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ADOPTION AND IMPLEMENTATION OF WASTE WATER TREATMENT TECHNOLOGIES: THE CASE OF TEXTILE INDUSTRIES

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This is to certify that the thesis prepared by Ameha Tegegne Dagnaw, entitled: “*Adoption and impact of environmental management technology: the case of waste water treatment technologies in textile industries*” and submitted in partial fulfillment of the requirement for the degree of master of arts (Environment and sustainable development) complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Advisor	Signature	Date

Chair of Department or Graduate Program Coordinator

DEDICATION

This thesis work is dedicated to my sweet daughter, Meklit Ameha for her active participation and encouragement.

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Acronyms

AGOA	African Growth and Opportunity Act
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
COMESA	Common Market for Eastern and Southern Africa
CRGE	Climate Resilient Green Economy
DS	Dissolved Solid
TDS	Total Dissolved Solid
EFCCC	Environment, Forest and Climate Change Commission
EIA	Environmental Impact Assessment
EiTEX	Ethiopian Institute of Textile and Fashion Technology
EMS	Environmental Management System
EPA	Environmental Protection Authority
ETP	Effluent Treatment Plant
ETIDI	Ethiopian Textile Industries Development Institute
ETP	Effluent Treatment Plant
ISO	International Organization for Standardization
KII	Key Informant Interview
MEFCC	Ministry of Environment, Forest and Climate Change
MOAL	Ministry Of Agriculture and Livestock
MOI	Ministry Of Industry
MOUD	Ministry of Urban Development
PH	Power of Hydrogen
RBC	Rotating Biological Contactors
RO	Reverse Osmosis
SS	Suspended Solid
TSS	Total Suspended Solids
WWTP	Waste Water Treatment Plant

ABSTRACT

Adoption and impact of environmental management technology: the case of waste water treatment technologies in textile industries

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Industrialization, although a promising tool to pull out many societies from poverty and enhances economic growth, is featured by different environmental consequences like pollution. Ethiopia's commitment to boost industrialization in order to achieve the middle income status plan by 2025 prioritizing the textile sector has brought about fast growth of textile industries which are known for their high polluting nature. Besides the adoption of waste water treatment technologies in textile industries to prevent water pollution, implementation of these technologies is not done accordingly and the result is far below the national expectation, water pollution due to discharge of untreated waste water from textile industries is increasing with time. This study is therefore intended to explore the implementation status of adopted treatment technologies in Ethiopian textile industries and identify challenges related to their implementation. Qualitative approach was employed in this research and data was collected via interviews, site visit/observation, notes from informal discussions during visit and open-ended questions. Results of the analysis showed that lack of environmental awareness and technical support from pertinent institutions, lack of treatment chemicals and spare parts, poor enforcement of environmental laws and lack of commitment both from industries and environmental governing bodies to do accordingly are main causes for poor implementation status of adopted technologies. Accordingly, it is concluded that environmental issues are not properly addressed to all key players that there is lack of integration among them and due attention is not given to the problem at all levels. It is therefore recommended that all concerned bodies particularly governmental regulatory bodies to do their utmost efforts in enhancing implementation of adopted technologies through providing support to textile industries, facilitating local manufacture of treatment chemicals, formulate an environmental organ at national level who own and responsibly manage environmental issues accordingly.

CHAPTER I: Introduction

1.1 Background

Industry is central to the economies of modern societies and is an indispensable means of growth. According to Ayodele and Falokun (2013), Governments especially in developing countries, see industrialization as a weapon for increasing national output to minimize dependence on developed countries and minimize fluctuation in foreign exchange earnings.

Mandara and Ali (2018) also argued that Industrialization is the backbone of a country's economic growth and development. It brings about an increased volume and varieties of manufactured goods resulting in increased employment and improved standard of living of the citizens.

The more developed a country's industrial capacity, the greater the potential for economic growth and development (European Commission 2006). Industrialization has assumed super importance for accelerating economic development in both the developed and developing nations, it reduces unemployment and poverty and is considered a pathway to prosperity. Ibbih and Gaiya (2013, P.150) conclude that industrial growth by all intents and purposes is an undisputed pre-requisite for economic growth and development. If transformation will take place and the trend of poverty is to be reduced, rapid industrialization in the African sub-region is an agenda to be pursued.

According to Mandara and Ali (2018), industrialization enhances the utilization of productive inputs (labor, capital and raw materials) and builds up a country's capacity to produce varieties of products given the country's technology, to produce non-durable and durable consumer goods, intermediate goods, finished and semi-finished goods and capital goods for domestic consumption, export or further production. Industrialization is therefore such a crucial and critical key to economic growth that it calls for improvement in systems, technologies and processes that will utilize natural resources more efficiently to bring about fast production growth (Ibbih and Gaiya, 2013, P.150)

However, industrialization is accompanied by serious challenges associated with environmental pollution due to discharge of huge volume of industrial wastes. Large quantity of water

consumption associated with the use of number of dyeing and printing chemicals releases toxic and highly contaminated wastewater to the environment resulting in severe surface and ground water pollution. This waste water causes pollution of surface and ground water, contaminate soil with harmful chemicals which in turn affects plant and animal life due to absorption and intake of minerals from the polluted and contaminated water and soil.

Following the Government of Ethiopia's commitment to undertake structural transformation of the economy from Agriculture to industry, it has prioritized the textile sector as a key area of boosting the industrialization process due to the comparative advantages that the sector has like local availability of raw material, low labor and power cost, and different market opportunities like AGOA (the African Growth and Opportunity Act) and COMESA (the Common Market of Eastern and Southern Africa).

Khurana (2018) mentioned that Ethiopia is today at the advent of industrialization in various business sectors and textile and apparel is one of the sectors that has received a lot of attention from the government and the objective is to become sourcing destinations of the world.

However, due to high polluting nature of the textile industry because of release of chemically contaminated waste water, the country is facing serious environmental pollution among the many (ground and surface water pollution in particular).

Nikolina Sajn (2019) discussed that the production of raw materials is responsible for a large share of the environmental impact of the textile and clothing industry, not least from growing crops for natural fibers. Cotton, which according to a 2015 report from European Clothing Action Plan (ECAP) accounts for more than 43% of all fibers used for clothes on the EU market, is considered especially problematic because it requires huge quantities of land, water, fertilizers and pesticides.

According to Kant (2012 p.23), textile effluent is a cause of significant amount of environmental degradation and human illnesses, about 40 percent of globally used colorants contain organically bound chlorine, a known carcinogen. All the organic materials present in the wastewater from a textile industry are of great concern in water treatment because they react with many disinfectants especially chlorine.

From the washing of fibers to bleaching, dyeing and washing of finished products, the textile industry uses high volumes of water throughout its operations and on average, approximately 200 liters of water are required to produce 1 kg of textiles (Chokalingam, Prakash and Maruthavanan, 2009). Of all the steps involved in textiles processing, wet processing creates the highest volume of wastewater. The large volumes of wastewater generated also contain a wide variety of organic and inorganic chemicals, used throughout processing and this can cause damage to the nearby water bodies, soil and human health if not properly treated before being discharged into the environment. Understanding the adverse impact of industrialization on the environment on one hand, and its unreplaceable contribution to economic development on the other, it is therefore more than a choice to keep industrialization with appropriate mitigation measures. This can be achieved using the concept of sustainable development and the use of appropriate environmental management technologies like modern waste water treatment technologies.

Cordero (2005) mentions sustainable development concept recognizes that economic growth and environmental protection are inextricably linked but they are not necessarily opposed. With the use of competent and appropriate technologies which are specific to industries and the kind of waste they generate, environmental friendly operations are possible and hence the adverse impact of industries can be minimized.

According to Cordero (2005), environmental care and economic growth are not incompatibles but to meet them is not easy; the adoption of technologies in order to limit pollutant emissions and resource consumptions requires incentives and enforceable rules that promote the use of renewable technologies. One of these technologies is the waste water treatment technology that allows industries to treat the waste water from their operations to an acceptable degree and comply with relevant national and international standards.

Accordingly, many textile industries in Ethiopia have installed such treatment technologies but the treated water in most cases do not comply to the specific environmental standards mostly due to poor operational practices (Ethiopian Textile Industry Development Institute (ETIDI), 2015). This paper is thus intended to explore the policy, legal, institutional and operational dimensions to identify the major challenges in the implementation of adopting waste management technologies in the textile industries.

1.2 Statement of the Problem

The Government of Ethiopia has developed a strategic plan in 2013 (Ethiopian Industrial Development Strategic Plan (2013-2015) FDRE Ministry of Industry) in order to achieve the country's vision of achieving lower middle income status by the year 2025 through green industrialization as briefly presented in the Climate Resilient Green Economy (CRGE) strategy. As a result, the number of manufacturing industries is increasing from time to time. Following this industrial growth, environmental problems especially severe pollution of surface and ground water sources has reported to be increasing and causing an adverse health impacts to human beings and the ecosystem.

Mean while, the current track record of Ethiopia indicates that most of the textile industries lack competency in environmental compliance/management and are not inline with the global demand of carbon neutrality and environmental pollution (ETIDI 2015). There are no enough and well-established effluent treatment facilities and even those installed are not functioning properly in many plants (ETIDI 2015). As a result, surface and ground water sources at different places in the country and nearby textile industries are getting severely polluted with chemically contaminated and hazardous waste water released from the industries. Unless an immediate mitigation action (like adoption of waste water treatment technologies) is taken and a systematic environmental management system is established, it will cause impairment of human health with different diseases like cancer, disruption of the ecosystem through destroying aquatic animals and plants and also will compromise sustainability of the industrialization process. To mention some, different studies like Beyene (2009), Nigussie (2008), Rooijen & Gebre (2009), and Diriba-Dadi (2018) have shown the adverse impact of industrial pollution on surface and ground water in and around Addis Ababa and its severe consequence on human health and the environment at large.

However, none of these studies critically investigate the root causes and challenges related to problems of the industries not to meet environmental standards or the inability of adopted treatment technologie installed in the textile industries to treat the wastewater to the required quality. Due to this, the textile industries despite adoption and installation of treatment technologies, still textile industries are major causes of pollution for ground and surface water

sources. The aim of this study is thus to fill this gap through identifying the root causes and challenges faced by the industries to implement the adopted waste water treatment technologies properly to comply with environmental standards and propose appropriate mitigation measures.

1.3 Objectives of the Study

The general objective of this study is to explore the implementation status/performance of waste water treatment technologies in Ethiopian textile industries and identify challenges faced by the industries to meet environmental standards and prevent pollution.

Specific objectives

The specific objectives of this study include:

- To assess the policy, organizational and operational structure in the implementation of waste water treatment technologies in the textile industries
- To examine the type and performance of installed treatment technologies in terms of meeting national and international environmental standards.
- To understand the major challenges in implementing the technologies

1.4 Scope of the Study

The study considers about 25% of the textile industries in Ethiopia which have wet processing facilities and the selected industries are from Addis Ababa, Amhara and Oromia regions. Within these industries, the existing and adopted waste water treatment technologies and their performance/compliance to national and international environmental standards and challenges related to implementation of these technologies have been examined.

1.5 Limitations of the Study

The limitations of this study are only water pollution is considered while industries cause different kinds of pollution including air, noise and soil pollution. In addition to this, in spite of the fact that nearly all manufacturing industries contribute for environmental pollution with different degrees, the study focuses on textile industries only for the interest of time and budget.

1.6 Significance of the Study

The study will have the following significances for different parties:

- Academia: For academia, this research work can be used as a reference and starting material to trigger further studies in the field.
- Policy makers/regulatory bodies: For policy makers and regulatory bodies, it is an alarm showing the natural environment especially surface and ground water sources are at risk due to industrial pollution and need revision or modification of development plans and do corrective actions based on the findings.
- Industrialists/operators: it shows the environmental and societal status of their firms and gaps related to implementation of the adopted environmental management technologies so that they may take appropriate action or make necessary process adjustments to act in an environmental friendly and socially acceptable manner which otherwise their business and/or the development activity will not be sustained.
- Community: This research work informs the community about the existing environmental problems related to the textile industries and helps to strengthen all rounded participation and follow up of industrial activities with respect to pollution.

1.7 Organization of the Paper

This study is divided in to five chapters. The first chapter is about introduction of the study followed by back ground to the study, statement of the problem, general and specific objectives, scope, limitations and significance of the study. Chapter two encompasses review of some related literatures to the subject and conceptual frame work of the study. The third chapter is about methodology used for this study and includes sampling technique, sample sources, data collection and analysis methods. In chapter four, the adoption and implementation of waste water treatment technologies in textile industries is discussed based on the research objectives and the conceptual frame work developed for this study. Finally, chapter five presents conclusion and recommendations made for this study.

