines a financial cost-benefit analysis (financial LCC) with the economic valuation of environmental impacts (environmental LCC) quantified by LCA. The financial costs and benefits are known as internalities. The most common negative

internalities considered in the analyzed studies are the operational and maintenance costs of the treatment facilities as well as the transportation costs. The positive internalities include gate fees and sales of electricity and materials recovered. From a financial perspective, waste collection proved to be a stage with significant impact in the management system.

The environmental impacts are known as externalities and do not have market value. Concerning waste management, the externalities commonly analyzed are the greenhouse gas emissions, other air, water and soil emissions, resources depletion, energy and materials recovery and disamenities.

c) Cost-Benefit Analysis (CBA)

CBA is an established methodology used in the field of welfare economics to estimate and compare the costs and benefits of alternative policies and scenarios (Nepal, 2010) as sited from (Marques, 2013). According to RDC and PIRA (2003) as sited from Marques (2013), a CBA is an economic evaluation tool used to compare the costs and the benefits of several activities. Moreover, CBA is used to determine the total costs and the benefits of a policy option. In the social welfare perspective, the total benefits should overcome the total costs. These costs and benefits must be considered across the whole life cycle of the system affected by the policy decision. The environmental impacts are usually considered as externalities. The externalities are benefits or costs incurred to third party that are not involved directly in the activity that cause the cost or benefit. And it can be noise or river pollution (costs) or the improving of a landscape (benefits). These costs and benefits are not easily translated into an economic value i.e. there is no market price. Besides the benefits to the environment, an environmental policy decision will also incur implementation costs. The internal costs of implementation of a policy or project are known as internalities, as they are internal to the traditional economic model. In order to evaluate the internal and external costs a common unit should be used, i.e., the externalities must be measured in a monetary value. Through LCA, for each option, is determined the environmental, social and economic impacts. The monetary valuation of the impacts is achieved when performing the CBA (Marques, 2013).

2.1.2.3. Economic valuation techniques for externalities

According to Marques (2013), regarding waste management operations, the externalities are the costs and benefits related to the environmental and social impacts resulting from those operations (and which are difficult to quantify in monetary terms). The impact categories commonly valuated in monetary terms are Greenhouse gases emissions, Air, water and soil pollution, Resources depletion, Energy and material recovery, Disamenities (e.g. visual effects, noise, odor, traffic, etc.) and employment. Apart from energy and material recovery, externalities usually represent an external cost since they are related to a loss of human welfare. The energy and material recovery are external benefits because the recovered energy allows replacing electricity or heat produced from conventional sources and the recovered materials replace the primary raw materials. As per Walker (2004) sited from Marques (2013), generally, employment is a positive social impact from the implementation of waste management strategies Moreover, most of those impact categories are dependent on the quantities of waste treated and, thus, they are referred to as variable externalities. And EC (2000) sited from Marques (2013) said the disamenities are considered fixed externalities, since they do not have a direct relation to the quantities of waste treated or disposed

Table 1: Environmental Externalities grouped based on two dimensions

Descriptions	**Variable externality**	**Fixed externality**
External costs (negative impact)	Costs of emissions to air, soil and water Costs of resource depletion	Disamenity costs
External benefits (positive impact)	Avoided costs with the electricity production from an alternative energy (waste to energy - WTE).	--------

According to Eshet (2007) sited from Marques (2013), externality values in monetary terms have been estimated based on various concepts, which often measure the value that "people ascribe to their preferences concerning the non-market environmental-attributes". These preferences can be measured through direct (stated/expressed preferences) and indirect (revealed preferences) methods. However, other methods attribute approximated values to pollution based on costs of measures to minimize impacts (e.g., implementation of regulatory,

remediation, repair and rehabilitation measures), which are estimated by experts. On the other hand, the dose-response functions (DRF) set a relationship between the pollution category and its impact and correspond to the most important step of another environmental valuation methodology, Impact Pathway Analysis (IPA). Since this type of studies are complex and expensive, using existing valuations by adjusting the estimated values through the benefit transfer (BT) method, has been common practice among researchers and policy makers. The following Fig. 2 illustrates the various methods usually applied in the monetary valuation of the externalities.

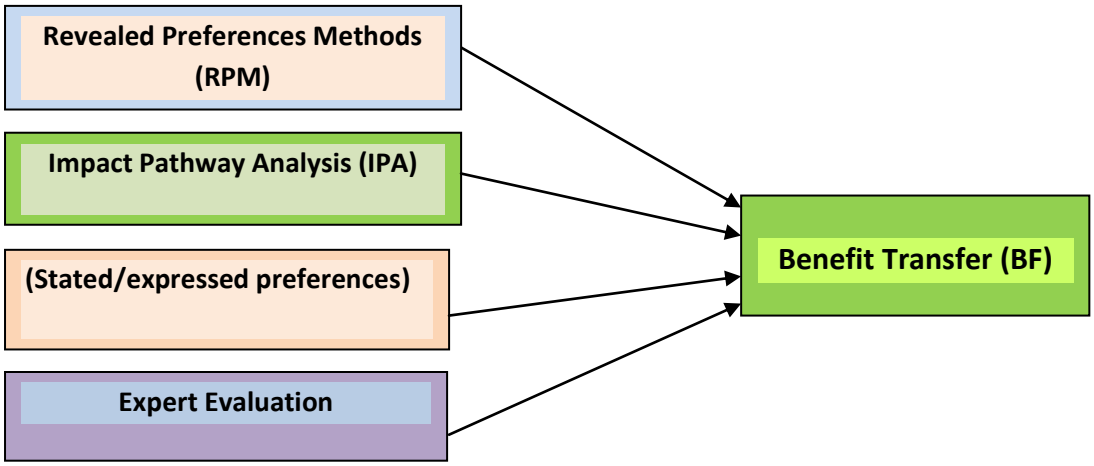


Fig 2: Methodologies for the Environmental Valuation

a) **Revealed Preferences Methods (RPM)**

The RPM are indirect techniques to assign monetary value to the environmental impacts. The externalities' values are estimated indirectly through the purchase of the marketed goods or services which should reduce or avoid the related environmental negative impact.

b) **Stated Preferences Methods (SPM)**

The SPM are direct techniques for estimating the monetary values of externalities. This kind of methods provides an evaluation of the preferences of each individual for a given welfare level resulting from the different goods or services through questionnaires conducted directly to the people.

C) **Impact Pathway Analysis (IPA)**

The IPA is the most used methodology for calculating the damage costs resulting from a pollutant emission. It does not evaluate the preferences of general public regarding environmental issues. Concerning the valuation of emissions from waste treatment facilities through this methodology, Rabl (2008) sited from Marques (2013), identified four main steps:

1) Identification of the relevant technologies and the pollutants emitted per tonnes of waste;
2) Calculation of increase of pollutants' concentration in affected areas through dispersion models and chemical reactions;
3) Computation of the dose from the increased concentration and all impacts arising from exposure (of people, animals, plants, buildings) to that dose, using dose-response functions (DRF);
4) Monetary valuation of those impacts, multiplying by the damage cost. The damage cost includes all costs related to market and non-market attributes. The costs of market attributes are mainly associated with the treatment costs (e.g., by disease, for remodeling or reconstructing buildings or for water cleaning). The costs of non-market attributes are determined from the estimation of WTP to prevent damage. This WTP is, usually, assessed using the CVM (as mentioned above).

c) **Benefit Transfer (BT) Method**

The BT method implies an economic value transfer of a public (non-market) good from a study site (where the primary valuation was made) to another, usually called policy site, where the new valuation is being done (Mavsar, 2004) as sited from (Marques, 2013). Researchers have made extensive use of this method since carrying out new primary studies consumes much time and money.

In the primary studies, the monetary valuation is often conducted using the methods mentioned above for estimating the people preferences (i.e. the WTP for a benefit or an avoided cost) or damage costs. In this regard, the value transfer can be conducted by three main approaches.

- Unit value transfer;
- Benefit function transfer;
- Meta-analysis function transfer.

The first approach is the most used for point estimates of value (Zhao and Wang, 2010), being relatively easy when the (study and policy) sites have similar characteristics and are located in the same country. For instance, in this case, the WTP for a public good at the policy site is calculated, multiplying its population density by the average WTP estimated in study site. Otherwise, some factors should be considered such as the differences between geographical, cultural, socioeconomic and political conditions of each site, which raises questions on the validity of the approach (Eshet et al, 2007a) sited from (Marques, 2013). As the income is an important factor that affects the WTP, the base values (estimated in the primary valuations) can be adjusted using the incomes' differences (mainly for transfers between countries). Therefore, according to Mavsar (2004) as sited from Marques (2013) the adjusted value at the policy (Vp) site can be estimated by the following formula

$$\mathbf{Vp = Vs \times (Yp / Ys)^{\beta}}$$

Where: Vs is the primary value estimate from study site, Yp and Ys are income levels at the policy and study sites, respectively; β is the income elasticity of WTP for environmental good. And according to (Edward B. Barbier, 2017), the income elasticity of the WTP for environmental improvement is unlikely to be constant and taking 0.1-0.2 for low income and reaching values of 0.6-0.7 for highest income levels is acceptable.

The second approach predicts the WTP at the policy site, transferring the benefit function of one (or few) similar study site, i.e., combining the coefficients estimated at the study site (βs) with the main characteristics (which influence the WTP) of the policy site (Yp), following an econometric model. The choice of model can lead to transferability problems, as suggested by Leon-Gonzalez and Scarpa (2007). The validity of this approach requires the acceptance of a null hypothesis, where there are no differences between the result of original study and the estimated benefit transferred (Kristofersson and Navrud, 2005). A short sample is another limitation, leading to errors of transferability. In fact, the benefit function approach is often preferred to the value transfer, since more information can be transferred. However, the errors related to this one can also be more significant (Brouwer and Spaninks, 1999). Hence, Leon-Gonzalez and Scarpa (2007) have proposed the use of a Bayesian Averaging Algorithm that selects subsets of the study sites selected in which the assumptions of equality are valid.

Meta-analysis function transfer is "a methodology for summarizing results of existing studies by estimating statistical relationships between values reported in studies to explanatory variables capturing heterogeneity within and across studies", as defined by Bergstrom and Taylor (2006). On the one hand, the original estimates (carried out in the study site) of WTP are considered (in this methodology) as dependent variables in a regression model. On the other hand, the characteristics of the policy site, the valuation method and the socioeconomic features of the study site are included as independent (explanatory) variables in the model (Zhao and Wang, 2010). This approach providing more rigorous measures, since information from a great number of study sites is used. Nevertheless, the most disadvantage of meta-analysis approach is, mainly, related to the great errors and potential bias, which can result from combining studies. Therefore, some authors defend the exclusion of primary studies using different environmental valuation methods in meta-analysis model (Walton et al., 2003).

2.1.2.4. Monetary Estimates of the Externalities

According to Marques (2013), many studies have been carried out their environmental valuations based on international databases and/or considering specific studies with similar characteristics and objectives, using the BT method, in order to estimate (monetarily) the value of externalities. and extensive studies in many research works regarding environmental valuation of waste management strategies were considered. Concerning the landfill and incineration facilities, the most reviewed studies in literature have been estimated the following externalities:

- Greenhouse emissions;
- Other emissions to air;
- Emissions to water (leachate);
- Disamenities;
- Energy and material recovery.

According to Dijkgraaf and Vollebergh (2003) sited from Marques (2013) estimated all these external costs and benefits, comparing the two options (landfill and incineration) in the Netherlands. The authors used an extensive study about both waste disposal options as a basis for comparison. The latter provided the environmental impacts quantification, considering all emissions from landfill, incineration, and energy and materials production. Then, the costs of these environmental impacts were estimated applying the IPA.

Table 2: Comparative external costs and benefits among various waste treatment options (Netherlands)

Impact category		**Landfilling (€/ton)**	**Incineration (€/ton)**
Environmental costs:	Emissions to air	5,85	17,26
	Emissions to water	0,00	0,00
	Chemical waste	2,63	28,69
	Land use	17,88	0,00
Environmental savings:	Energy function	4,76	22,62
	Materials function	0,00	5,76

Source: adapted from Dijkgraaf and Vollebergh (2003)

Nahman (2011) as sited from Marques (2013) estimated the emissions and disamenity costs of landfilling in the City of Cape Town, in South Africa considering three different scenarios: (1) existing landfills without energy recovery located in urban areas; (2) existing landfills with energy recovery located in urban areas; and (3) a new regional landfill with energy recovery. The values estimated are depicted in following table below.

Table 3 – Comparative external costs and benefits among various waste treatment options (South Africa)

Alternatives	**Greenhouse emissions**	**Other air emissions**	**Leachate**	**Disamenities**
Scenario1-Existing urban landfills without energy recovery	2,56	0,04	0,009	5,17
Scenario2-Existing urban landfills with energy recovery	0	0,06	0,009	3,62
Scenario3-New regional landfill with energy recovery	0	0,005	0,009	0

(Values based on the current currency conversion 1 South Africa rand = 0,09 euros)

Source: adapted from Nahman (2011)

From an integrated waste management perspective, Jamasb and Nepal (2010) as sited from Marques (2013) evaluated the environmental aspects related to the different waste management options in the UK, as mentioned before. The authors considered two scenarios: the first scenario (*business-as-usual, BAU*), based on the waste management policies for the year 2005/2006, was compared with a second one, which looks at the UK legislation following the implementation of the EU Directives. External costs encompassing the environmental damage from transportation and waste treatment (including composting and recycling) were estimated and compared, as shown in Table 4

Table 4 – Comparative external costs and benefits among various waste treatment options (UK)

Facilities	**€/tonne of waste**
Incineration E (with electricity recovery only)	Damage from emissions to the air (mainly NOx and SO2) = €50 CO2 = €2,55 (low) - €12,03 (high) ,Disamenity impacts = €8 Total = €60,55 - €69,67
Incineration E&H (with heat and electricity recovery)	Damage from emissions to the air (mainly NOx and SO2) = €28,18 , CO2 = €2,55 (low) - €12,03 (high) Disamenity impacts = €8 Total = €38,73- €48,21
Landfill A (without any form of energy recovery)	Global warming (mainly consist of CH4) = €8 CO2 = €2,13 (low) - €10,04 (high) , Damage from leachate = €1,5, Disamenity impacts = €10 Total = €21,63- €29,54
Landfill B (with energy recovery)	Global warming (mainly consist of CH4) = €5 CO2 = €1,27 (low) - €6,01 (high), Disamenity impacts = €10 Total = €16,27- €21,01
Recycling	CO2 = €0,31 - €1,49 , Pollution from transportation = €0,16 Total = €0,47- €2,65

In fact, among the three treatment options, recycling is the most appropriate treatment option in an environmental standpoint. Beyond the lower external costs, this strategy adds

benefits such as primary raw materials savings through the partial or total substitution by recycled materials and the generation of direct employment.

EcoRecycle Victoria (2003) compared the external costs and benefits of several waste management options, considering extreme scenarios; high scenario encompassed the most optimistic estimates for environmental valuation data, in opposition to the low scenario. The monetary values of resource savings were estimated, using two databases, namely NPCC (2000) and RMIT (2003).Considering a standard recycling, the resource savings were evaluated on 40,5 € ($50) per tonne of waste recycled, considering the high scenario. Under low scenario, these external benefits were calculated in 24.3 € ($30) per tonne of waste recycled.

Concerning the employment, many authors ignore this externality because, in theory, it is considered that any unemployment is the result of a transitional period between one job and another, so it does not generate social benefit or cost. However, some European countries have been faced with a significant rate of unemployment due to a medium-long term lack of employment opportunities. In these cases, the benefits and costs of employment should be considered (RDC and PIRA, 2003).

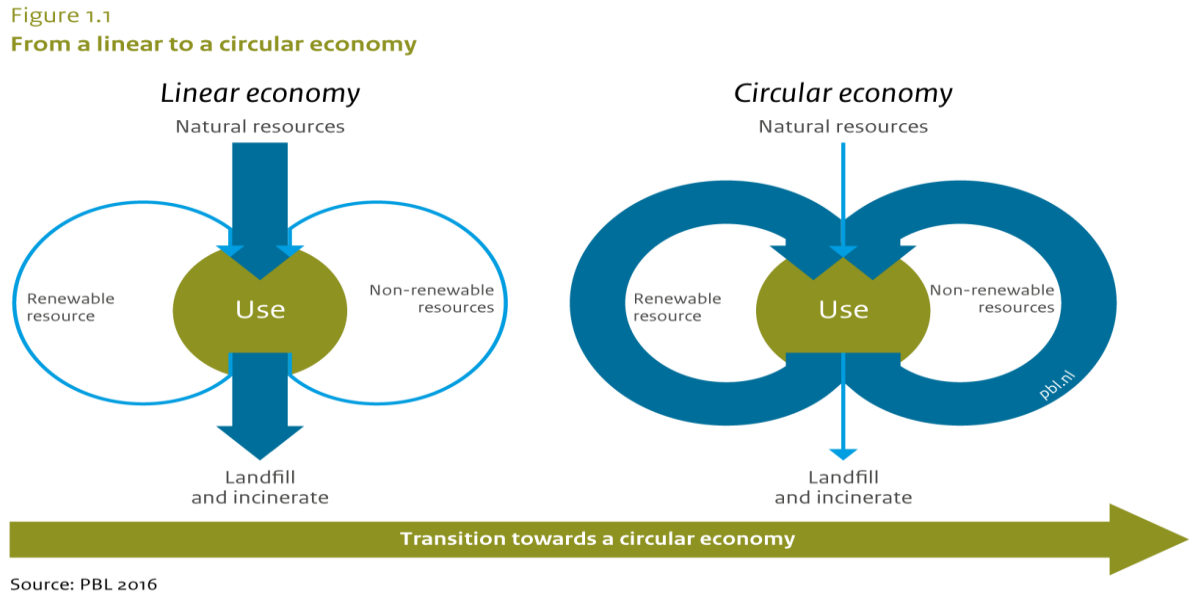
Concerning direct employment created by waste recycling, Walker et al. (2004) estimated based on a study by the U.S. Institute of Local Self Reliance found that one direct job is created for every

15,000 tons (13,608 tonnes) of solid waste landfilled each year. Recycling generates nine Jobs in collection and processing activities. This assessment counts only jobs created through actual direct handling of materials and does not include jobs created in manufacturing using recovered and composted materials, nor would it include jobs in enviro-depots, the tire flaking plant, education, or other secondary and derivative industries that rely on recycled and composted materials.

2.1.3. Circular Economy

Based on report review of Potting (2017), several circularity strategies exist to reduce the consumption of natural resources and materials, and minimize the production of waste. They can be ordered for priority according to their levels of circularity described in the following figure.