1.8 Concepts and Definitions

Waste Water: Water which is generated as a by-product from process unit operation having constituents which can cause harmful & hazardous effect to human, animal, plants, aquatic & microbial life / different life forms on the earth. (WunJern, Empirical College Press, 2006)

Waste Water Treatment: is a process which is being done on the waste water to change its quality for drinking or other purposes. Waste Water treatment takes place in a Waste Water treatment plant which should be designed under different circumstances (Kordrostami, 2015)

Environmental Management: The result of strategic practices regarding the natural environment, often based on managers' perceptions regarding the importance given to the environment and the many external restrictions that are imposed (Coyle & Thom chick, 2001)

Environmental Management System (EMS): is Part of an organization's management system used to develop and implement its environmental policy and manage its environmental aspects (ISO 14001).

Biological Oxygen Demand (BOD): BOD₅ is a measure of the quantity of dissolved oxygen used by microorganisms in the biochemical oxidation of the organic matter in the wastewater over a 5-day period at 20⁰C (Singh, 2012).

Chemical Oxygen Demand (COD): COD is a measure of the oxygen equivalent of the organic material chemically oxidized in the reaction and is determined by adding dichromate in an acid solution of the wastewater (Singh, 2012).

Water Pollution: "Such contamination of water or such alteration of the physical, chemical, or biological properties of water or such discharge of any sewage or trade effluent or any other liquid, gaseous or solid substance into water as may, or is likely to create a nuisance or render such water harmful or injurious to public health or safety or to domestic, commercial, industrial, agricultural or other legitimate uses or to the life and health of animals or aquatic organism (Pathak, 2013).

Pollutant: is a substance which when introduced into environment causes undesirable effects or spoils resources. Long or short term damage may be caused due to pollutant Biodegradable pollutants only cause short term damage, (Chaudhry and Malik, 2017).

Primary treatment: the first stage of wastewater treatment that removes settleable or floating solids only; generally removes 40% of the suspended solids and 30-40% of the BOD in the Wastewater (Cheremisinoff, 2002).

Secondary treatment: a type of wastewater treatment used to convert dissolved and suspended pollutants into a form that can be removed, producing a relatively highly treated effluent (Cheremisinoff, 2002).

Sedimentation: also known as settling, may be defined as the removal of solid particles from a suspension by settling under gravity (Kumar 2016)

Aeration: exposing to circulating air; adds oxygen to the wastewater and allows other gases trapped in the wastewater to escape and is the first step in secondary treatment via activated sludge process (Chavan, 2001).

Suspended Solids: which represent the solids that are solids: in suspension in the water. Generally comprised of 70% organic and 30% inorganic solids and can be removed by physical or mechanical means (Kumar 2016)

CHAPTER II: Literature Review

2.1 Industrialization and Environment

Industrialization is the backbone of a country's economic growth and development bringing about an increased volume and varieties of manufactured goods resulting in increased employment and improved standard of living of the citizens (Mandara and Ali, 2018).

At the same time, industrial processes can have negative environmental impacts, causing climate change, loss of natural resources, air and water pollution and extinction of species (European Commission 2006).

Since ages, industrial growth has started to affect environment with severe downside problems causing tremendous stress on the entire bionetwork and natural system components like water, air, soil, biodiversity including surrounding eco-system (Patnaik, 2017). Industrialization, as an option other than agriculture helps to bring about economic growth both in developing and developed countries but it is also accompanied with adverse environmental impacts like pollution and depletion of natural resources. Everett et al., (2010), mentioned that the relationship between economic growth and the environment is complex that several different drivers come into play, including the scale and composition of the economy – particularly the share of services in GDP as opposed to primary industries and manufacturing – and changes in technology that have the potential to reduce the environmental impacts of production and consumption decisions whilst also driving economic growth.

According to Bhandari (2016), industrialization has resulted in the increase in the emission of harmful effluents and pollutants both into water, soil and air. These effluents have caused a severe and irreversible destruction to the different species residing in those specific ecosystems. (Patnaik, 2017) also mentioned that with a sudden boom in industries, the pattern of resource utilization in the form of energy, water usage etc increased drastically leading to the inevitable resource disturbance and imbalance.

Toprak (2017) discussed that the unsustainable “footprint” of industrialization or any other economic activity would first lead to sharply rising input prices, and ultimately to the depletion

of crucial inputs, pushing substitution costs to unaffordable high levels. This could have significant impacts on growth, both in developed but even more so in developing countries.

According to Guo (2008), environment does not only provide the substance foundation and activity space for human, but also is responsible for production castoff by human activity. Cordero (2005) also describes that in a simple model for the relationship between the natural and the social systems we have on the one side, the flow of natural resources to the system, and on the other side, the flow of waste products back to the environment. Guo (2008) further discussed that economic development not only enhances the integration of national power and improves the people's life quality, but brings a number of serious environmental problems, such as air pollution, water pollution, soil degradation, desertification, and so on.

Patnaik (2017), in his report "Impact of Industrialization on Environment and Sustainable Solutions – Reflections from a South Indian Region" described the impact of industrialization on environment as follows:

Industrialization has brought economic prosperity; additionally it has resulted in more population, urbanization, obvious stress on the basic life supporting systems while pushing the environmental impacts closer to the threshold limits of tolerance. With booming industrial growth and relatively low land mass, environmental sustainability is now becoming a significant deciding factor in industrial development process. Accumulating evidences constantly indicate that the transition of the existing industries into eco-industrial network through successful implementation of green approaches provides a viable solution to preserve the natural resources of the region while concurrently enhances the regional economy on a sustainable basis. It calls for an appropriate planning and integrated framework in harmony with the environment, after careful assessment of past and prevailing conditions. The empirical knowledge on affected area helps understanding the local context and developing further course of action based on ground realities. With this aim, a study was conducted on the current industrial pollution and environmental setting of Puducherry. A causal chain analysis indicated severe impacts of industrialization on local environment while highlighting its immediate and root causes. The findings form a base for suggesting sustainable solutions to curb rampant pollution in Puducherry region and similar scenarios found across the world.

Economic and environmental performance must go hand in hand, the natural environment is central to economic activity and growth, providing the resources we need to produce goods and

services, and absorbing and processing unwanted by-products in the form of pollution and waste (Everett et al., 2010),

If industrialization is carried out in a sustainable manner, taking into account the often fragile nature of the surrounding environment, societal patterns and economic conditions, this can achieve lasting improvements in living standards, incomes, working conditions, education and healthcare. If, on the other hand, industrial development is coupled with environmental degradation and resource depletion, societal exploitation and economic recklessness, the associated benefits, if any, will not last (European Commission, 2006).

2.2 Adverse Environmental Impacts of Textile Industries

Chavan (2001) mentioned that any industrial activity causes pollution in one form or another and so does the textile industry. Kant (2012) also discussed that the textile dyeing and finishing industry has created a huge pollution problem as it is one of the most chemically intensive industries on earth, and the number one polluter of clean water (after agriculture). Having a very long value chain the textile industry is one of the most complicated manufacturing sectors being fragmented and heterogeneous dominated by small and medium sized enterprises.

According to Chavan (2001, p.15), this industry covers a wide spectrum of production activities and is diverse in terms of raw materials and techniques employed, chemicals used and the final products. It is composed of wide number of sub-sectors covering the entire production cycle from the production of raw materials to semi-processed intermediate products and final/consumer products. The complexity of the whole production is so high to the extent of facing difficulties in finding a clear-cut classification among the different activities involved.

The textile industries are also among those manufacturing industries which use vast amounts of natural resources such as water, land and other resources throughout their entire lifecycle, from production of fibers, manufacturing, distribution, consumer use to the clothes' end-of-life at disposal and consecutively they are major causes of environmental pollution by discharging huge volume of waste water. Choudhary (2017) mentioned that textile processing industry is characterized not only consuming large volume of water required for various unit operations but also by the variety of chemicals used for various processes.

Laitala (2018) also explains that textiles constitute a substantial proportion of the global environmental burden that environmental impacts occur in all stages including fiber production due to agriculture and industrial synthesis through a variety of processes such as spinning, weaving, sewing, and further to application of various properties such as color, waterproofing, flame retardants, etc.

According to Choudhary (2017), the whole textile processing activities generate many waste streams, including liquid, gaseous and solid wastes, some of which may be hazardous and the nature of the waste generated depends on the type of textile facility, the processes and technologies being operated and the types of fibers and chemicals used. However, liquid effluent is of utmost concern because of its high volume and pollution potential. Quantity and nature of waste generated depends on the fabric being processed, chemicals being used, technology being employed, operating practices etc.

Toprak et al. (2017) described that the textile industry uses high amounts of chemicals and water to form waste after processing, this sector has been convicted of pollution as one of the world's biggest criminals and in the textile industry, about 2000 varied chemicals are used, including dye, transfer agents etc. There is a long sequence of wet processing stages requiring inputs of water, chemicals and energy and generating wastes with different degrees of pollution at each stage. Choudhary (2017) also mentioned that the important pollutants present in a typical textile waste effluent are color, bio-chemical oxygen demand (BOD), chemical oxygen demand (COD), toxic heavy metals, residual chlorine, dissolved solids (DS), suspended solids (SS) and non-biodegradable organics termed as refractory materials.

Large numbers of textile industries are located on the coastal areas due to ease of transport to the various places in world and help in building nations economy, but on the contrary the effluents released from these industries are proving a great problem for the marine life (Shertate and Thorat, 2014). The harmful chemicals and colloidal matter presents in textile effluents increases the turbidity, gives bad appearance, foul smell and prevents the penetration of sunlight into water bodies required for the photosynthesis which interfere with the oxygen transfer mechanism and hence marine life (Rummi 2017).

Kelly (2007) also explains that in addition to its heavy use of pesticides and insecticides, the textile sector creates a huge impact on both environmental and human health through the extractive supply chain for petroleum-based synthetic fibers. The textile dyeing process is also considered as highly wasteful; between 70 and 150 liters of water may be required to dye 1kg of textiles (Babu et al. 2007).

Textile industries use and release a wide range of chemicals at various stages during the product's lifecycle that, especially when untreated, causes serious threat to our living environment. According to Chokalingam (2009) and Badu et al. (2007), the textile dyeing industry uses high volumes of water throughout its operations, from the washing of fibers to bleaching, dyeing and washing of finished products and on average, approximately 200 liters of water are required to produce 1 kg of textiles.

Similarly, Brown and Anliker, as cited in Amte and Mhaskar (2013, p.93) summarized the effects of textile effluent on the environment and the toxicity with respect to fish and other aquatic organisms, sewage bacteria and plants to be severely damaging and irreversible. For example, suspended solids can clog fish gills, either killing them or reducing their growth rate. Other important impact, they also reduce light penetration and the ability of algae to produce food and oxygen (Tufekci et al. 2007).

2.3 Environmental Management Practices in Ethiopia

2.3.1 Policy, Legal and Institutional Frameworks

Incorporation of environmental rights under the constitution, adoption of environmental Policy and the conservation strategies, ratification of multilateral environmental conventions, establishment of the Environmental Protection institutions are some of the basic moves towards heading for environmental protection and sustainable development in Ethiopia.

The Ethiopian Constitution provides a coherent and integrated framework addressing Environmental Management issues as well as the foundation for environmental regulation and policy in Ethiopia. In doing so it resulted in the considerable body of environmental legislation which has developed since 1994. The right to environmental protection and to live in an

environment that is not harmful to health or well-being is set out in the constitution. This fundamental right underpins environmental policy and laws.

The 1994 Constitution of Ethiopia under Articles 43, 44 and 92 claims the following: In Article 43, the right to development, where peoples' right to:

- improved living standards and to sustainable development,
- participate in national development and, in particular, be consulted with respect to policies related to development of projects affecting their community, & the enhancement of their capacities for development and to meet their basic needs, are boldly recognized.

Similarly, in article 44, Environmental rights, all citizens are entitled to:

- Live in a clean and healthy environment
 - Compensation, including relocation with adequate state assistance.
- Moreover, in article 92, Environmental Objectives, it is declared that,
- Government shall endeavor to ensure that all Ethiopians live in a clean and healthy environment
 - The design and implementation of programs and projects of development shall not damage or destroy the environment.
 - Peoples have the right to full consultation and to the expression of views in the planning and implementation of environmental policies and projects that affect them directly.
 - Government and citizens shall have a duty to protect the environment.

Proclamation No, 1/1995 proclaims that there shall exist clean and healthy environment all over the nation to ensure the provision of the right of all citizens to a clean and healthy environment. According to this constitutional right, the following laws/proclamations were proclaimed so as to bring the commitment in to action.

- Conservation Strategy and Environmental Policy of Ethiopia– 1997
- Ethiopian water resources management proclamation - proclamation No. 197/2000
- Proclamation for the Establishment of Environmental Organs – 295/2002
- Environmental Impact Assessment Proclamation – 299/2002
- Pollution Control Proclamation – 300/2002

- Solid Waste Management Proclamation - proclamation No. 513/2007
- Proclamation of Industrial Pollution Council of Ministers Regulation No. 159/2008

The overall Ethiopian Environmental Policy Goal is to improve and enhance the health and quality of life of all citizens and to promote sustainable social and economic development through sound management and use of natural, human-made and cultural resources and the environment as a whole to meet the needs of the present generation without compromising the ability of future generations to meet their own needs (Environmental Policy of Ethiopia 1997).

Accordingly institutional arrangement is also done at all levels (from Federal to Regions and Woredas) to enhance the implementation and enforcement of these proclamations/laws and policies without affecting the development process. The institutions who take the lion's share in mobilizing environmental concerns are:

Environment, Forest and Climate Change Commission (EFCCC)

Previously the Ministry of Environment, Forest and Climate Change (MEFCC) of the Federal Democratic Republic of Ethiopia, and these days, the Environment, Forest and Climate Change Commission (EFCCC) is an independent organization accountable directly to the Office of the Prime Minister.

The commission, in cooperation with pertinent Federal Ministries like Ministry of Industry (MOI), Ministry of Agriculture and Livestock (MOAL), Ministry of Urban Development (MOUD),... and also with Regional institutions has the following key functions:

- Prepare environmental protection policy laws and ensure the implementation
- Prepare directives, devise systems and ensure their implementation;
- Prepare environmental protection standards directives concerning soil, water, and air
- Enhance environmental awareness and training programs;
- Ensure the implementation of international treaties concerning the environment to which Ethiopia is a signatory
- Provide advice and technical support to the regions on environmental matters

Regional Environmental Protection Offices

In all regions except Addis Ababa and Dire Dawa, responsibility of environmental matters goes to Regional Land and Environmental Protection Bureau. But Addis Ababa and Dire Dawa have Environmental Protection Authority (EPA) offices under the city administrations.

Accordingly, the bureaus share the following duties and responsibilities.

- follow up the implementation of national environmental policy and laws
- Prepare regional environmental protection and directives and upon approval follow up and supervise their implementation
- regulate and follow up that any development project shall conduct EIA prior to the project implementation and review of the project's EIA report
- undertake environmental auditing of industries for safe disposal and handling of wastes
- Prepare appropriate standards to protect the environment including soil, water and air as well as the biological system in the city.

In addition to this, environment is a hot agenda these days and is mainstreamed in all ministries (at least in principle) and each ministry is directly or indirectly aware and involved in environmental issues.

2.3.2 Waste Water Treatment Technologies in Ethiopian Textile Industries

Industrial waste water (effluent) from industries must meet the national effluent discharge quality standards set by Governments and consequently any effluent treatment plant (ETP) must be designed and operated in such a way to enable the treated waste water meet those prescribed standards (Sing 2012).

Currently, there are about 160 textile and garment industries in Ethiopia of which 25 industries have wet processing facilities (ETIDI 2017). Due to the different and large volume of chemicals that are used in the different operations of the wet processing unit, this category of the textile industry is characterized by generation of chemical intensive waste water and responsible for environmental pollution. Appropriate waste water treatment technology is therefore required for textile industries with wet processing facilities.

As it is the case in all other countries in the world, industrial waste water in Ethiopia is treated with the use of waste water or effluent treatment plant (ETP). Waste water treatment processes can involve physical, chemical and biological processes depending on the required effluent standards and nature of the wastewater (Environmental Protection Agency, Ireland, 1995).

The researcher, in his field visit/observation has learnt that most of the effluent treatment plants adopted and installed in the textile industries are conventional treatment plants having biological treatment, chemical treatment or combination of the two. In all cases, there are common treatment steps to be followed sequentially to complete the treatment process (Singh 2012). The common treatment steps are Preliminary, Primary, Secondary and Tertiary treatment.

Preliminary treatment: An important part of any wastewater treatment plant is the equipment and facilities used to remove items such as rags, grit, sticks, other debris, and foreign objects (Babu et al., 2007). Preliminary treatment operations typically include coarse screening, grit removal and, in some cases, comminution of large objects.

The purpose of preliminary treatment is to ensure a satisfactory quality of final effluent and final sludge product and to protect the treatment process from malfunction associated with accumulation of screenings, debris, inorganic grit, excessive scum formation or loss of efficiency associated with grease or oil films or fat accumulations (Environmental Protection Agency, Ireland, 1995).

Upon arrival via the sewer system, the wastewater is sent through a bar screen, which removes large solid objects such as sticks and rags. Leaving the bar screen, the wastewater flow is slowed down entering the grit tank, to allow sand, gravel and other heavy material that was small enough not to be caught by the bar screen to settle to the bottom. All the collected debris from the grit tank and bar screen is disposed of at a sanitary landfill (Kumar, 2016). In grit chambers, the velocity of the water through the chamber is maintained sufficiently high, or air is used, so as to prevent the settling of most organic solids and reduce the size of large particles so that they will be removed in the form of sludge in subsequent treatment processes (Singh, 2012).

Primary treatment: Primary treatment is the second step in wastewater treatment and is designed for the physico-chemical separation of solid and grease components from the wastewater (Kumar 2016). In many industrialized countries, primary treatment is the minimum level of pre-application treatment required for wastewater irrigation (Jaidev Singh (2012).

The objective of primary treatment is the removal of settle-able organic and inorganic solids by sedimentation, and the removal of materials that will float (scum) by skimming (Pescod 1992). Primary treatment is also referred as physico-chemical treatment (coagulation and flocculation) and requires chemicals for these processes to remove much, possibly all of the color depending on the process used, (Marciniak et al. 2018).

According to Pescod (1992), the removal rate is dependent on the influent wastewater quality and approximately 25 to 50% of the incoming biochemical oxygen demand (BOD₅), 50 to 70% of the total suspended solids (SS), and 65% of the oil and grease are removed during primary treatment. Some organic nitrogen, organic phosphorus, and heavy metals associated with solids are also removed during primary sedimentation.

The basic units needed for a stand-alone physico-chemical treatment plant are screening, an equalization unit, a pH control unit, chemical storage tanks, a mixing unit, a flocculation unit, a settling unit and a sludge dewatering unit (Singh 2012).

Secondary treatment: Secondary treatment is a biological treatment process that removes dissolved organic matter from wastewater through microorganisms which consume organic matter from the waste as their food supply (Kumar 2016).

The objective of secondary treatment is the further treatment of the effluent from primary treatment to remove the residual organics and suspended solids (Pescod 1992). In most cases, secondary treatment follows primary treatment and is also called biological treatment since it involves the removal of biodegradable dissolved and colloidal organic matter biologically using aerobic processes (Graham et al., 2013). Aerobic biological treatment is performed in the presence of oxygen by aerobic microorganisms (principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more microorganisms and inorganic end-products (principally CO₂, NH₃, and H₂O). Several aerobic biological processes are used for secondary

treatment differing primarily in the manner in which oxygen is supplied to the microorganisms and in the rate at which organisms metabolize the organic matter (Pescod 1992).

Different researches show that output quality from biological treatment can satisfy nearly all national standards for most of the required parameters except color. The basic units needed for biological treatment are: screening, an equalization unit, a pH control unit, an aeration unit, and a settling unit (Singh 2012).

A properly designed biological ETP can efficiently satisfy BOD, pH, TSS, oil and grease requirements Metcalf & Eddy (2003). However, most compounds in industrial wastewater may be toxic to the microorganisms so pretreatment may be necessary. Similarly most dyes are complex chemicals and are difficult for microbes to degrade so there is usually very little color removal.

Depending on the nature of the wastewater, a treatment plant may require both biological and physico-chemical treatment processes and hence combined physico-chemical and biological ETPs are used in such cases. According to Singh (2012), these are also the most common forms of ETP used for the treatment of textile wastewater and are likely to meet most water quality standards as they provide the benefit of physical, chemical and biological treatment and can therefore raise the efficiency of BOD and COD removal to 90 %.

The basic units needed for a physico-chemical and biological treatment plant according to Singh (2012) are screening, an equalization unit, a pH control unit, chemical storage tanks, mixing units, flocculation units, a primary settling unit, an aeration unit, and a secondary settling unit.

Tertiary and/or advanced treatment: Tertiary and/or advanced wastewater treatment is employed when specific wastewater constituents which cannot be removed by secondary treatment must be removed and treated water is claimed to be reused for industrial or other purposes (Babu et al., 2007). Tertiary treatment consists of processes that are designed to achieve higher effluent quality than attainable by conventional secondary treatment methods and these include polishing steps such as activated carbon adsorption, ion exchange, reverse osmosis, electro dialysis, chemical oxidation, and nutrient removal (Graham 2013). Although not technically a tertiary process, final effluent disinfection is often performed after secondary or

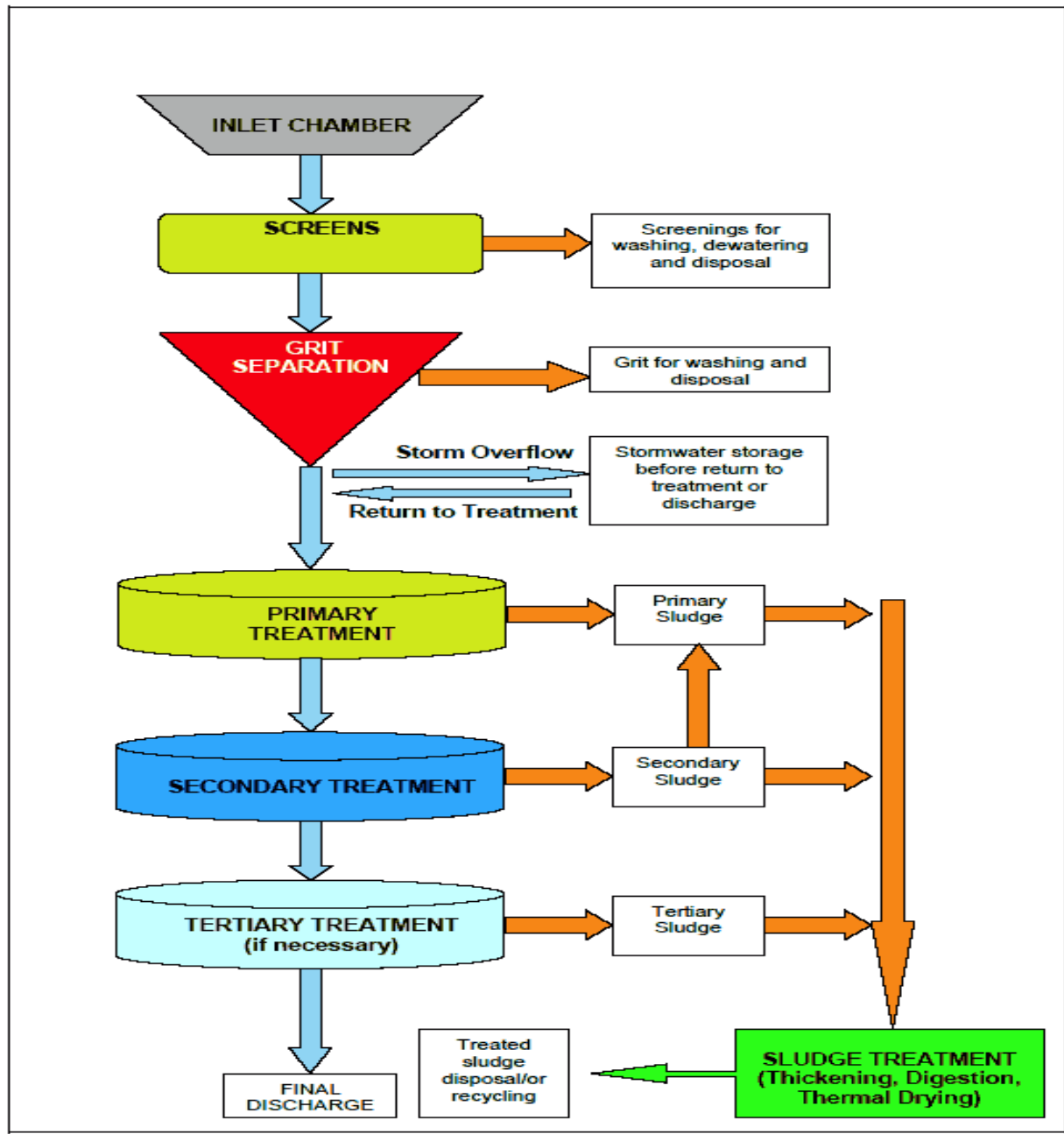
tertiary treatment using chlorination, ultraviolet methods, ozonation, and other methods designed specifically to kill residual organisms in the wastewater after all previous treatment steps.