Fig 3: From linear to circular economy

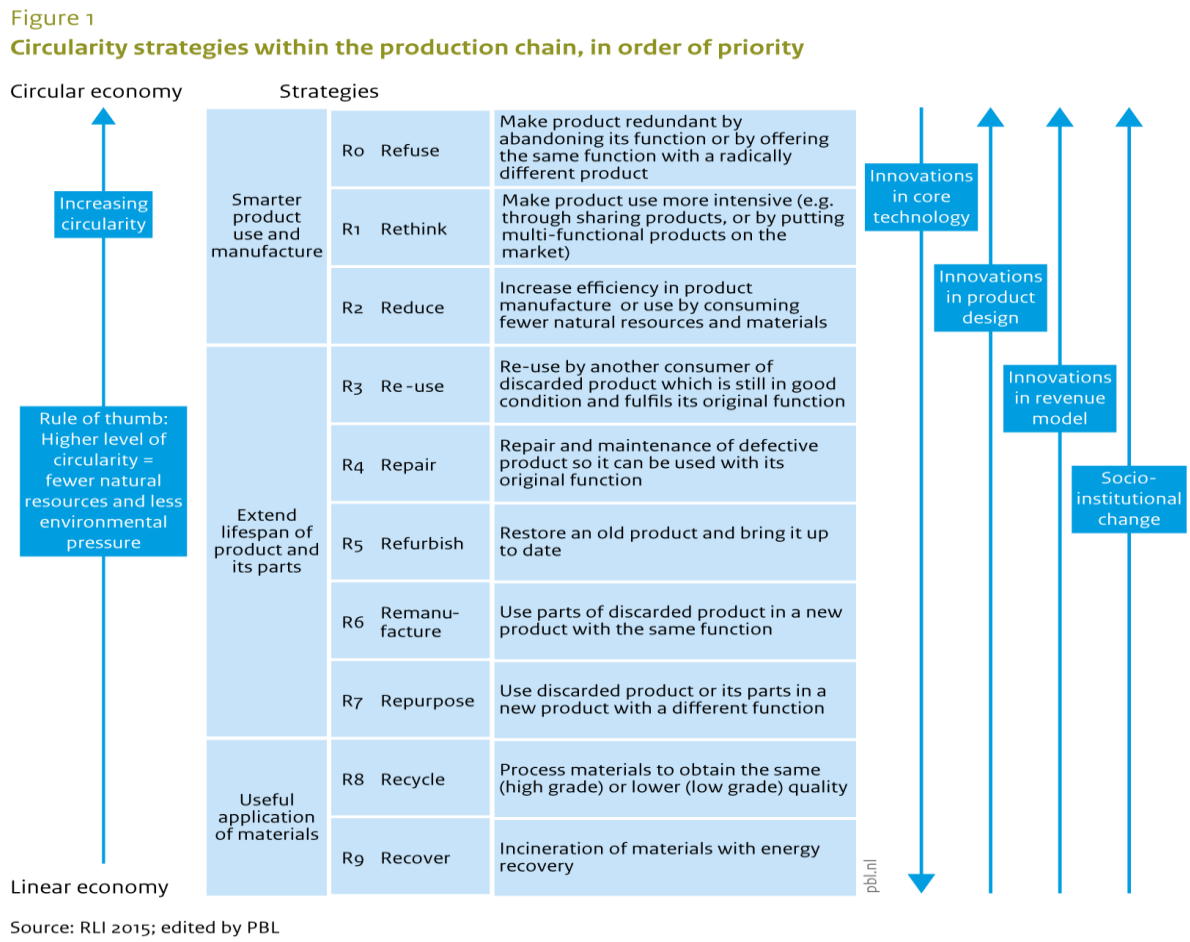


The idea of a circular economy is seen as a logical alternative to a linear economy. In a linear economy, natural resources are extracted to produce new (primary or virgin) materials which in turn are used to manufacture products that are incinerated or dumped in a landfill after use. A product chain includes all steps from extraction of raw materials up to the processing of the discarded product as waste. Recycling materials from a discarded product might be energy intensive, and the recycled materials often cannot be applied again for the same type of product because they are of lower quality due to material mixing and contamination. This is why recycled materials are mostly applied to manufacture products with lower quality requirements, such as road foundation layers in which typically construction and demolition waste is processed. A material chain can therefore be longer than a single product chain. In a circular economy, the materials from a discarded product ideally maintain their original quality so they can be applied again in the same type of product. As a result, no natural resources are needed for the production of new materials, and discarded products no longer become waste. This *ultimate circularity*,

in which a product chain is closed because the materials can be applied over and over again as show on the above Figure, is probably not feasible in practice. It is, however, the ideal situation which Circular Economy transitions aspire to bring about.

Potting (2017) states that several circularity strategies exist to reduce the consumption of natural resources and materials, and minimize the production of waste. They can be ordered for priority according to their levels of circularity of the figure shown below.

Fig 4: Circularity strategy within the production chain, in order of priority



2.2. Empirical Literature Review

2.2.1. Plastic packaging and its waste

According to Hahladakisa (2018), over the last 60 years plastics production has increased manifold, owing to their inexpensive, multipurpose, durable and lightweight nature. These characteristics have raised the demand for plastic materials that will continue to grow over the coming years. However, with increased plastic materials production comes to increase plastic material wastage creating a number of challenges, as well as opportunities to the waste management industry. During the last 15 years, the global annual production of plastics has doubled, reaching approximately 299 million tons in 2013. In addition, the global plastic demand is dominated by thermoplastic types of polypropylene (PP) (21%), low -and linear low- density polyethylene (LDPE and LLDPE) (18%), polyvinyl chloride (PVC) (17%), and high-density polyethylene, (HDPE) (15%). Other plastic types with high demand are polystyrene (PS), and expandable PS (8%), Polyethylene Terephthalate (PET) (7%, excluding PET fiber) and the thermosetting plastic polyurethane. In Europe, the use of plastics is mostly dominated by packaging (38%), followed by building and construction (21%), automotive (7%), electrical and electronic (6%), and other sectors (28%), such as medical and leisure. However, such diverse consumption leads to a diverse waste stream. Large volumes of plastic wastes are generated,it is because of the short lifespan of many plastic products as approximately 40% of plastic products have a service life of less than 1 month. This large waste creates serious environmental and management problems.

Despite significant worldwide advances in management, treatment and recycling in the last three decades, the largest fraction of plastic waste still possibly ends up in dumpsites or is openly burned. At best, they might end up in engineered landfill. In many developing countries plastic recycling is often not controlled by an appropriate regulatory framework, and environmental protection is poorly enforced, resulting in significant contamination of the ambient environment in areas where plastic is recycled.

2.2.2. Polyethylene Terephthalate (PET)

According to article review of Bach (2012), Polyethylene Terephthalate (PET) is a semi-crystalline polymer belonging to the family of polyesters. It is the most favorable packaging material for drinking water. PET bottles have been marketed for the last four decades and they have gradually replaced polyvinylchloride (PVC) and glass bottles on the markets.

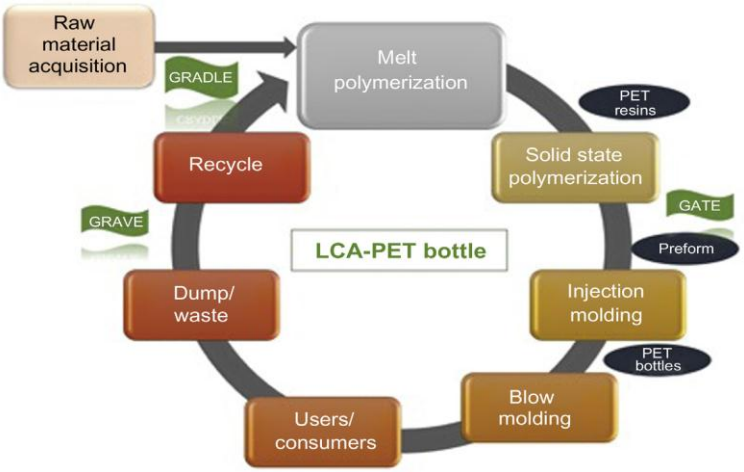


Fig 5: Process flow diagram for PET bottle production

And Marathe (2019) describes, in the life cycle of a PET bottle the stages leading to its production is termed as the upstream life cycle whereas the stages pertaining to its collection and disposal are regarded as downstream life cycle. The LCA of PET bottle can be divided in various stages for ease of understanding and data collection. The various stages are termed as "Gates" and thus provide a structure to the study.

The first stage being Cradle to Gate that comprises of raw material acquisition where the resources needed for the production of raw materials required for the production PET is taken into consideration. The raw materials are transported to the factories where they are mixed and heated and are subjected to unit operations such as melt polymerization and solid state polymerization at high temperatures. The resin beads are molded in the plastic fabrication stage in preforms according to the various sizes of PET bottles. The same preforms are then transported to the sites where they are blow molded in full sized bottles that are further filled with the constituents of the same depending on the application. This Gate to Gate stage of the life cycle where the production process of PET takes place often is a major contributor to the impact footprint. Waste collection, recycle, and disposal are considered the Gate to Grave Stage, post-consumption of PET bottles. The life cycle of the PET bottle can be seen as a closed loop when the waste is recycled back to production of bottles.

Nowadays, the recycling of PET bottles is a common environmentally friendly procedure, and is used to reduce plastic waste and to reprocess plastics for other applications.

2.3. Conceptual framework

This study focuses on the environmental impact of used PET bottles. The variable assigned in the left side of the graph is independent variable (Used PET plastic bottle from different water companies as waste for Addis Ababa) which is expected to affect the dependent variables (environmental impacts from recycling, incineration and landfill treatment method of the same wastes). In view of this, a conceptual framework of the study is developed as follows:

Independent Variables (X_i)	Calculated per Unit value impact for treatment option (a_i)	dependent variables (Y)

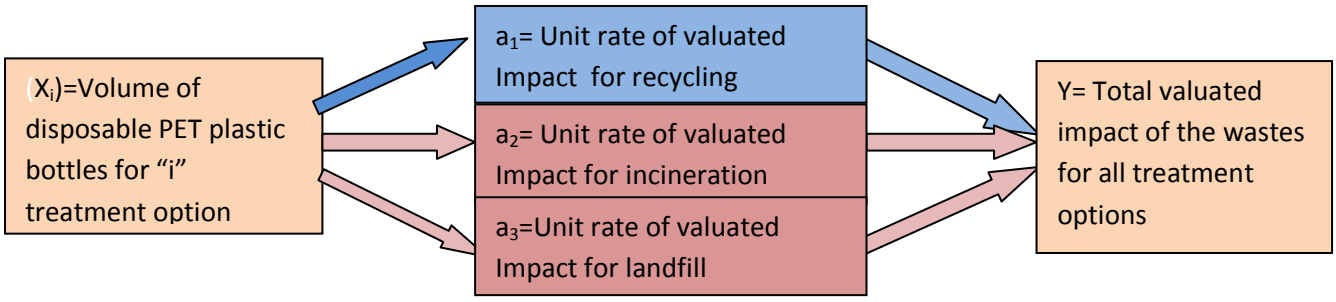


Fig 6: Conceptual frame diagram (own source)

From this conceptual frame work, the following mathematical model will be generated

$Y = A_1X_1 + A_2X_2 + A_3X_3$;

Where

A_1, A_2 and A_3 are the unit rate valuated impacts of respective treatment option and

X_1, X_2 and X_3 are quantity of PET bottle for specific treatment option rejected per annum.

3. RESEACH METHODOLOGY

3.1. Introduction

This chapter deals with the research methodology parts that explain and justify the approach that is adopted in order to answer the proposed research questions. This section provides an overview of the study's research approach which lays within the quantitative and qualitative methods strategies. The chapter discusses pragmatic study philosophy, procedures and activities to be under taken, focusing on the study's research design, for data collection questionnaire for in-depth interview is developed, target population is selected and interviewed for the same, data processing and analysis instrument development is carried out.

3.1. Research Design

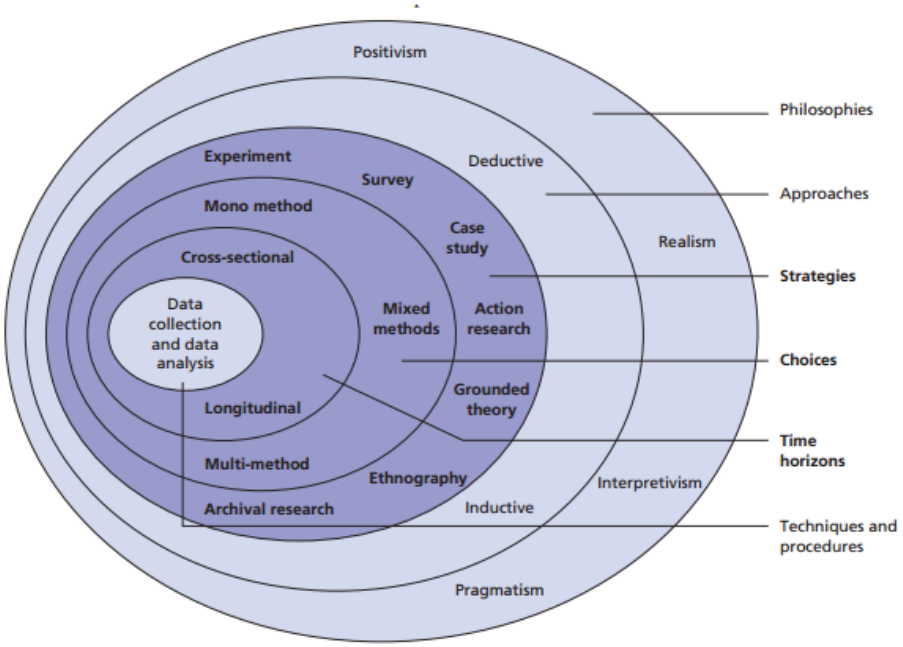


Fig 7: The research onion

***Source:* © 2015 Mark Saunders, Philip Lewis and Adrian Thornhill**

3.1.1. Research philosophy

According to Creswell (2014), there are four research philosophies such as Post-positivism, Constructivism, Transformative and Pragmatic. For the following basic reasons, this particular thesis employs pragmatic research philosophy as:-

- Pragmatism is not committed to any one system of philosophy and reality. This applies to mixed methods research in that inquirers draw liberally from both quantitative and qualitative assumptions when they engage in their research.
- Individual researchers have a freedom of choice. In this way, researchers are free to choose the methods, techniques, and procedures of research that best meet their needs and purposes.
- Pragmatists do not see the world as an absolute unity. In a similar way, mixed methods researchers look to many approaches for collecting and analyzing data rather than subscribing to only one way (e.g., quantitative or qualitative).
- Truth is what works at the time. It is not based in a duality between reality independent of the mind or within the mind. Thus, in mixed methods research, investigators use both quantitative and qualitative data because they work to provide the best understanding of a research problem.
- The pragmatist researchers look to the "*what"* and "*how"* to research based on the intended consequences— where they want to go with it. Mixed methods researchers need to establish a purpose for their mixing, a rationale for the reasons why quantitative and qualitative data need to be mixed in the first place.
- Pragmatists have believed in an external world independent of the mind as well as that lodged in the mind. But they believe that we need to stop asking questions about reality and the laws of nature (Cherryholmes, 1992). "They would simply like to change the subject" (Rorty, 1990, p. xiv).

3.1.2. `Research Approach

According to Creswell (2014), the mixed methods case study design involves the use of one or more core designs(i.e., convergent, explanatory sequential, exploratory sequential) within the framework of a single or multiple case study design. The intent of this design is to develop or generate cases based on both quantitative and qualitative results and their integration. We have found two basic variants of this design. One is a deductive approach where researchers establish the cases at the outset of the study and document the differences

in the cases through the qualitative and quantitative data. A second is more of an inductive approach where the researcher collects and analyzes both quantitative and qualitative data and then forms cases—often multiple cases—and then makes comparisons among the cases. So, this research follows **inductive approach**.

3.1.3. Research Type

There are different research types (purposes) while searching different books. However, this research employs exploratory research type. According to Saunder (2016), an **exploratory study** is a valuable means to ask open questions to discover what is happening and gain insights about a topic of interest. An exploratory study is particularly useful if you wish to clarify your understanding of an issue, problem or phenomenon, such as, if you are unsure of its precise nature.

3.1.4. Research Strategy

According to Saunder (2016), case study Research strategy that involves the empirical investigation of a particular contemporary phenomenon within its real-life context, have multiple sources of evidence. So, the strategy follows case study methodology.

3.1.5. Research Choice (Method)

According to the book of Saunder (2016) and Creswell (2014), there are three types of research choices such; quantitative, qualitative and mixed method. This research has employed a **mixed research choice**.

3.1.6. Time Horizon

According to Saunder (2016), cross-sectional data is the data which collected in a snapshot time horizon can apply for case study as many case studies are based on interviews conducted over a short period of time. So, this research also employs the cross-sectional research time horizon approach.

3.2. Sampling Design

According to Saunder (2016), the sample selected is related to the population that is highlighted in the research question and objectives. However, such a population may be difficult to research as not all elements or cases may be known to the researcher or easy to access. Consequently the researcher may redefine the population as something more manageable. This is often a subset of the population and is called the **target population.**

Sampling techniques available to you can be divided into two types:

- Probability or representative sampling;
- Non-probability sampling

Non-probability sampling (or **non-random sampling**) provides a range of alternative techniques to select samples, the majority of which include an element of subjective judgment. In the exploratory stages of some research projects, a non-probability sample may be the most practical, although it will not allow the extent of the problem to be determined. With **purposive sampling** you need to use your judgment to select cases that will best enable you to answer your research question(s) and to meet your objectives. For this reason it is sometimes known as **judgmental sampling**. Purposive sampling is often used when working with very small samples such as in case study research and when you wish to select cases that are particularly informative (Neuman 2005).qualitative data will be gathered using this purposive sampling method.

3.3. Data type and Source

The research uses both primary data and secondary data for the study from targeted population. Regarding the sample size for in depth interview, Saunder (2016) summarizes the limited to be within 5 to 30. So, this research collects qualitative data from 6 interviewee of higher officials and experts in water company and Environmental Control Authority and quantitative data of disposable PET plastic bottles and treatment related information are sourced from Addis Ababa Solid Waste Administration Agency, Food and Beverage institute assessment report and Ethiopia Conformity offices.

3.4. Questionnaire Design and Data Gathering Instrument

According to the book of Saunder (2016), in-depth interviews can be very helpful to conduct exploratory, qualitative interviews where your research design adopts an inductive approach. Based on this fact, the study arranges in depth interviews for responsible person of Water Company and Environment Protection Authority officials.

3.5. Validity and Reliability

According to the book reviewed from Creswell (2014), **validity** is the ability of the instrument to measures what the researcher intends to measure. This is a way of justifying the appropriateness of instrument utilized by the researcher in the study. Validity is concerned

with whether or not findings are really about what they appear to be about. To make this research valid, proper questioners for interview are developed and appropriate observations and document analysis has been assessed from concerned bodies for the study; **Reliability** is a measure which addresses accuracy of research methods and techniques to produce data. It refers to the extent to which data collection techniques or analysis procedures yield consistent findings; according to Saunder (2016) Survey data from government organizations are also likely to be reliable, and the findings from interviews, observation and document analysis were consistent enough. In general, using the above techniques for both measures, this study gives great concern to maintain the validity and reliability of the data accordingly.

3.6. Data Processing and Analysis

The data for this study is properly edited, processed and tabulated in order to avoid the errors which come along with data processing practice.

3.7. Ethical Consideration

As per Creswell (2014) ethical consideration criterion are applied and the following safeguards are employed to protect the informant's rights: the research objectives are articulated verbally and in writing so that they are clearly understood by the informant, permission to proceed with the study is received from the informant, the informant is informed of all data collection devices and activities, and the final decision regarding informant anonymity were rest with the informant.

4. DATA ANALYSIS AND INTERPRETATION

The objective of this chapter is to provide the findings and results of both quantitative and qualitative data from secondary and primary sources respectively.