The different treatment steps/levels and processes at each step with the purpose of each process is summarized in (Table 1) and a generalized waste water treatment process model is shown in (Fig. 1) below.

Table 1: Wastewater Treatment Levels and Processes (Singh (2012))

Treatment Level	Description/purpose	Process
Preliminary	Removal of large solids such as rags, sticks, grit and grease that may damage equipment or result in operational problems	Physical
Primary	Removal of floating and settleable materials such suspended solids and organic matter	Physical and chemical
Secondary	Removal of biodegradable organic matter and suspended solids	Biological and chemical
Tertiary	Removal of residual suspended solids/ dissolved solids	Physical, chemical and biological

Fig. 1. Generalized Waste water treatment Process Model (Athar Rizwan, 2008).



2.3.3 Performance of adopted Waste Water Treatment Technologies

It is a common experience to hear from different classes of the community and some international business firms complaining that the textile industries in Ethiopia are causing pollution to the environment, especially of surface and ground water. In addition to this, it can also be witnessed without looking for further references just by having a close look at different rivers nearby those industries carrying colored water. This color of the water is nothing but due to the release of chemical intensive waste water from textile industries.

These days, most of the textile industries having wet processing facilities have already adopted and installed waste water treatment (effluent treatment) technologies (ETIDI 2013). But environmental pollution especially of surface and ground water pollution due to discharge of waste water from the textile industries is intensifying parallel with increasing number of these industries. Due to the malfunctioning of the effluent treatment plants for different reasons (mostly because of poor operational practice like assignment of non professional operators and use of non appropriate chemicals), the textile industries, whether they install treatment plants or not, are causing pollution to the nearby surface and ground water bodies (ETIDI 2015).

However, this does not necessarily mean the adopted technologies are not effective to treat the wastewater to the required standard. The data collected from both ETIDI and the industries (laboratory test result report of treated waste water from the ETPs for the years 2013 - 2018 shows that the test results vary irregularly from one industry to another while the adopted technologies being the same. In the case of some textile industries, the test result for different waste water parameters (BOD, COD, TSS....) are far below the allowable limit of discharge for textile industries and hence comply with the national standard (Table 2). While in other textile industries, the test results for those waste water parameters (BOD, COD, TSS....) is higher than the allowable limit of discharge and fail to comply with the standard.

The difference in the performance of ETPs while using the same technology as mentioned above is not only between different textile industries but also within the same industry evaluated at different times. i.e. it was found that test results of some waste water parameters which was

below the allowable limit of discharge at one year will be higher than the allowable limit of discharge for the coming year (ETIDI evaluation report 2013 - 2018).

In both cases, it was observed that, though inconsistently, the required quality of waste water treated with the adopted technologies can comply with the national standard and this clearly shows that the adopted waste water treatment technologies are good enough to treat the wastewater to the required standard regardless of other factors related to operation of the ETPs. According to the site visit/observation and discussion results with senior officials from ETIDI and different experts in the factories, the inconsistency in the test results of waste water parameters and/or ETPs' performances is proved to be operational problems and lack of integration among key stakeholders. Operational problems include lack of treatment chemicals and other inputs in the local market, lack of technically skilled man power, unprofessional operations of ETPs, lack of continuous follow up and support from pertinent environmental regulatory bodies, lack of enforcement of laws/regulations and also lack of commitment from the companies' side.

It is therefore due to this implementation or operation gap that the quality of treated waste water becomes inconsistent from industry to industry and also within industries themselves. Regardless of these constraints, we can understand that the adopted technologies are capable of treating the waste water to the required national environmental standard.

Table 2: Limit Values for Discharges to Water (MEFCC)

Parameter	Limit Values
Temperature	40 °C
pH	6 – 9
BOD ₅ at 20 ⁰ C	90% removal or 50 mg/l, whichever is less
Total nitrogen (as N)	80% removal or 40 mg/l, whichever is less
COD (mg O ₂ /l)	80% removal or 150 mg/l, whichever is less
Total phosphorus (as P)	80% removal or 10 mg/l, whichever is less
Suspended solids	30 mg/l
Total ammonia (as N)	20 mg/l
Oils, fats & grease	20 mg/l
Phenols	1 mg/l
Mercury (as Hg)	0.001 mg/l
Nickel (as Ni)	2 mg/l
Cobalt (as Co)	1 mg/l
Lead (as Pb)	0.5 mg/l
Antimony (as Sb)	2 mg/l
Tin (as Sn)	5 mg/l
Chromium (as Cr VI)	0.1 mg/l
Chromium (as total Cr)	1 mg/l
Arsenic (as As)	0.25 mg/l
Cadmium (as Cd)	1 mg/l
Zinc (as Zn)	5 mg/l
Copper (as Cu)	2 mg/l
Sulphide (as S)	2 mg/l
Benzene, toluene & xylene (combined)	1 mg/l
Organophosphorus pesticides (as P)	0.003 mg/l
Organochlorine pesticides (as Cl)	0.03 mg/l

Source: Provisional Standards for Industrial Pollution Control in Ethiopia (MEFCC)

2.3.4 Implementation Challenges of Adopted Technologies

Following the introduction of different environmental laws and regulations, especially Regulation No. 159/2008 (Proclamation of Industrial Pollution Council of Ministers), it was expected that all manufacturing industries install appropriate waste water treatment plants after 5 years from the issuance of this proclamation (January 2009).

Accordingly, most of the textile industries with wet processing facilities have adopted and installed waste water treatment plants to comply with this proclamation but the performance of these treatment plants largely vary from industry to industry (ETIDI, 2017). Some of the textile industries are successful in treating the wastewater to the required standard with the adopted technology while some others fail to do so and continue polluting the environment. There are different reasons mentioned to be major causes of this problem.

The data collected from ETIDI and researcher's site visit/observation notes confirm that the basic challenges which faced in the adoption and implementation of waste water treatment technologies in Ethiopian textile industries include poor awareness about prevention and impact of water pollution, lack of treatment chemicals and other inputs in the local market, lack of technical skills and support from national environmental governing bodies, absence of enforcement of environmental laws, lack of commitment and integration among key stakeholders.

However, besides the many challenges faced by the industries regarding effective implementation, adoption of the technologies by itself has its own foot print in the aspect of environmental management in the country. Different stakeholders particularly manufacturing companies and environmental governing bodies confirmed that their understanding of operating in an environmental friendly way has been improved as a result of implementing these waste water treatment technologies. Most industrialists, though less committed and passive to operate their waste water treatment plants effectively and consistently, they are at least clear of the importance of the technologies to protect pollution and operate in line with environmental policies.

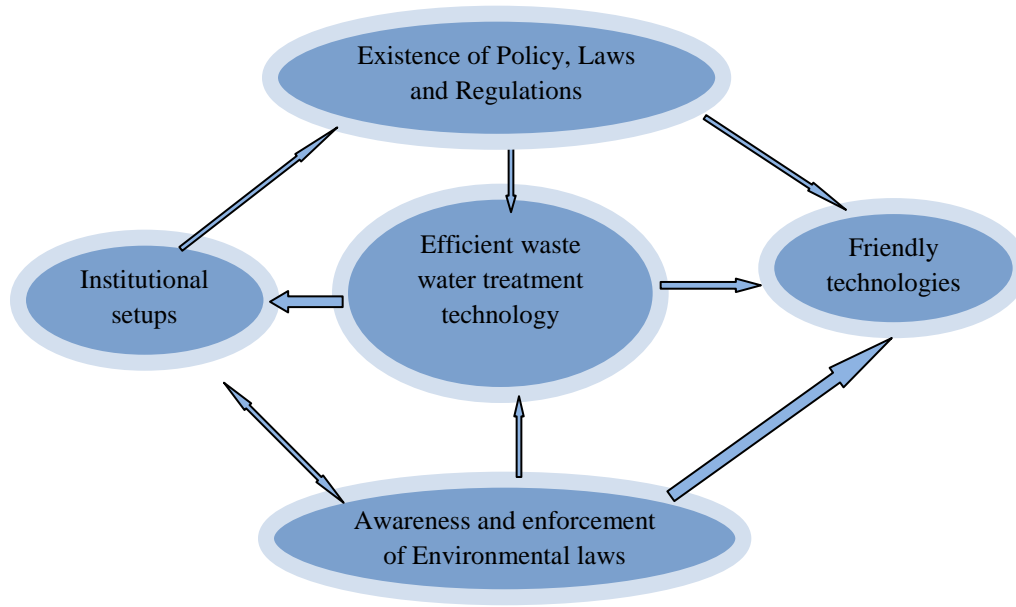
2.4 Conceptual Framework

In many countries, environmental management technologies are adopted and implemented to protect environmental pollution and/or degradation, comply with environmental laws, regulations and standards, meet customer requirements and improve companies' competency in the global market. However, adoption of technologies is not a one stop activity and requires the commitment and active involvement of all potential stakeholders.

Accordingly, this study tries to explore the determinant factors influencing the implementation of adopted waste management technologies in the Ethiopian textile industries and analyze in the dimension of these factors which are identified to be policy factors, institutional factors, environmental factors and technological factors (Fig.2).

As it is shown in Figure 2 below, this research principally tries to see the integration of the aforementioned factors for successful implementation of adopted waste water treatment technologies. To this end, the existence of environmental policy and laws/regulations is a key and decisive factor that govern the formulation of appropriate institutions and procedure to enhance implementation of the adopted technologies. The influence of institutions in terms of awareness creation, law enforcement and selection of appropriate technologies is vital in the implementation process.

Figure 2. Conceptual frame work of the research (constructed by the researcher)



CHAPTER III: Research Methodology

3.1 Description of Study Area and Sample Size

The textile industries in Ethiopia are distributed all over the regions, particularly in Addis Ababa, Amhara, Oromia, South and Tigray regions. However, most of the industries are located in and around Addis Ababa. The researcher's initial plan was to consider those textile industries located in Addis Ababa and the nearby Oromia cities (Sebeta and Sendafa) for the interest of budget and time. But during the preliminary assessment it was learnt that the treatment plants in two of the proposed industries (Ayka Addis and Sagindima textiles) were not fully operational by then and hence these industries were substituted by two other equivalent textile industries (Kombolcha and Bahir Dar textiles) from Amhara region through a recommendation from ETIDI taking into consideration their manufacturing processes/facilities and environmental performances as good representatives of all textile industries.

3.2 Sample Size Determination

Based on their production activities, the textile industries can be classified as fully integrated (from ginning to finishing or dyeing and printing), semi integrated (from garment, knitting to finishing), dyeing and printing, dyeing only and garment washing. Sample industries for this study are therefore supposed to have wet processing facilities in general and represent either of the above five categories in particular. Accordingly, selection of sample industries chosen for this study was done in consultation with the Ethiopian Textile Industries Development Institute (ETIDI) and two industries from Addis Ababa (ELTEX textile & garment factory & KK plc), two from Amhara region (Kombolcha and Bahir Dar textile Sh. Co.) and one industry from Oromia (MNS manufacturing plc) and a total of five textile industries were selected.

Size of sample was therefore determined based on the type of manufacturing processes and accordingly the type of waste generated from each industry. While selecting these target industries, effort has been made to make them representative of all kinds of textile industries in Ethiopia in terms of their production processes and generation of waste water. In all cases, the selected industries have wet processing and operational wastewater treatment plants with nearly similar technologies but highly different treatment performances.

3.3 Sampling Technique

The purpose of this study is to explore implementation status and impact of adopted environmental management waste water treatment technologies in Ethiopian textile industries and understand the challenges related to its implementation. Concrete and adequate data is therefore required to enable the researcher to understand the existing scenario. This requires the researcher's direct involvement in the sampling process through site visit/observation and also direct interaction with experts/operators and executing bodies via interviews and discussions during site visits so that tangible and valuable input/data can be obtained. These factors imply the application of Qualitative approach and hence qualitative method is employed in this study.

In this regard, purposive sampling, as one of the most common sampling technique of qualitative research was used to allow the researcher to collect the required quality data which can address the research objectives and as discussed above, five textile industries were selected based on their environmental performance (effectiveness of their treatment plants), inclusion of different textile manufacturing processes and continuous operation of their wastewater treatment plants. The selected industries are MNS manufacturing PLC, KK PLC, ELTEX textile and garment factory, Kombolcha Textile Sh. Co. and Bahir Dar Textile Sh. Co.

3.4 Sources of Data and Methods of Data Collection

Both primary and secondary sources of data were used in this study. Primary data are those which are collected fresh and for the first time, and thus happen to be original in character. Secondary data, on the other hand, are those which have already been collected by someone else and which have already been passed through the statistical process (C.R. Kothari, 2004, p. 95). Primary data include those data obtained through interviews, site visit, questionnaire and other related face to face interaction with the respondents while secondary data refers to those data obtained from documents, reports, records, books and other related sources.

In this study, primary data was collected through:

- i. Interviewing resourceful and experienced personnel in all the three institutions (Environment, Forest and Climate Change Commission (EFCCC), Ethiopian Textile

Industry Development Institute (ETIDI) and the textile industries) because these institutions are the key players with regard to the environmental management in the textile industries. To this end, Director General of compliance monitoring and control Directorate of EFCCC, Senior/Lead environmental analyst of ETIDI and Deputy Manager of Kombolcha Textile Sh.Co. have been interviewed because these people were identified as most resourceful and experienced with respect to environmental management and/or wastewater treatment plants in the respective institutions and the sector at all. In addition to this, informal interviews were made with five ETP operators from each textile industry during site visit of ETPs as shown in (Table 3) below.

Table 3. Number of interviewed persons in each institution

Name of Institute	Number of people interviewed
EFCCC	1
ETIDI	1
Five selected industries (Ayka Addis, Bahir Dar, ELTEX, Kombolcha and KK)	1+5 = 6 (one as key informant from Kombolcha and 5 ETP operators informally interviewed from each factory)

- ii. Site visit/observation of the wastewater treatment plants in the textile industries during operation and also the treated wastewater being discharged to the environment. The researcher had conducted series of visits to wastewater treatment plants of targeted industries thereby observing the current status of those wastewater treatment plants, taking notes and photos wherever possible. The researcher found this experience to be very important part of the data collection process because it enables to observe the actual phenomena taking place in the wastewater treatment systems.
- iii. Using open-ended questionnaires distributed to technical experts from the national regulatory body (EFCCC) and the textile industries. A total of 30 participants (5 from EFCCC and 25 from selected textile industries as shown in Table 3) were involved in this process and 28 of them respond accordingly. These experts were those who in one way or another involved in the operation of the waste management process or used to do so in previous times.

Secondary data like the national environmental policy, proclamations and regulation documents were collected from EFCCC while laboratory test results of the wastewater from each industry, daily laboratory test records and also 5-years environmental performance reports of textile industries were collected from ETIDI and the pertinent industries.

3.5 Data Analysis

Data analysis is the central step in research. Whatever the data are, it is their analysis that, in a decisive way, forms the outcomes of the research, Flick (2004). Given the centrality of the analysis in qualitative research, in general, a kind of stocktaking of the various approaches to qualitative analysis and of the challenges it faces seems necessary,

There are many different techniques of analyzing qualitative data. Kawulich (2004) suggested that the way researchers choose techniques of analyzing data should stem from a combination of factors, which include the research questions asked, the theoretical foundation of the study, and the appropriateness of the technique for making sense of the data. Analyzing qualitative data typically involves immersing oneself in the data to become familiar with it, then looking for patterns and themes, searching for various relationships between data that help the researchers to understand what they have, then visually displaying the information and writing it up.

Cohen et al., (2007) describes that qualitative data analysis involves organizing, accounting for and explaining the data; in short, making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities. He also suggested that there is no one single or correct way to analyze and present qualitative data; how one does it should abide by the issue of *fitness* for purpose.

The significance of deciding the purpose is that it will determine the kind of analysis performed on the data. This, in turn, will influence the way in which the analysis is written up. The data analysis will also be influenced by the kind of qualitative study that is being undertaken. For example, a biography and a case study may be most suitably written as descriptive narrative, often chronologically, with issues raised throughout. An ethnography may be written as narrative or stories, with issues raised, but not necessarily conforming to a chronology of events, and including description, analysis, interpretation and explanation of the key features of a group or culture. Cohen et al., (2007:461)

In this study, the main purpose is to explore the root cause for unsuccessful implementation of adopted waste management technologies through collecting qualitative data from pertinent institutions and analysis of these data proceeds in order to meet this research objective. Accordingly, data was analyzed with an inductive approach to build a theory behind the research problem arising.

CHAPTER IV: Adoption and Implementation of Waste Water Treatment Technologies in Textile Industries

4.1 Introduction

This chapter focuses on the analysis and interpretation of data collected using qualitative approach. To this end, data is analyzed to the interest of addressing the research objectives within the dimension of Policy/regulations, institutional setup, environmental factors and technological factors.

With regard to policy factors, it has been tried to consider environmental proclamations, regulations, strategies and laws that enhance environmental management practices; Institutional factors comprise trainings, enforcements and technical support provided to industries. Environmental factors include pressure from customers, regulatory bodies and commitments while technological factors incorporate complexity, relative advantage and compatibility or adoptability of the technology.

4.2 Environmental Policy/Regulations

Khurana (2018) discussed that as a comparative advantage and best opportunity for Ethiopia's industrial transformation policy, the textile sector is given top priority with special incentives like tax exemptions, duty free access and different market opportunities like AGOA for industrialists and number of textile/garment industries in the country is growing dramatically more than ever.

According to ETIDI (2017) report, as a result of the Government policies, textile and garment manufacturing companies, ranging from medium to large scale, in the area of ginning, spinning, weaving, finishing and garment have proliferated and today stands more than 190. Of this total number of industries most are engaged in garment manufacturing and only 25 are textiles with wet processing (dyeing and printing) facilities. It is this group of industries which are responsible for the generation and discharge of waste water that cause pollution to the nearby water bodies.

The Ethiopian Constitution (1994) provides a coherent and integrated framework addressing Environmental Management issues as well as the foundation for environmental regulation and policy in Ethiopia. Directly emanated from this Constitution (article 44, Environmental Rights),

national environmental policy and different proclamations have been issued and implemented nationwide.

The data obtained from Environment, Forest and Climate Change Commission (EFCCC) indicate the national environmental policy, different proclamations and regulations as mentioned in section (2.4.1) are already in place to enhance environmental management system in Ethiopia. Of all these proclamations, Proclamation No.300/2002, Environmental Pollution Control Proclamation is about environmental pollution that may result due to discharge of untreated wastewater from manufacturing industries to the nearby environment as in (figure 3) below.

Fig3. Textile wastewater discharged to the environment without treatment (Tripathy, 2013)



According to this proclamation, Part two, article No. (3) and sub-article (3), no manufacturing industry is allowed to discharge untreated or hazardous waste and hence all manufacturing industries are supposed to have appropriate modern waste management technologies. The proclamation says “Any person engaged in any field of activity which is likely 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.” (p.1961). This proclamation mostly applies for those manufacturing industries that

were being newly established and to be established after the introduction of such environmental responsibilities.

Latter in 2008, a new regulation, Regulation No. 159/2008, Prevention of Industrial Pollution Council of Ministers Regulation was issued taking into consideration existing industries (those industries who were under operation or a project to which an application to obtain a license to establish a factory has been submitted before or on the date of entry into force of this regulation). Article (12), sub-article (1) of this regulation says “An existing factory that is in an industrial sector listed in a directive issued pursuant to this regulation shall, within a maximum of 5 years, fully comply with the provisions of this regulation”.

One can understand that this regulation was so generous that those existing manufacturing industries were not forced to fix the waste management system/technology (wastewater treatment plants in this case) in a short period of time. They were rather granted a 5 years grace period to fix and put in place modern wastewater treatment plants considering different factors that the industrialists may face (capital, land, local availability of technology and knowledge/skill).

Institutional setups for mobilizing and executing such issues are not accessible to the industries and the community. In this regard, the institutional setups to oversee, advice and regulate such environmental affairs like provision of technical support on technology selection and implementation, awareness on environmental responsibilities and rights, trainings on compliance to environmental standards and create conducive environment for implementation of adopted technologies are not accessible to company level interventions.

4.3 Type and Performance of Adopted Technologies

According to site visit/observation results and the data collected from ETIDI & selected industries the adopted technologies are mostly conventional type with preliminary, primary and secondary components. Among the 25 textile industries with wet processing facilities, 21 industries have adopted these conventional waste water treatment technologies. The rest 4 industries do not have any treatment facility and still are not interested to adopt the technologies since there is no case that affects their operation (ETIDI, 2013). This is explained to be due to

lack of commitment of the industries to obey the laws on one hand and absence of enforcement of environmental laws particularly Proclamation No.300/2002 by the pertinent environmental governing bodies on the other hand.

With regard to the performance of installed waste water treatment technologies, the evaluation report of ETPs collected from ETIDI indicate that there is a big gap in the implementation of these technologies from industry to industry and even within the same industry at different times. The evaluation reports of waste water laboratory test results shows that some industries like Kombolcha and Bahir Dar textile succeed in complying with the national standard but some others like MNS do not while having the same industrial processes and adopting the same treatment technologies. The main reason for this are operational problems related to assignment of appropriate professionals to run the treatment plants, continuous follow ups and use of appropriate treatment chemicals.

Besides the difference in performance of treatment plants of different industries, it has also been observed that treated water quality of a given textile industry at some year complies with the national standard and fails at some other years. A senior official from Bahir Dar textile Sh.Co explains this during the researcher's site visit and discussion to be due to inconsistent operation of the treatment plant like assignment of non-professional operators, application of irrelevant chemicals and non-continuous (interrupted) operation. Those textile industries which assign trained operational and use appropriate treatment chemicals with continuous follow ups are successful and comply to the standards while those who do not assign trained professionals and do not use appropriate chemicals fail to comply with the standards.

The following graphs (fig. 4 & 5) obtained from ETIDI's evaluation report of the treatment plants illustrate the inconsistency in the performance of the wastewater treatment plants at different times and at the same time the capacity of the adopted technologies to treat the waste water to the required quality/standard.

Fig 4. Evaluation results of ETPs (BOD values) in textile industries for the year 2013 (ETIDI)

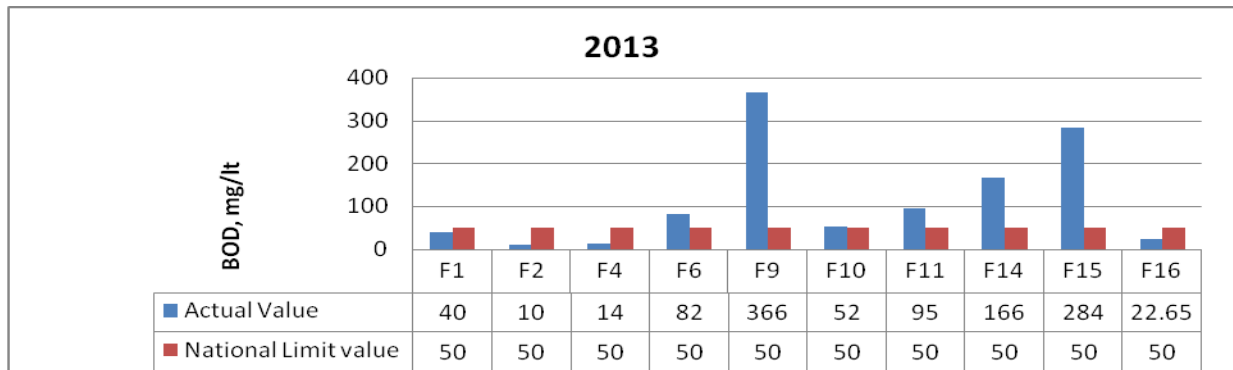
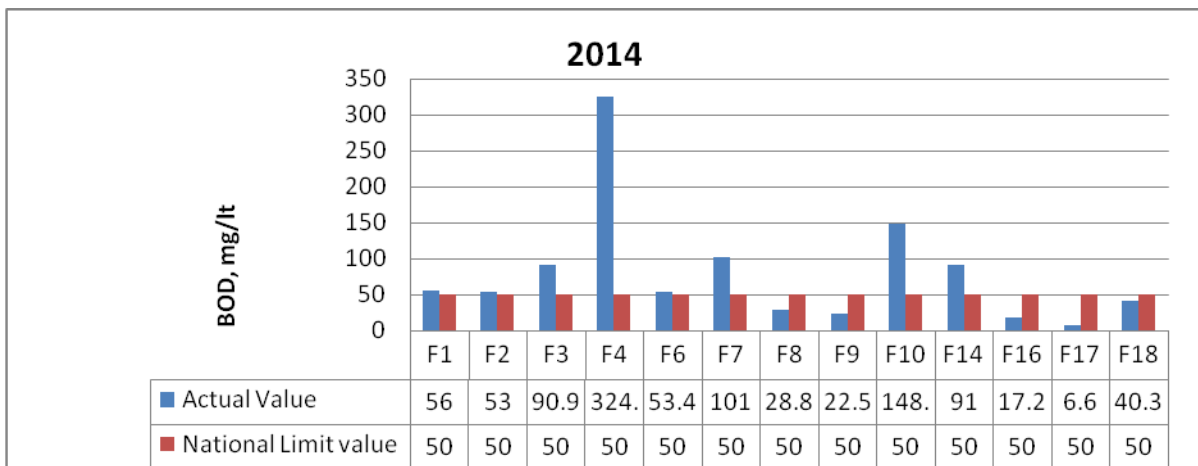


Fig 5. Evaluation results of ETPs (BOD values) in textile industries for the year 2014 (ETIDI)



F1, F2, F3 represents the different factories Factory1, Factory2, Factory3.....