4.1. Quantitative data analysis for valuation of Environmental Impacts

4.1.1. Mathematical Model for Valuating of Environmental Impact of packaging waste

To determine the unit rate valuated impacts of each treatment option for Ethiopia, studies from three countries namely United Kingdom, Netherlands and South Africa has been considered and the adjusted value for the policy site (Ethiopia) is estimated by the following formula:

$$Vp = Vs \times (Yp / Ys)^{\beta}$$

Where: Vs is the primary value estimate from study site, Yp and Ys are income levels at the policy and study sites, respectively; β is the income elasticity of WTP for environmental good (and take β=0.1 for Ethiopia).

And also the GDP of the countries for the year 2018 is taken from latest (2020) popular statistics of United Nation data source as follows:

Table 5: Income levels Ethiopia and three other countries in million USD

Country	Income level (GDP) in million USD in 2018
United Kingdom	2,647,899.00
Netherlands	777,228.00
South Africa	295,440.00
Ethiopia	70,315.00

Source: United Nation Data @2020

Using the above formula and numerical valuated environmental impacts of specific country data, the unit rate valuated rate of specific treatment option is estimated here below:

Table 6: Unit rate valuated environmental impacts of specific treatment option for Ethiopia

	Cost and benefits for different waste treatment type in Euro per tone				
	Incineration with electricity production		**Landfill without energy generation**	**Recycling**	
Country	**Cost**	**Energy and material Benefit**	**Cost**	**Cost**	**Energy and material Benefit**
United Kingdom (UK)	65.11		25.585	1.56	32.4
Ethiopia (E1)	45.3		17.8	1.08	22.5
Netherlands (N)	45.95	28.38	26.36		
Ethiopia (E2)	36.13	22.3	20.73		
South Africa (SA)			7.79		
Ethiopia (E3)			6.74		

The valuated impact for recycling and landfill is taken from literature review of UK study as the study includes damage cost from emission of NOx, SO_2 and CO_2, disaminity impact and pollution from transportation. On the other hand, for the purpose of data compatibility, values for incineration are taken from Netherland study. So, the mathematical formula for the valuated environmental Impact of packaging waste is modeled as follows:

$$\mathbf{Y= 21.}42X_1\mathbf{-12.83}X_2\mathbf{-17.8}X_3$$

Where

X_1, X_2 and X_3 are annual quantity of PET bottles in ton for recycling, incineration and landfill treatment Option for packaging waste of the city respectively.

4.1.2. Estimated amount of disposable PET waste

4.1.2.1. Solid Waste data in Addis Ababa

Since it is difficult to get actual waste generation amount of the city, this study uses the following assumption to estimate the amount of total plastic generation volume from the estimated amount of total waste generated in Addis Ababa. And the total plastic waste for is computed in the following Table 7 accordingly.

Table 7: A.A Waste composition ratio from total waste generated (source: AASWAA)

Waste type	Composition percent	Waste type	Composition percent
organic,	64%	house hold hazard,	0.40%
paper and cardboard	5.30%	metals,	1.20%
Plastic	5.20%	fines,	7.80%
glass,	2.10%	inert metals,	1.70%
textile,	4.00%	sanitary products,	3.50%
charcoal,	2.10%		

Table 8: Estimate of total plastic waste generated in Addis Ababa (Source: AASWAA)

Year	**Waste generation in tone**	**dumped waste in tone**	**Ratio of dumped waste in %**	**Plastic Waste in ton @ 5.2% generation rate**
2012	544171.2	453476	83%	**28,297**
2013	602643.6	502203	83%	**31,337**
2014	665730.9	579,766	87%	**34,618**
2015	860271.9	748,062.60	87%	**44,734**
2016	919338.5	766115.7	83%	**47,806**
2017	965305.425			**50,196**
2018	1013570.696			**52,706**

Note that: 2017 and 2018 waste generation quantity is estimated based on the 5% rise of urban waste generation rate of the city.

Table 9: Quantity and types of Plastic waste in Addis Ababa collected for recyclers (Source: AASWAA)

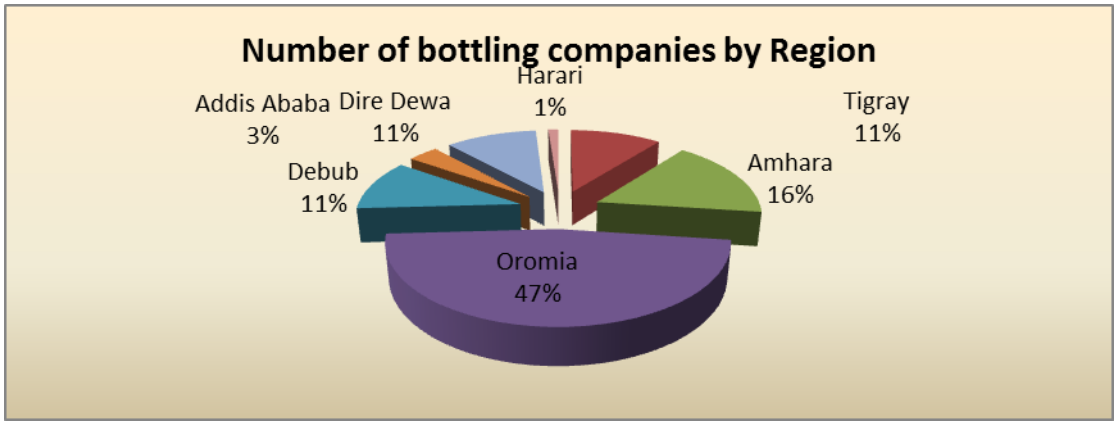
Year	**2016**			**2017**			**2018**	
Waste type	Plastic bag	PET bottles from all sources	Plastic container (not PET bottles)	Plastic bag and PET bottles	PP bag	Plastic containers (not PET bottles)	Plastic containers including PET bottles	plastic bags including PP
Quantity in ton	1878.2	10943.3	3937	10310.9	1981	284.7	18648 (14,711 PET estimate)	5945
collected plastic waste for recycler in ton	16758.5			12576.6			24593	
Total generated plastic waste in ton	47806			50196			52706	
percentile collection capability for recycling	35%			25%			47%	

4.1.2.2 Estimated Volume of disposable PET water bottles in Addis Ababa

Based on the following assumption, the estimated quantity of disposable PET water bottles in Addis Ababa is calculated here below:

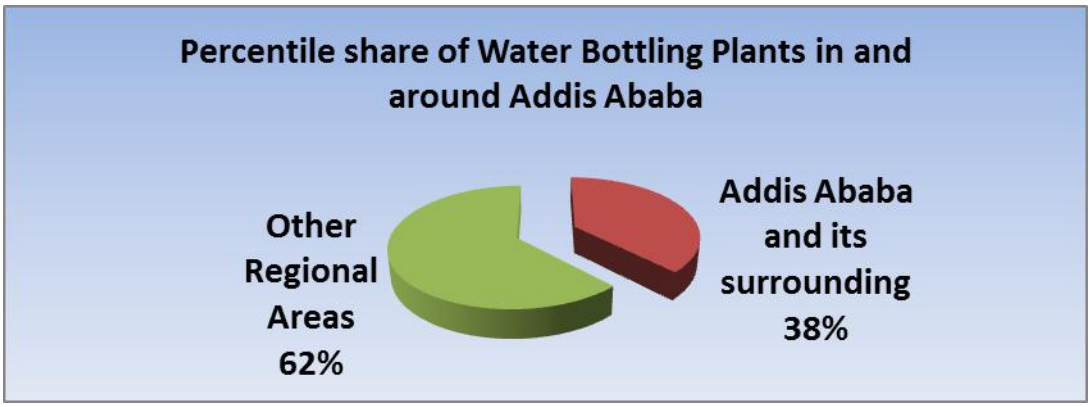
- ✓ Total production in 600ml bottle is 2,375,349,340 bottles per year and to do this analysis actual production capacity from the table, annual working day of 300 and 75% for other down time are considered(source for production capacity: from annexed table of food and beverage institute assessment report)
  - Production for the city and its surrounding plants will be 1,215,900,000 bottles so, share in % for Production capacity of Addis Ababa and its surrounding plants to that of total number is 51% (source: EFBI assessment report)

Fig 8: Plant Distribution of bottling companies by Region (Source: ECA)



- ✓ Percentile share of Addis Ababa and its surrounding plants with respect to number total bottling companies in Ethiopia is 38 %. (Source: ECA data)

Fig 9: Percentile Share of Water bottling plants in and around Addis Ababa (Source: ECA)



And therefore, for compatibility of stated production capacity of the plant in Food and beverage institute assessment data and ECA information, the researcher assumes the following points for estimation of disposable PET water bottles in Addis Ababa:

a. Total quantity of disposable waste is calculated based on the actual production capacity data for product size of 600ml.

b. Average weight for 600ml bottle is assumed 20g per piece (data: own experience)

c. Based on the percentile value of production share for Addis Ababa and its surrounding plants from total production (51%) and percentile share value of Addis Ababa and its surrounding Water Bottling Plants to that of total plants in Ethiopia (38%), Average value of 44.5% from total production capacity is assumed for determination of quantity generated disposable bottle in Addis Ababa.

Total disposable PET in Addis Ababa is assumed as

= Total quantity of bottles produced in the country * percentile share of generated bottles in the city * weight per bottles

= (2,375,349,340.00 bottles * 44.5% *0.02Kg)/1000

= **21,140.6 ton/ year**

4.1.3. Estimated economic valuated environmental impacts in Addis Ababa

The amount of waste for each treatment options is estimated as per PET bottles collected by AASWRAA (Addis Ababa Solid Waste Recycling Administration Agency) and the volume of recycled waste is then calculated by using waste quantity difference of 18648 ton PET and container generation in 2018 budget and 3937 ton container generation in 2016. So, the net result becomes 14,711 ton of PET bottles for the year 2018 (tradeoff between collected PET bottle from other sources and unmeasured reject bottles from bottling companies is considered for analysis) .

Note that: according to the information from Landfill administration team leader, the amount of plastic waste for incineration is negligible so the impact is calculated based on both recycling and landfill treatment options (source : Interview findings).