According to the above information, if we consider the BOD values of some industries in each year we find inconsistency of the ETPs performances.

For example, Factory 1 (F1), Factory 2 (F2), Factory 4 (F4) and Factory 16 (F16) have a BOD value below the allowable national limit so that they comply with the required standard in the year 2013. But in 2014, it is only F16 among these that maintain its performance and still complying with the standard. On the other hand, Factory 9 (F9) has a BOD value above the allowable national limit in the year 2013 but has shown a remarkable improvement in 2014 and has a BOD value far below the national limit complying with the standard. So, using the same technology and equipments the difference in the performance of treatment plants from industry to industry and also within industries at different times is justified to be due to lack of inconsistent operation procedures as mentioned above.

The fact that the treated waste water quality complies with the national standard even inconsistently proves the friendliness/ adoptability of the technologies with local capacity except for the different challenges related to commitment on both the environmental governing and executing bodies towards raising awareness of the community, supply of necessary inputs, building capacity of the sector and enhance enforcement of environmental laws/regulations. Therefore, successful implementation of the adopted technologies will not take too long from now by solving these problems with increasing environmental awareness and accountability.

4.4 Implementation Challenges of Adopted Technologies

With an introduction and implementation of new and/or modern technologies, there is always an expectation of improved services/products more than ever making use of the new technologies. It sounds the same towards protecting water pollution due to textile industries as a result of adoption and implementation of waste water treatment technologies in Ethiopia.

However, the result up to now is not satisfactory and is far below people's expectation. Because water pollution due to discharge from textile industries is increasing from time to time (ETIDI 2013). This is because adoption and implementation of such technologies is not a plug-and-play type to bring about desired changes immediately. It is rather accompanied with different challenges that may differ from place to place contextually. According to the data collected from all primary sources (EFCCC, ETIDI, the textile industries and site visit/observations), the major challenges for effective implementation of adopted waste water treatment technologies among the many are:

1. Lack of enforcement of environmental laws (Poor commitment and action of the environmental governing bodies at all levels to do so). Environmental laws/regulations are not equally enforced among all textile industries and this has created discrimination between textile industries. An environmental expert from ETIDI complains that, as a result of this, there are still manufacturing industries that do not install waste water treatment plant and no action has been taken so far on those industries based on assessment of waste water quality on regular basis.

2. Absence of technical support by pertinent bodies to industries on awareness, operation, input supply and regular follow ups. According to the information collected from ETIDI and all textile industries considered in this study, it is confirmed that government environmental regulatory bodies do not provide capacity building support to industries. While selection, design approval, installation and commissioning of appropriate treatment technologies should have been supervised and approved by these regulatory bodies, all these activities are executed by the textile factories themselves.
3. Lack of treatment chemicals, spare parts and other inputs in the local market. Respondents from all industries said that these items are not usually available in the local market and the foreign market is too costly and complicated requiring extra time and money. This concern of factory experts was cross-checked with the evaluation report of wastewater quality test result issued by ETIDI. Accordingly, it was found that some parameters which are under allowable limits at one time are found to be above those limits at other times and this was explained to be due to lack of necessary inputs and uniform operation practice of the treatment plants.
4. Poor commitment of companies to operate the treatment plants with relevant professionals and fulfill all necessary logistics and facilities. One of the gap identified by the researcher during site visit/observation was the treatment plants in most cases are not being operated by relevant professionals. An ETP operator whom I interviewed in MNS textile said that someone who is idle in any section will be assigned to run the ETP whenever necessary. This has been confirmed by most of the research participants from EFCCC, ETIDI and the factories themselves. Relevant professionals are not employed in this area while management and application of chemicals by itself requires special training and higher professional input. An operator whom I found running the ETP was not trained in this field and he told me that whoever is not busy in other sections in the factory will run the ETP. This is completely unacceptable because it may result in different damages to the machines, to the factory and to the operator himself. In this regard, commitment of the top management is very important to recruit and assign professionals for such sensitive and risk full activities.

5. Lack of incentives and labeling mechanisms to encourage well performing companies with respect to environmental management issues. Those textile industries which are performing well environmentally (Kombolcha and Bahir Dar for example) have never been incentivized or at least recognized and given any kind of technical support to further build their capacity and some of these textile industries mention that this discourages them from working harder with respect to waste management. They further complain that it is due to lack of commitment of the environmental governing/regulatory body to conduct regular follow ups and take measures according to environmental performance of the industries and this has been mentioned as one of the implementation challenge.

Meanwhile, adoption & implementation of these waste water treatment technologies in textile industries has brought about inspiration to most of the industrialists even out of the textile sector to treat their industrial effluents and comply not only with national standards but also with their potential customers'/buyers' requirements in the context of social & environmental compliances.

The public also to some extent have the awareness that industrial pollution can be prevented through the use of such treatment technologies and it has been a means for new thinking and good practice with regard to control of industrial pollution. It can therefore be taken as a good start towards raising public awareness on the concept of pollution prevention and accordingly participate at all levels of protecting the environment due to industrial activities. It is also undeniable that some textile industries are treating their industrial waste water to an acceptable quality as per the national environmental standard thereby minimizing water pollution.

The pollution load of waste water from many textile industries is reduced at least partially due to implementation of these technologies and this has a positive impact and contribution to the existing pollution prevention activities in particular and environmental management system establishment plans in general. Adoption of these technologies therefore has contributed to the understanding of technological solutions for pollution prevention and also ensured the possibility of treating the waste water from the textile industries to an accepted quality complying with national environmental standards. Additionally, it also helps to identify our gaps in the local context for effective and efficient implementation of the technologies in the future.

4.5 Institutional Setup

Institutional setup and/or capacity is one of the factors that influence the effective implementation of adopted technologies. To this end, the environmental strategy of the national environmental governing body, its leadership commitment and technical support it provides to industries are discussed based on the findings of the research/data collected from pertinent sources.

In terms of environmental strategies, the national environmental governing body has different plans and procedures mostly emanated from those environmental proclamations according to which different industries shall exercise environmental friendly operations and hence achieving the overall environmental goal of the country.

However, it seems due to lack of commitment that both the federal and regional environmental bodies are not accessible and do not accordingly communicate with the industries in terms of disseminating environmental information, giving trainings/awareness and related technical supports and supervise for their environmental performances.

In this regard, 29 out of 32 research participants in this study respond that the environmental regulatory bodies have neither provide trainings/workshops to factory experts in addressing necessary environmental information and technical support related to adopted technologies nor supervise the effective implementation of the technologies and hence environmental performance of the industries.

To the same issue, the data obtained from EFCCC's higher officials is contradictory to that of experts within the same institution. The Director General of Compliance Monitoring and Control Directorate in MEFCC mention that awareness on environmental issues and related information is addressed to factory experts/operators and the community through workshops but three out of five research participants from the same institution (EFCCC) agree with ETIDI and factory experts saying that they have never experienced with an awareness workshop or training on environmental issues given to factory experts and the community.

The environmental governing body has also never advised or participated in selection, installation and approval of treatment technologies to be adopted. The Director General of the Compliance Monitoring and Control Directorate in EFCCC and a senior official in ETIDI both confirmed this fact during the interview for this study explaining that technology selection and installation is done by the industries themselves and there is no approval mechanism after installation. This can be very dangerous because the industries may run for lower price not for adoptability and friendliness to the local context or national environmental requirements while buying the technologies. In all cases it is learned that institutional intervention (both support and supervision) is very poor at all levels.

Another important requirement which the regulatory bodies lack to have is an accredited laboratory to test quality of the wastewater before being discharged to the environment. It is mandatory for an environmental regulatory body to have such an accredited laboratory which otherwise is difficult to blame industries for their polluting action. None of the 6 research participants from EFCCC was able to clearly mention the status or efficiency of installed treatment technologies because they neither have accredited testing laboratory nor they use external qualified laboratories to test the quality of the wastewater and judge the performance of effluent treatment plants (ETPs).

4.6 Environmental Factors

Environmental factors in the context of technology adaptation and implementation refer to pressure from customers, regulatory bodies, government support and management commitment. In this dimension, therefore, data collected from the aforementioned selected participants is analyzed with respect to these variables.

According to the comment from nearly all research participants particularly those from textile industries and ETIDI, environmental awareness and advisory service/support by pertinent environmental bodies is very poor both within industries and the public at large. A senior official from Bahir Dar textile Sh. Co. says that:

I used to work in manufacturing industries for more than 20 years and I have never come across a time where any sort of environmental campaign or environmental awareness and/or training being delivered to experts working in

manufacturing industries by the pertinent environmental institutions. It is only when affected community somewhere else complains of pollution due to wastewater from nearby industries that so called experts from a regulatory body came and give warnings to the company and similar news through the national television that we hear about pollution.

He also added, in some areas where there is water scarcity, there are cases that farmers in the surrounding area request for the industrial waste (both liquid and solid waste) to use for gardening and feeding their animals. This request has no objection by the industries, it is rather considered as a favor to the community. He believes that, this all happens due to lack of awareness about the hazardous nature of the waste in both the company and community side.

To my question if he knew what the environmental responsibility of the company is, he replied me that he has no idea of such responsibility which the company is supposed to discharge.

One of the issue that bother companies in their day to day plan and activity is to meet their customers' requirements, where environmental compliance is supposed to be among the many and mandatory requirements.. In this regard, during the researcher's visit of a wastewater treatment plant and informal discussion with line managers about environmental standards and compliance, it was learned that environmental compliance is not an issue for the textile industries because they supply their products for domestic/local market and local buyers do not require such compliance issues. Even in some cases where international buyers request environmental compliances, they mostly refer to the physical presence/installation of waste management plants but not their effectiveness.

Pressure from regulatory bodies was supposed to be governing to bring about companies comply with environmental laws and regulations, industrial discharges meet environmental standards; citizens' environmental rights (Ethiopian Constitution, article 44, Environmental Rights) respected and in general the environment is protected from pollution and degradation. But according to the response of research participants particularly from ETIDI and the textile industries, it is understood that currently there is nearly no pressure from regulatory bodies to enable the industries operate in an environmental friendly way. Following the issuance of the environmental regulation in 2008 (Regulation No. 159/2008, Prevention of Industrial Pollution Council of Ministers Regulation), it was expected that all manufacturing industries comply with

national environmental laws and regulations through installing appropriate waste management technologies.

However, implementation of this regulation was not uniform among the different manufacturing industries. In this regard, the industries are classified in to three groups based on their status of implementing this regulation (ETIDI 2013).

1. Within the first group are those industries that install the required appropriate wastewater treatment technologies and accordingly operate in an environmentally friendly way.
2. The second group of industries comprises those which install wastewater treatment plant but are not operating with it.
3. The third group consists of those industries which at all do not install any kind of wastewater treatment plant but are operating and discharging their industrial effluents to the nearby environment without any treatment.

At the end of the day no evaluation was done for the environmental performance of the industries with respect to implementing the regulation and all industries were treated equally. Even these days, after additional 5 years since the expiry of the grace period, there are manufacturing industries who do not install appropriate waste management technologies (wastewater treatment plants). There was neither an incentive for those industries that perform accordingly nor a punishment to those who do not obey to the law.

Some companies regret for installing the technologies earlier due to extra cost they pay for installing the technologies. A senior official of one of these companies sorrowfully describes this as follows:

That was a punishment for us to install the wastewater treatment plant by then. Because, he said, we feel that we couldn't run our company further without putting the treatment plant in place and we borrowed large amount of money for that. We also buy chemicals every time, employ professionals who operate the system, high amount of power required, many, many.... We knew that it is good to operate according to the law, but the challenge is others are not doing accordingly and we cannot compete equally in the market. We had higher production cost than others who do not invest on treatment plants and hence have different profit margins. We are happy to protect the environment and the community from pollution, but it is also business, our company has to be profitable. It is only when you are financially strong and profitable that you can compete with others. He screamed.....