Y= 21.42*(14,711) –12.83*(0)–17.8 *(21,140.6-14,711) Euro or

Y= 23.98*(14,711) – 14.36 * (0) – 19.93 * (6,429.6) USD for the year 2018

Table 10 : exchange rate and valuated impacts in different currency[1]

Description	Treatment Option	Euro	Birr	USD
Exchange rate		1	36.396048	1.119599
Rate per ton of waste	Recycle	21.42	779.603348	23.981808
	Incineration	-12.83	-466.9612958	-14.364454
	Landfill	-17.8	-647.8496544	-19.928860
Valuated amount	Total	200,673.42	7,303,719.43	224,673.74

Where: X_1, X_2 and X_3 are annual quantity of PET bottles in ton for recycling, incineration and landfill treatment Option for packaging waste of Ethiopia respectively.

[1] National Bank Of Ethiopia, Ethiopian Birr (Birr): Official foreign exchange reference as at 2020-01-08 21:41:57

4.2. Qualitative data Analysis from In-depth Interview

According to Yen (2011, qualitative data are more alphabetic than numeric. The data are likely to be represented in narratives or in data arrays, such as the word tables, hierarchies, matrices, and other types of diagrams. So, the participants' responses are presented here below in narrative ways.

4.2.1. General information about the participants

Though there is not any confidentiality issue whether the analysis includes the names of the interviewees or not, the researcher prefers to code the names of the same as participant 1, 2, 3, 4, 5, and 6. But the researcher believes that showing the backgrounds of the interviewees strengthen the validity and reliability issues of the data. So, table 10 summarizes the background of the participants as follows:

Table 11: General background information about the participants

Code	Organization	Position	Educational background and experience
1	Water bottling company	General manager	Not stated
2	Addis Ababa Solid Waste Administration Agency	Under Landfill Administration directorate, Pollution control and follow-up team leader	1st degree in Forestry 2nd degree in environmental change management 8 years experience in the Agency
3	Environment, Forestry, and climate change commission	Solid and hazard waste regulating directorate Director	Work at different position of the commission (Plastic monitoring, waste Recycling team leader, Legal expert)
4	City Government of Addis Ababa Environment Protection and Green development Commission	Environment Pollution Control Team Leader	Not Stated
5	Addis Ababa Solid Waste Administration Agency	Solid Waste recycling Directorate Director	8 years experience 2nd degree in Environmental Science
6	Addis Ababa Solid Waste Administration Agency	Solid Waste recycling Team leader	6 years Experience 2nd Environment and Climate Change Management

4.2.2. Analysis and interpretation of In-depth interview

After the interviews had been recorded and converted to text for analysis part, the summarized participants' responses are attached and presented separately for each questions. And to differentiate each and every participant's reply, their respective code number in bracket is attached at beginning or end of particular paragraphs of the respondent answer as follows:

Q1. ***How do you describe your organization's objectives in relation to the environmental impacts of packaging waste in general and disposable PET bottles in particular?***

Participant from manufacturing sector confirms that water companies are among the first disposable PET bottle waste contributor of the country. And to address such problems, the participant's company has done project feasibility study for disposable PET bottles recycling plant. In addition, their company joins in PETCO Ethiopia which is non-governmental company and recently established organization concerns for environment protection. PETCO Ethiopia is totally for basic agenda of cleaning the environment. This organization works as an agent for PET bottle waste contributor companies and it stands in the middle of PET bottle collectors and recycler companies in order to facilitate the productivity of waste collectors by providing technical supports, subsidies and similar benefits for the two wings (collectors and recyclers) (1).

The other five interviewees were from governmental offices that have direct responsibility to manage and control the environmental protection agendas of the country in general and Addis Ababa city in particular. For these reasons, their offices have specific objectives in relation to solid waste in general and disposable PET bottle waste in particular.

Q2. How do you explain the sustainability development issues of water bottling companies for its disposable PET bottles?

PET bottle is one among plastic products and its waste management practice will affect and challenge the business's sustainability for additional tax burden or total plastic bottle ban. So, to make the business safe from environmental issues for sustainable development agenda of the same, their disposable PET bottle should be collected and recycled accordingly (1,2).

According to (3), the sustainable development issues are stated in social, environment and economy aspect. And the respondent emphasizes that any development project

should not compromised the environment for the specific benefit of economy and/or social and vice versa**.** At the same time (3) describes the experience of Ethiopia for sustainability is mainly relied on both the economy and social aspects of the country's development concern. Little concern is given for waste management practice of the companies for re-use, recycle or collection of their disposal. Participant (4) from Addis Ababa city environment protection and green development commission team leader appreciates the water companies' and regulatory bodies decision for banning of bottle neck sleeve months' time ago. In addition to this, the respondent added the plastic label as potential sustainability issue of the business.

Participant (5 and 6) considers the water companies trend as an issue of sustainability for the business. The number of water companies, population size and the consumption behavior of the people is at increasing rate, and these factors also amplify the rate of disposable pet bottles to the environment. But they noted that the collection and recycling management practices of the country in general and the city does not grow to challenge the increasing waste issues.

Q3.In what ways do different countries and water companies act in response to environmental issues for their disposable plastic bottles?

The participants explain different countries and companies experiences of managing environmental impacts for disposable plastic bottles as follows:

- ✓ By collecting and processing PET bottle wastes through integrated operation of PET recycling plants under the management of PETCO. (South Africa and Kenya)(1)
- ✓ By implementing polluter pay principle for Subsidizing PET bottle collectors and recycler companies (Japan) (1, 2, 4)
- ✓ By reducing the overall environmental impacts of plastic packaging by replacing the plastic label to paper one. (Rwanda's experience) (6)

Q4.How do you describe the country's experiences in managing of environmental impact from packaging wastes in general and disposable PET bottle in particular?

In Ethiopia, Different initiatives are done to support the management of packaging waste in general and disposable PET bottles in particular. Among others, the following

are described by the participants:

- ✓ The recent establishment of PETCO Ethiopia to support the collection and recycling practice of the country. (1)
- ✓ TOP water has already installed its own PET bottle recycling plant and One water is in progress to establish the same. (1)
- ✓ Months ago, water companies and governmental bodies jointly decide for banning of plastic neck sleeve from bottled water product (6)
- ✓ Addis Ababa Solid Waste Management Agency supports around 6000 members in 74 waste collector associations and 15 recycler companies of the city in both technical matters and financial subsidies of 2 birr per kilogram of collected PET bottles by collectors. (2,3,4,5,6)
- ✓ For Coca Cola company's plastic waste contribution for the city, the company supports the disposable PET waste collectors in both financial and awareness creating programs.(6)

Q5.How do you evaluate the data management practice of the city's Solid wastes in general and PET bottles in particular?

All participants have agreed that the data management experience of the country in general and the city in particular is in poor condition. It is hardly possible to get the relevant data of disposable PET bottles from concerned governmental offices. Of course, the specific waste generation rate of all solid waste is estimated based on previous study done by IGNIS (Income Generation and Climate Protection through the Sustainable Valorization of Municipal

Solid Wastes in Emerging Megacities) for the City of Addis Ababa, Ethiopia, but the current actual specific disposable PET bottles from different sources are not collected and recorded accordingly. In general, one can conclude that little focus is given for data management practice in the waste management process.

Q6.How can you express the significance of economic valuation for waste treatment options of packaging waste in general and disposable PET bottles in particular?

All participants have discussed and proposed almost similar responses among the three treatment options (recycling, incineration and landfill) towards their respective

strategic benefits. And as per their response, for its economic advantage of recovered material and social benefit of an employment opportunity, recycling can be considered as the first treatment option for plastic packaging wastes. And for high calorific value of plastic wastes, incineration will be their second choice and for its non-biodegradable characteristics of plastic waste and low soil compaction effects landfill treatment gets the least choice of all. But the participants could not support their suggestion in terms of valuated figures. participant(4) has notified to the researcher that departments for economic valuation task has been structured in their commission for common purpose of environmental impact valuation activities but the Authority couldn't exercise the same for such analysis yet.

On the other hand participant (3) argued that such valuation tasks needs advanced knowledge and should be performed by universities and researchers. And also participant (3) describes their office's experience of economic valuation practice in chemical area. These valuation tasks for the same has covered life cycle impacts of the chemical's history starting from material receiving stage to the stage of its obsolescence.

And finally, all the respondents agreed that in order to set proper policy and strategic directions for decision making, economic valuation technique should be implemented and practiced accordingly.

Q8. **How can you describe the existing policy and environmental regulatory frameworks of the country in managing of packaging waste in general and disposable PET bottles in particular?**

Participants (1, 2, 4, and 5) have pointed up similar idea for this specific question that the country is not underprivileged for not having policies and regulatory frameworks for solid waste management activities but the country is poor for its implementation practices.

On the other hand, participants 3 and 6 point out the deficiency of the regulation in different perspectives. Participant 3 explains his personal belief on plastic wastes that this plastic waste has become a challenge for Ethiopia during the last 10 years and the country is not clearly recognizing what is happening now for there is awareness problem for the community at large. The solid waste management proclamation no 513/2007 includes about plastic in its content of chapter 3, article 8 and sub article 1,2

and 3. And it describes not about PET or other plastic wastes but only about plastic bag. And now, the responsible body recognizes these gaps and they are doing to fill the same. Finally participant (3) concluded that the laws could not address the current solid waste issues of the country. And participants (3 and 6) have stated similar opinion that the regulation lack detail enactment for each and specific solid waste management practices.

Fig 10: Summary of participants' responses for the issues

Q9. **What should be done?**

Here, the participants' recommendations based on personal opinions are organized and listed as follows:

Participant (1)

- ✓ Now the disposable PET bottles management practices are relatively in good condition. It becomes source of revenue for the community, the semi processed flakes generates foreign currency and the environment becomes relatively clean. So, this practice and awareness program should be expanded to address all bottling companies.