We don't have even recognition for what we have done. We should have been given at least technical support or capacity building trainings in the field of treatment from the government if not incentives. What I can say finally is we are losers for doing according to the law, may be in the future if the so called environmental laws are enforced, I hope our company will have an acceptance both by the government and the community.

Lack of commitment and appropriate action to inform, mobilize and enforce relevant environmental laws and regulations from pertinent regulatory bodies causes negligence and irresponsibility to the companies. Interviewed experts from ETIDI mentioned that the very reason for such irregularities (different environmental status of the textile industries) is nothing but lack of follow up and necessary intervention by the pertinent governmental regulatory bodies.

Regarding the attitude of the companies towards environmental management, the senior official in TIDI who gave an interview for this purpose describes that:

The problem is not only because the industries do not install the environmental management technologies (wastewater treatment plants) currently but also they do not show an interest to do it in the future. Some company owners do not want to hear about this issue and have no intension to act accordingly.

He remembered what one company owner said in an incident where he was participating stakeholders meeting and feels very discouraged. The guy said:

..... "please don't disturb us. Why are you prioritizing peoples' lives over land and water? People need to eat first before thinking about what you call environment". (Very frustrating and discouraging)! This, I conclude is exclusively due to lack of awareness and understanding of responsibilities which should have been done earlier by the regulatory body who is fully mandated to oversee, disseminate and regulate all environmental related issues throughout the nation, he commented.

4.7 Technological Factors/ Friendliness/Adoptability

In this section the type of technologies adopted, their operational features, adoptability (complexity to be operated by local skill) and basic treatment processes have been examined. Accordingly, different technical reports from ETIDI, textile industries and site visit/observation results in the selected industries confirm that those wastewater treatment technologies adopted and installed in the textile industries are conventional type having mostly primary and secondary

treatment sections. Some industries have purely biological ETP, some others physico-chemical ETP and a third group have an ETP that combines both of the two components.

The physico-chemical treatment is also called primary treatment and it involves addition of chemicals to the wastewater to bring about changes in its quality and includes pH control, coagulation, chemical precipitation and oxidation. pH control is done by addition of acids or bases depending on the nature of the wastewater, coagulation and chemical precipitation are resulted from addition of chemicals like aluminium sulphate/iron sulphate followed by continuous agitation and oxidation is achieved by the action of these chemicals and /or oxygen. Figure 6 shows the primary treatment and primary sedimentation tank in MNS textile factory.



Figure 6: Primary treatment and primary sedimentation tank in MNS textile factory (Self captured picture)

In secondary/biological treatment system, soluble organic matter is made to be decomposed by the action of bacteria. The main objective of secondary treatment is to further purify the wastewater using bacteria to decompose those soluble organic materials. The basic principle here is the bacteria are supplied with continuous oxygen and they use organic component of the

effluent as their food and in doing so break them down to less complex and less hazardous compounds (Singh 2012).

In all cases, conventional treatment systems which comprise biological degradation and/or chemical oxidation through primary and secondary treatment components of wastewater are installed and implemented. These methods of treatment are not as complex as in the case of advanced wastewater treatment system that includes the use of reverse osmosis (RO), membrane filtration and evaporator systems in tertiary treatment. A treatment plant operator from Kombolcha textile Sh.Co. Mentioned that these technologies are not too much complicated and can be effectively implemented with the conventional approach with locally available knowledge and experience. Figure 6 shows the secondary treatment and secondary sedimentation tank in Komolcha textile Sh.Co.



Figure 7. Secondary (biological) treatment and secondary clarifier/sedimentation tank in Kombolcha textile Sh. Co. (Self captured picture)

It is only commitment to improve environmental awareness among the whole community, improve supply of necessary inputs and enforce environmental laws and regulations to achieve effective implementation of the technologies there by protecting the environment.

According to the different data collected from pertinent sources particularly from ETIDI (evaluation report of ETPs based on the test results of treated wastewater) and site visit/observation results, it was confirmed that the adopted technologies if well managed and operated accordingly can treat the textile wastewater to the required standard and therefore it can be concluded that the technologies are friendly and compatible/adoptable to the Ethiopian context without difficulty.

CHAPTER V: Conclusion and Recommendations

5.1 Conclusion

With the main objective of exploring the status and impact of adopted environmental management technologies (waste water treatment technologies in particular), this study was conducted on five textile industries having wet processing facilities in Ethiopia. Accordingly, in this thesis work, an attempt has been made to explore the status and implementation challenges of adopted waste water treatment technologies with particular emphasis on textile industries along with the existing constraints and opportunities which would help in planning and implementing appropriate waste management techniques to address pollution problems due to the growing industrial sector in Ethiopia.

Due to non availability of theoretical background developed previously, qualitative approach was employed in this study and data was collected through interviews, observation, notes taken during on-site visit and open-ended questions distributed to key personnel in the field. Finally, data was analyzed within the dimensions of Policy, institution, environment and technological perspectives against the prescribed objectives.

With regard to policy, it was proved that there are clear and accepted national frameworks according to which environmental issues shall be managed. These includes national environmental policy, environmental proclamations and regulations issued at different times and that there is no as such a gap in the availability of policy frameworks. However, the institutional arrangement and commitment to address important environmental issues (firms' environmental responsibilities and citizens' environmental rights) is found to be very limited and this has resulted in poor support and accessibility of the government regulatory bodies to manufacturing companies and the public at large.

Environmental factors like awareness, pressure from customers and regulatory bodies, management commitment and attitudes are largely influenced by mobilization and timely interventions of pertinent stakeholders. This component of the implementation process is also found to be not strong enough to bring manufacturing companies onboard of proactive movements against environmental pollution. Regardless of these shortcomings, the data analysis

clearly shows that the adopted waste management technologies are capable of treating the wastewater from textile industries to the required quality. It is therefore concluded that the adopted and installed wastewater treatment technologies are qualified enough for treating the wastewater to meet national environmental standards except for the poor implementation practice like weak institutional/technical support, lack of mobilization and supervision, weak enforcement of environmental laws and generally poor commitment from pertinent governmental and private institutions.

5.2 Recommendations

It is evident that industrialization process shall proceed together with appropriate environmental management technologies which otherwise will cause severe damage on the life supporting environment and compromise sustainable development. Meanwhile, there are opportunities to implement better environmental management practices while keeping the industrialization growing.

Accordingly, based on findings of the study on challenges and opportunities of implementing sound environmental management technologies (making adopted technologies functional and efficient), the following actions are recommended.

- The national industrial policy shall emphasize on mainstreaming of environmental issues including pollution prevention techniques among the key stakeholders in particular and the community at large
- Environmental awareness including environmental responsibilities and rights shall be communicated to all manufacturing industries nationally.
- Regulatory and other pertinent government bodies have the responsibility to assist and mobilize implementation of such technologies to enhance the industrialization process in line with the green development plan.
- Appropriate technical support (design, installation, operation, material supply, testing) shall be given to those manufacturing industries which already installed and are installing the technologies by the environmental governing institutions.
- The government must establish a system to incentivize and motivate those well performing manufacturing industries based on their environmental performance.
- Manufacturing of treatment chemicals and other necessary inputs to run the treatment technologies must be facilitated locally by the government.
- The government needs to establish a specialized unit/department at national level for the selection, design, installation, operation and maintenance of wastewater treatment plants.
- The national environmental regulatory body must establish or facilitate the establishment of an accredited laboratory to test treated water quality and assist the industries in this regard.

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Appendices

Appendix I: Five year textile industries' ETP performance report

ETIDI



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The Federal Democratic Republic of Ethiopia



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Ethiopian Textile Industry Development Institute

ቁጥር 02.3-1/1672
Ref. No 95 APR 2019
ቀን
Date

To: Addis Ababa University
College of Development Studies
Addis Ababa

Subject: Provision of cooperation

It is to be recalled that you have requested our office to provide the necessary support to your MA student, Amha Tegegne, who is conducting his MA thesis entitled “**Survey on Policy Framework, Organizational and Operational Environmental Management Technology in Ethiopian Textile Industry**” with a letter dated February 14, 2019, reference number CED/097/2010/2019.


Accordingly, attached herewith, we have compiled the requested information (interview and documents on environmental performance of selected Ethiopian textile factories with regard to waste water treatment for the last five years).

We reaffirm our commitment to render similar assistances for your researchers in promotion of university industry linkage to enhance environmental sustainability.

Sincerely yours,

Enclosed: 18 pages

Demile Asrat Yimer
Research & Testing Laboratory
Directorate Director



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**ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF DEVELOPMENT STUDIES**
**Survey on policy framework, organizational and operational dimension,
implementation, impact and challenges of adopting Environmental
Management Technology in Ethiopian textile industries.**

Introduction

Dear Respondent,

First of all, I would like to thank you for your willingness to participate in this study. The objective of this questionnaire is to collect the necessary primary data for my research on the topic " Adoption and Impact of Environmental Management Technology in Ethiopia, The Case Of Waste Water Treatment Technologies in Textile Industries": its Practice, Efficiency, Challenges and Implications on green and sustainable development for the partial fulfillment of the requirements for the degree of Masters in Environment and Sustainable Development at Addis Ababa University.

Your genuine responses for these questions are quite vital for the success of this study and therefore you are kindly requested to give your response freely and accurately on the space provided under each question.

Finally, I would like to confirm you that all the information you provide in this questionnaire will be strictly confidential and will exclusively be used for this research purpose only.

NB. No need of writing your name. Thank you very much ahead for your cooperation!

Researchers' Name: Amcha Tegegne,
Address: Cell phone: +251 911623502,
e-mail: berekahun@gmail.com



Part I: Demographic characteristics of the respondents

1. Name..... Theodoros Zekarias
2. Sex: Male female
3. Age: 15-20 20-25 25-35 35-40 above 40
4. Educational status: Collage graduate University Degree post graduate
Other (specify)
5. Your responsibility Lead Environmental Analyst

Part II: Survey questions

1. Name of organization Ethiopian Textile Industry Development Institute
2. What are the national environmental policies, rules and regulations that govern and dictate the Ethiopian environmental management systems in manufacturing industries?
Ethiopian Environmental Policy
Environmental Pollution proclamation
Solid waste management proclamation
3. How are environmental issues managed in your organization? We've environment Team under Research & Testil Lab Directorate with primary respon- sibility of assisting the textile sector by giving trained technical support, consultancy services.
4. How is the awareness of environmental issues particularly pollution addressed to manufacturing industries and the local community to help them understand its adverse impacts and act accordingly? At ETIDI, we give training & awareness to the textile companies to address issues related to pollution
5. What activities does the environmental regulatory body perform to aware the manufacturing sector and the public at large about environmental issues particularly pollution?
Nothing
6. Are there environmental institutional set ups and structures in place up to factory level to assist in building capacity of the manufacturing sector for improving environmental performance?
Not

2



7. At what interval does the pertinent environmental regulatory body supervise and/or inspect manufacturing industries for their environmental performance?
Not at all.
8. What type of waste management/waste water treatment technologies are adopted and implemented in the textile factories?
Conventional Type (Primary & secondary) - Chemical or Biological or Both
9. Who is responsible for the selection, installation and approval of the treatment technologies installed in the textile factories?
The factories themselves & ETID
10. Are there any incentives and/or awards for manufacturing industries on successful compliance to national environmental standards/regulations?
No
11. How do you measure the performance of installed/adopted waste treatment technologies and how efficient are they to wards complying with national environmental standards?
- Sample collection & laboratory analysis (in our own lab)
- Mostly inefficient because of poor follow-up & management
12. How close and cooperatively does your organization work with environmental regulatory bodies with regards to environmental management and /or pollution?
No close cooperation with environmental regulatory bodies.
13. Do you report about environmental performance of the textile industries to the environmental regulatory body regularly?
No, we have no close contact with them.
14. What are the basic challenges in implementing the adopted waste management/treatment technologies?
- Poor follow-up, assistance & enforcement from regulatory bodies
- Less commitment from factory owners.
- Lack of adequate availability of chemicals & inputs.
15. What do you suggest will be good to be done in the future by pertinent institutions and other stakeholders to protect environmental pollution and/or degradation?
- Strong assistance & follow-up & enforcement from regulatory bodies
- Strong commitment from factory owners.
- Government intervention in provision of chemicals and other inputs necessary for environmental monitoring.