Participant (2)

- ✓ The Environmental Protection Authority should give great concern for monitoring and controlling part of every company's environmental management plan for realizing its obligation beyond approval of the companies EIA.

- ✓ Previously, Addis Ababa solid wastes were composed of little share for PET bottles. But after the trend of bottled water consumption becomes commodity, the volume of disposable PET bottles was also increase in the city and that situation changed the nature of landfill area to low compacted land. That practice and similar related factors contributed its share for land slide incident of the area. So, to compensate the impact of previously deposited bottles from bottling companies, these companies are expected to participate in land developmental activities of this area.
- ✓ The participant finally has proposed an idea for the establishment of environmental activist group who serves as the voice of the environment

Participant (3)

- ✓ The participant here propose three basic solution for current problems of environmental issues of disposable PET bottles:
  - Develop and implement specific working legal enactment for disposable PET bottle
  - Create awareness on the environmental impacts of disposable PET bottles for higher official, professional and public at large
  - Challenge the impacts of disposable PET bottles through latest technology that centers recycling of PET bottles.

Participant (4)

- ✓ The respondent believes the existing proclamations for environment protection are sufficient enough to challenge the current problems of solid waste management practice. What the respondent emphasis and propose for change is to strengthen the regulations by rules and directives and then develop action plan for responsible agency.
- ✓ In addition, the participant believes that the effectiveness of disposable PET bottle waste management activity should not be dependent on single agency rather it is done between and among environmental protection Authority, solid waste management agency, bottling companies, waste collectors, recyclers any other stakeholders. So, the respondent has recommended on the establishment of formally organized team for this specific disposable PET bottle.

Participant (5)

- ✓ The participant has proposed ideas on:
  - Implementation of polluter pays principle for water bottling companies.
  - Bottling companies to have their own collection system and recycling plant at least for their own wastes
  - Revising of the existing proclamation to PET bottle specific
  - Performing of different researches in this specific area

Participant (6)

- ✓ Special focus should be given for the revision of existing environmental proclamation and also the regulation should define specific mandates for authority and agency tasks.
- ✓ The AASWAA should be organized in order to be data and information center for the city.

Fig 11: Summarized recommendations of the participant

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

In this chapter the main results of the study are summarized, conclusions are drawn, recommendations are forwarded and finally both limitation and future direction of the research is addressed.

5.1. Summary of the findings

The study findings are summarized as follows;

1. The model for estimation of environmental impacts for plastic packaging waste in general and disposable PET bottles in particular for the country is formulated in the following way:

   $Y = (23.98\ X_1 - 14.36\ X_2 - 19.97\ X_3)$ USD

   Where X_1, X_2 and X_3 are annual quantity of Plastic packaging (disposable PET bottles) in ton for recycled, incinerated and landfill treatment options of waste management practice respectively.

2. Based on the estimated total generated amount of plastic waste for the city and waste collected for recycling, the last three consecutive years waste collection trends and performance of the city is measured. And the result is summarized in the following table:

   Table 12: Summary of total generated plastic waste and collected plastic waste for recycle

Waste by type	**2016**	**2017**	**2018**
Total generated plastic waste	47,806 tons	50, 196 tons	52,706 tons
Collected Plastic waste for	16,758.5 tons	12,576.6 tons	24,593 tons
Performance in percent	35%	25%	47%

3. The volume of the city's disposable PET bottles from water companies for the year 2018 is estimated to 21,140.6 tons. And from this volume an estimate of 14,648 tons are collected for recycling, 6,429.6tons are thrown to landfill and insignificant volume of PET bottles for incineration is assumed. So, the valuated environmental impact of disposable PET bottles for the year 2018 was estimated to **224,673.74 USD**.
4. The qualitative findings from in depth interviews are summarized and listed here below:
   a. Water companies are taking **their own initiatives** for their business sustainability issues of plastic wastes. The case of neck sleeve, collaboration with PETCO Ethiopia, establishment of their own disposable PET bottles recycling can be taken as an

example for their initiatives. On the other hand, they are lagging for replacing of the existing plastic label by paper type one.

b. Though EPA states about polluter pay principle (chapter 3, article 3 and sub article 4 of proclamation 300/2002), but the authority hasn't prepared itself for implementation yet.
c. It is hardly possible to get specific, properly organized and reliable data of waste from the solid waste administration agency of the city.
d. The existing environmental policies and proclamations has two basic problems:
    i. Implementation problem for the existing laws
    ii. The legislation lacks specific enactment to challenge the current environmental issues like disposable PET bottles.

5. Summary of Interviewees recommendations
    a. Create awareness program on collection and recycling obligations for bottling companies, higher government officials and public at large (chapter 2, article 3 and sub article 3 of proclamation number 300/2002)
    b. Bottling companies should actively participate in land development activities of potentially sliding area for the cost of their previously damped plastic materials (chapter 3, article 3 and sub article 4 of proclamation 300/2002)
    c. It is recommended to establish environmental activist group for the voice of the environment
    d. Introduce latest technology to fill the gap of value adding recycling operation ((chapter 3, article 3 and sub article 3 of proclamation 300/2002)
    e. Since the environmental problems of disposable PET bottles for the country is significant in its nature, it is recommended for universities to focus their researches in this area.

5.2. Conclusions

The main objective of this research was to model economically valuated environmental impacts of plastic packaging wastes in monetary terms for different treatment options of the country in general and Addis Ababa in particular. According to the analysis and discussion of the study conclusions are made on the nature and relationship between volumes of wastes for specific treatment options as independent variables and valuated environmental impact as a dependent variable. And the model is illustrated here below:

$$\mathbf{Y = (23.98\ X_1 - 14.36\ X_2 - 19.97\ X_3)\ USD}$$

Where: X_1, X_2 and X_3 are annual quantity of Plastic packaging (disposable PET bottles) in ton for recycled, incinerated and land filled treatment options of waste management practice respectively.

In addition to the main objective, the research has also four specific objectives. The first specific objective of this study was to quantify the estimated amount of disposable PET water bottles in Addis Ababa. And the volume of the city's disposable PET bottles from water companies for the year 2018 was estimated to **21,140.6** tons.

The second specific objective of the study was to estimate the percentage of total volume and per unit valuated impact for each treatment options of the disposable PET bottle in Addis Ababa from water companies. And the data for the year 2018 showed that an estimate of **14,711 tons (69.4%)** were collected for recycling and **6,429 (30.6%)** tons were thrown for landfill assuming that insignificant volume of PET bottles was consumed for incineration. And the valuated environmental impacts of disposable PET bottles were **23.98, -14.36** and **-19.97 USD** per ton of wastes for recycling, incineration and landfill treatment options respectively. And the positive sign indicates benefit for the environment and the negative sign indicates cost for environment.

The third specific objective was to model and calculate the total environmental valuated impacts of disposable bottles for actual data and alternative waste treatment options. So, based on the representative model for valuation of environmental, the result is computed as follows:

$$Y = 23.98X_1 - 14.36X_2 - 19.97X_3$$

Where**:** X_1, X_2 and X_3 are annual quantity of PET bottles in ton for recycling, incineration and landfill treatment Option for packaging waste of Ethiopia respectively.

And city's calculated estimated value of the environmental impact of disposable PET bottles for the year 2018 will be:

Y = 23.98*(14,711) –14.36*(0)–19.97 *(21,140.6-14,711)

Y = 224,673.74 USD for the year 2018

And finally as a fourth objective of the study, recommendations for the findings are discussed here below.

5.3. Recommendations

- Though the valuated environmental impacts (224,673.74 USD or 7,303,719.43 birr) of disposable PET bottles in Addis Ababa for the year 2018 can be considered as great achievement for all parties in the collection and recycling system of the operation, the overall valuated environmental impacts of plastic material for the city is 29,524.56 USD for the year 2018. And due to the 24,593 tons (47%) plastic material collection performance activities from total estimate quantity of 52,706 tons plastic generation, the city alone lost an opportunity of 1,234,460.9USD or 40,129,995.7 birr as an environmental benefit for the 53% landfill plastic treatment option. So, to gain the maximum advantage from plastic wastes, the treatment option should focus on recycling for plastic packaging material as a whole.
- To implement incentive payment system and/or to apply polluter pay principle for water sector in general and individual bottling companies in particular as per articles of environmental proclamation number 300/2002 for Incentives schemes (chapter 4, article 10 and sub article 2) *"Incentives for the introduction of methods that enable the prevention or minimization of pollution into an existing undertaking shall be determined by regulations issued hereunder."* And/or for control of pollution (chapter 2, article 3 and sub article 4) *"Any person who causes any pollution shall be required to clean up or pay the cost of cleaning up the polluted environment in such a manner and within such a period as shall be determined by the Authority or by the relevant regional environmental agency"* the following points should be fulfilled as a precondition at least at their minimum requirement level:
    - specific regulatory enactment for specific solid wastes (like PET),
    - strong management information system,
    - country oriented environmental impact valuation model done by IPA approach and
    - organized functional agency to handle the system
- The majority of recycler companies are selling semi processed product called flakes for export market. Though this operation is important for both strategic advantage of economy (generate hard currency) and environment (cleaning effect), the country is selling materials for other countries' advantage of further value adding process. On the other hand, Chapter 2, article 2 and sub article 3 of environmental

proclamation number 300/2002 states that "*Any person engaged in any field of activity which is likely which is to cause pollution or any other environmental hazard shall, when the Authority or the relevant regional environmental agency so decides, install a sound technology that avoids or reduces, to the required minimum, the generation of waste and, when feasible, apply methods for the recycling of waste.*" So, to utilize the maximum benefit of disposable PET bottle, the investment office should encourage and give priority for projects of complete recycle processing plants.

- To protect environmental damages of the country at the early stage of the problem's life time, environmental activist group for the voice of the environment should be established.

5.2. Limitation and future research suggestion

Due to accessibility of single source extrapolated data for waste generation capacity and growth rate trend of disposable PET bottles from the city's solid waste administration agency and lack of sufficiently and properly organized data for the determination of waste ratio for each treatment options for the same, assumption based calculation has done for analysis part of the study.

Though these assumptions were drawn from engineering background of the researcher analytical skill for mathematical computation, and both eight years direct and seven years indirect managerial experience of the researcher's knowledge to draw reasonable assumption for this particular study, the researcher recommends future studies at least for three basic reasons:

- The valuation model for this particular research is developed based on BT method from other countries study. So, further research is important to make country specific valuation model for environmental impacts of plastic packaging waste.
- In addition, the nature of this research is exploratory type and it is advisable to bring the study to explanatory level by doing additional studies in order to increase the certainty level of this and consecutive researches' findings.
- This study is focused on recycling, incineration and landfill waste treatment options of the country. In addition, to reduce the life cycle environmental impacts of PET materials, the researcher recommends future researches on recently developed circular economy model.

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Annex

Table 13: List of water bottling companies with actual production capacity

N°.	Company Name	Product Name	Actual (Attainable) capacity	
1.	Yes Brands Food and Beverage PLC	Yes water	108,000,000.00	20,000 bottles/hr
2.	PasificIndustry	Promise water	20,000,000.00	
3.	ABM manufacturing	Unique water	18,900,000.00	3500 bottles /hr
4.	AlmazEsheteMiniral Water Bottling Company	Blue bottled Water	37,800,000.00	93,335 bottles/day
5.	BitwededBahiru Industry	Hiwot water	54,000,000.00	10,000 bottles/hr
6.	Herbal Trade and Industry spring water factory	Spa spring water	15,075,000.00	61,757 bottles/hr
7.	TeshomeGode Natural Mineral Water Factory	Selam Natural Spring Water	40,000,000.00	
8.	S B G industry PLC	Arki Bottled Water	54,000,000.00	10000 bottles/hr
9.	Damot Industrial &Commertial PLC	Gift Botteled water	27,000,000.00	3500 L/hr
10.	KBFgeneral trading PLC	Fahm water	54,000,000.00	2500bottles/hr
11.	Ashraf Agricultural and Industrial plc	Safi Bottled Water	10,800,000.00	2000 bottles per hr
12.	Hasasa dream For a Better Life Natural Spring Water PLC	Life Packaged Drinking water	8,100,000.00	1500bottles/hr
13.	Maiaynee Business PLC	Right Bottled Water	13,500,000.00	0.5L=2500bph
				1L=2700 bph
				2L=1500 bph
14.	Ambo Mineral Water PLC	Ambo Sparkling Mineral Water	not considered	48,000 Bottles/hr
15.	East Africa bottling company	Soft drink	not considered	216,000 bottles/hr
16.	Belima International Business PLC	Daily Bottled water	61,907,040.00	0.6L=2,304,000 bph
				1L=2,332,800 bph
				2L=2,242,560 bph

17.	Konjit Industry and Trade PLC	Konjo Bottled water	60,750,000.00	162,000,000 L/year
18.	DebereBirhan Natural Spring Water S.C	Aquasafe Bottled water	28,080,000.00	2,340,000 bottles/year
19.	MDE Bottling PLC	Aqua Uno Bottled water	2,735,580.00	2,727,965 dozen/year
20.	Origin Investment PLC	Origin Bottled water	102,393,720.00	136524960 l/year
21.	Kunis Bari General	Sheger Bottled water	25,920,000.00	72,000 HL/year
22.	AbhawaTradindPLc /Mogle Bottling Manufacturing	One Bottled Water	99,000,000.00	28,000 ton/ 792,000HL/year
23.	NON Agro Industerial&TradingPlc	Esey Bottled Water		3,588,000 l/year
24.	Free Purified Spring Water PLC	Free Spring Water	40,500,000.00	7500 l/hr
25.	Eftien Purified Water PLC	Eftien bottled water	30,326,400.00	5616 l/hr
26.	Altewba Trading PLC	Care bottled water	33,600,000.00	2800 l/hr
27.	General Group PLC	Avantenaturalwater	7,800,000.00	7000 l/hr
28.	Ayaan Water PLC	Ayaan water	27,000,000.00	4000/5000 l/hr
29.	Twin Cities Industrial PLC	Vita water	36,000,000.00	3300/4000l/hr
30.	S H F Trading PLC	Aqua Dire Purified Water	43,200,000.00	8000l/hr
31.	Abdulreshed Elemi	Aqua Liban	27,000,000.00	5000l/hr
32.	Tamire&Family	Alfa water	56,700,000.00	10500 bottles/hr
33.	Jar Natural spring Water Industry PLC	Desses Bottled Water	27,000,000.00	bottles /hr
34.	Dalol High Level Natural Spring water and Soft Drink	-Raya bottled water	5,400,000.00	1000 bottles/hr

	PLC			
35.	Alaje Mercy Natural Spring Water Bottling PLC	Alaje Mercy bottled water	23,760,000.00	4400 bottles/hr
36.	Fereji and Family PLC	Aquabilen bottled Water	8,100,000.00	1000-2000 bottles/hr
37.	Kuyshilu Business PLC	Hagere water	17,820,000.00	3300 half literpcs/hr
38.	Halal Ethiopia PLC	Diamend Natural Water	16,200,000.00	3000btls/hr
39.	AbdurazikWorkecho Sky Mineral Water Factory	Sky Water	21,600,000.00	
40.	MGF industry plc	Hi SpringWater	21,600,000.00	
41.	EngeenierZelalem W/AmanuaelBeza natural spring water	Beza spring water	27,000,000.00	
42.	Nestle Waters Ethiopia share company(sululta branch)	Abyssinia Water	81,250,000.00	65million liters/year
43.	TGMD Trade Works plc	Real Water	27,000,000.00	
44.	BishanGari Purification Industry plc	Desert Quench Water	27,000,000.00	
45.	Ahlel Bet Bussinesplc	Hawd Water	21,600,000.00	
46.	Aqua Silva Bottled Water	Aqua Silva Water	27,000,000.00	
47.	ITF plc	Viva water	24,300,000.00	
48.	Bekoji Spring Water plc	BekojiWater	10,800,000.00	2000bph
49.	Gogo Industrial plc	Guna Water	16,200,000.00	
50.	Firesibat Trade Work plc	NiceWater	24,300,000.00	
51.	Violet General Trading plc	CheersWater	27,000,000.00	
52.	Nyal PLC	AVA Bottled Water	27,000,000.00	
53.	Best Water Factory	Best brand bottled drinking water	54,000,000.00	
54.	Eden Business S.C	Eden Bottled Water	54,000,000.00	
55.	Afman Holdings plc	Prima Aqua Water	27,000,000.00	
56.	AL-AKL Trading PLC	Ambasader		

		Bottled Water	27,000,000.00	
57.	Tramp Business PLC	Aqua Yava Bottled Water	27,000,000.00	
58.	Sororo water bottling water	Sororo packaged Drinking spring Water	16,200,000.00	
59.	Telil spring water	Telil Packaged Drinking Spring Water	24,300,000.00	
60.	Yekabdi Agro processing PLC	Wow Bottled Water	43,200,000.00	
61.	Abaya Spring Water	Abaya Spring Water	27,000,000.00	
62.	Zybm bottled water &non alcoholicbev factory	Melkammoringa		
63.	Selam	Armay Water	16,200, 000.00	
64.	**Double S Business Group PLC	Pacific Bottled Drinking Water	27,000,000.00	
65.	Geremba Bottling PLC			
66.	AbebeDinkuBottled water &non alcoholicbevefactory	Top water	75,600,000.00	14,000 bph
67.	Asku soft drink PLC	Aqua addis	189,831,600.00	837 bpl
68	Agmas Manufacturing PLc	Agmas water	37,800,000.00	
69		Nova	43,200,000.00	

Data source: Ethiopia Food and Beverage Institute assessment report

ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF MANAGEMENT

Interview Guide

Dear Sir/ Madam;

First of all I would like to extend my appreciation and gratitude for your willingness to respond to my questions. My name is **Tesfaye Temesgen.** I am attending the Executive MBA program at Addis Ababa University, College of Business and Economics. Currently, I am conducting a research on '***Environmental Impacts of disposable PET plastic bottle: The case of water bottling companies in Addis Ababa***' for the partial fulfillment of the requirements of Master's degree in Executive Business Administration. This interview is made so as to have more in depth on the matter under study.

Taking into consideration that your response is very valuable to complete this study, you are kindly requested to participate in this survey which will not take you more than 30 minutes. Thus, I kindly request you to answer all the questions assuring you that all responses will be used only as an input for this study.

Thank you for your time!!

Part I: General background

I. Interviewee Name : ----------

II. Organization : : ----------

III. Position : ----------

IV. Experience : ----------

V. Other : ----------

Part II: I again kindly request you to answer all listed questions assuring that your experience and capabilities will have valuable impact on the study.

1. How do you relate your organization's objectives in managing of environmental impacts to that of packaging waste in general and disposable PET bottles in particular?

2. How do you describe the sustainable development issues of bottled water business for its disposable PET bottles?

3. In what ways do different countries and companies act in response for sustainable development issues of their plastic water bottling business?

4. In what way your office manages the Environmental impacts of wastes in general and disposable PET bottle in particular?

5. How do you explain the specific data management practice of your office for all wastes in general and PET bottles in particular?

6. How can you describe the important of economic valuation of environmental impacts of any project in general?

7. How can you express your office's experience in valuation of environmental impacts for any wastes in general and PET bottles in particular?

8. How can you describe the existing policy and environmental regulatory frameworks for managing of environmental impact of any project in general and PET bottles inn particular?

9. What should be done?

END OF QUESTIONNAIRE

Thank you very much for your participation.