Theodoros B.
01 March 2019
... 0334



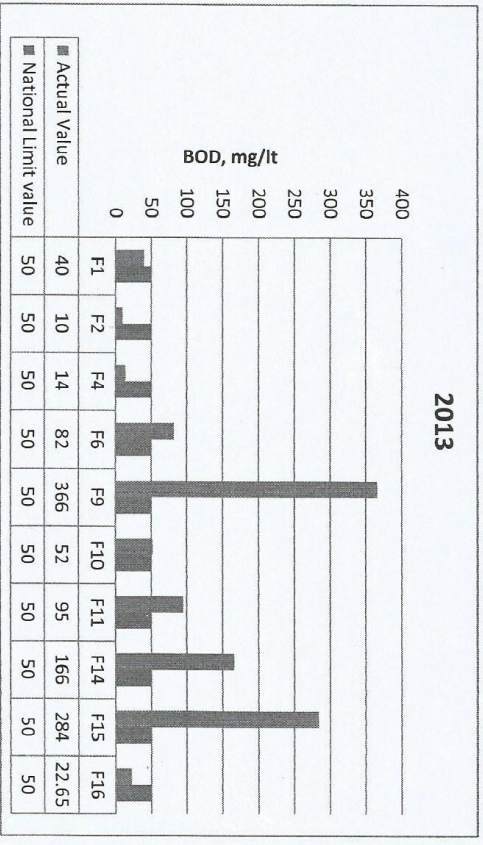
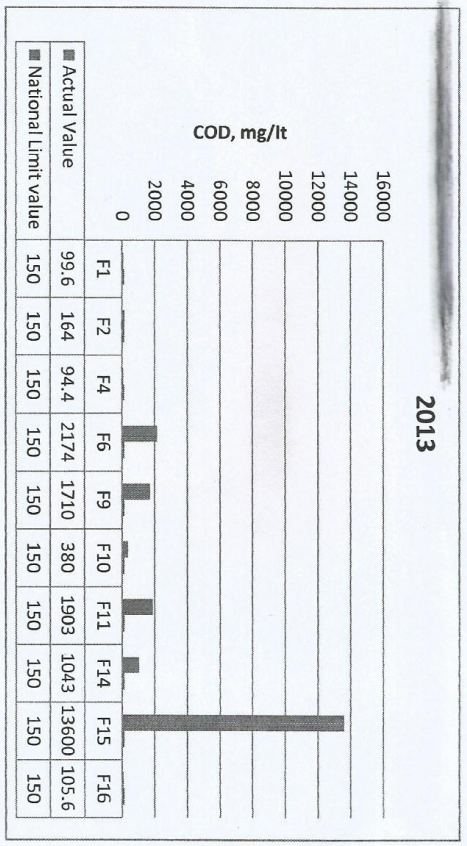


COD

Factory Name	Actual Value	National Limit value
F1	99.6	150
F2	164	150
F4	94.4	150
F6	2174	150
F9	1710	150
F10	380	150
F11	1903	150
F14	1043	150
F15	13600	150
F16	105.6	150

BOD

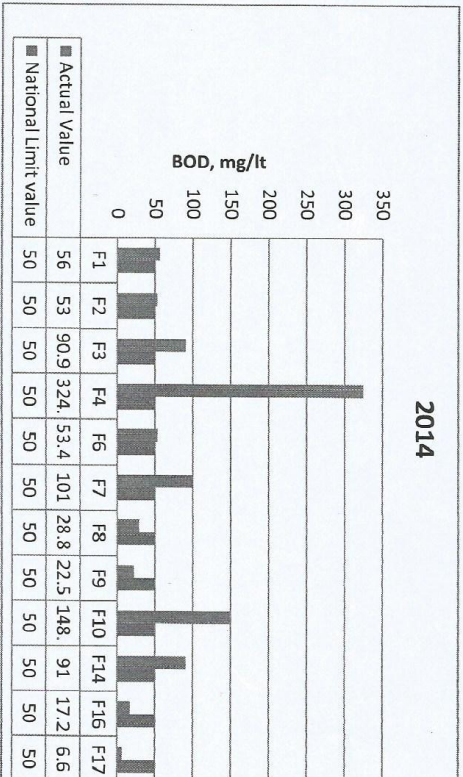
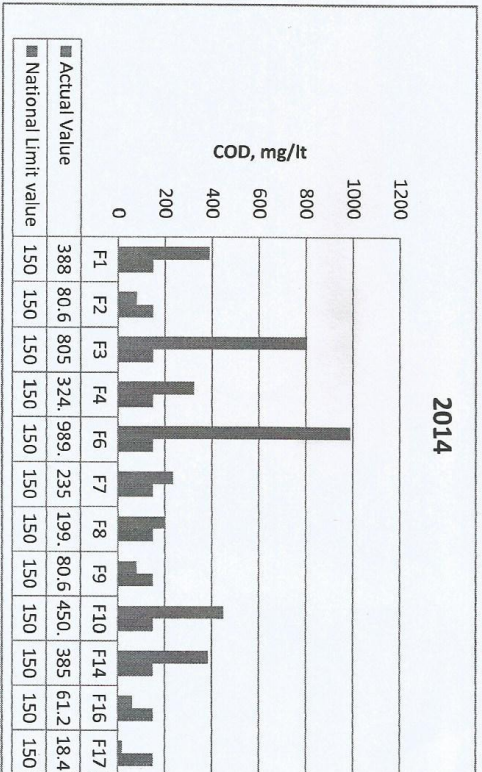
Factory Name	Actual Value	National Limit value
F1	40	50
F2	10	50
F4	14	50
F6	82	50
F9	366	50
F10	52	50
F11	95	50
F14	166	50
F15	284	50
F16	22.65	50





Factory Name	Actual Value	National Limit value
F1	388	150
F2	80.6	150
F3	805	150
F4	324.8	150
F6	989.28	150
F7	235	150
F8	199.9	150
F9	80.67	150
F10	450.24	150
F14	385	150
F16	61.25	150
F17	18.4	150
F18	220	150

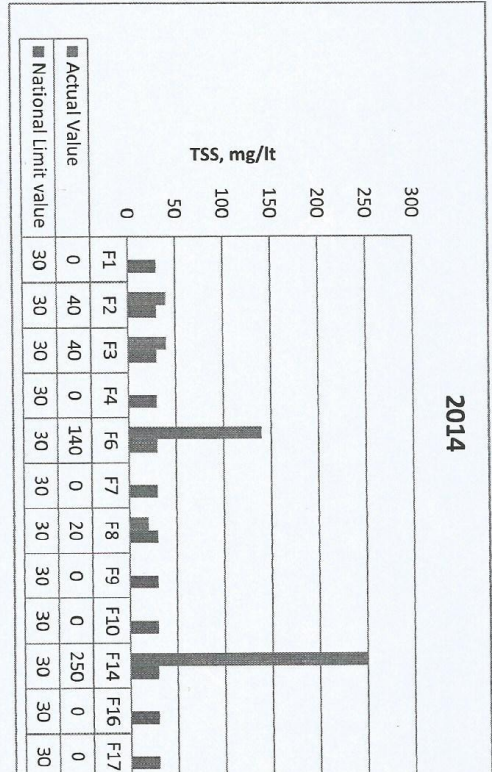
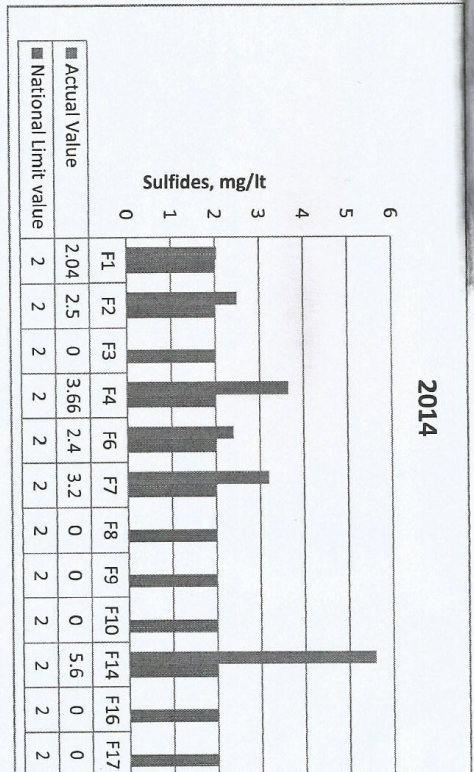
Factory Name	Actual Value	National Limit value
F1	56	50
F2	53	50
F3	90.9	50
F4	324.8	50
F6	53.4	50
F7	101	50
F8	28.8	50
F9	22.5	50
F10	148.8	50
F14	91	50
F16	17.29	50
F17	6.6	50
F18	40.35	50





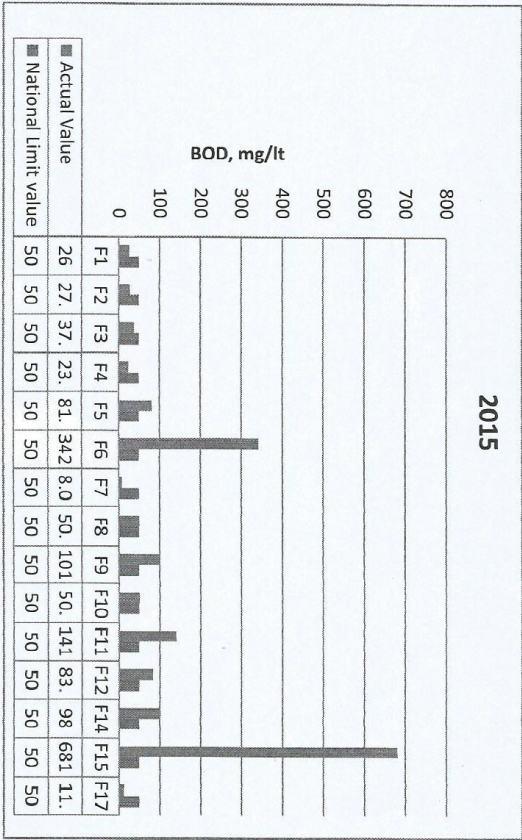
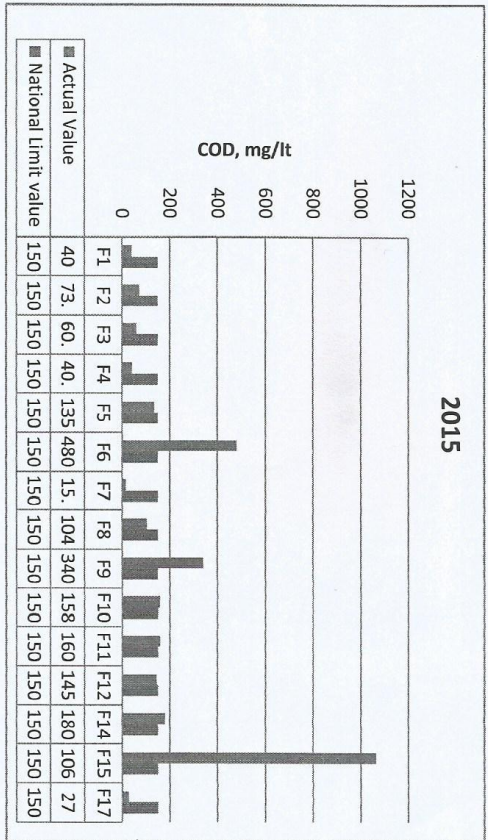
Factory Name	Actual Value	National Limit value
F1	2.04	2
F2	2.5	2
F3	0	2
F4	3.66	2
F6	2.4	2
F7	3.2	2
F8	0	2
F9	0	2
F10	0	2
F14	5.6	2
F16	0	2
F17	0	2
F18	0	2

Factory Name	Actual Value	National Limit value
F1	0	30
F2	40	30
F3	40	30
F4	0	30
F6	140	30
F7	0	30
F8	20	30
F9	0	30
F10	0	30
F14	250	30
F16	0	30
F17	0	30
F18	0	30



COD		
Factory Name	Actual Value	National Limit value
F1	40	150
F2	73.4	150
F3	60.3	150
F4	40.9	150
F5	135.17	150
F6	480	150
F7	15.5	150
F8	103.8	150
F9	340	150
F10	158.4	150
F11	160.16	150
F12	144.7	150
F14	180	150
F15	1064	150
F17	27	150

BOD		
Factory Name	Actual Value	National Limit value
F1	26	50
F2	27.8	50
F3	37.5	50
F4	23.8	50
F5	81.27	50
F6	342	50
F7	8.01	50
F8	50.8	50
F9	101	50
F10	50.91	50
F11	141.05	50
F12	83.5	50
F14	98	50
F15	681	50
F17	11.47	50

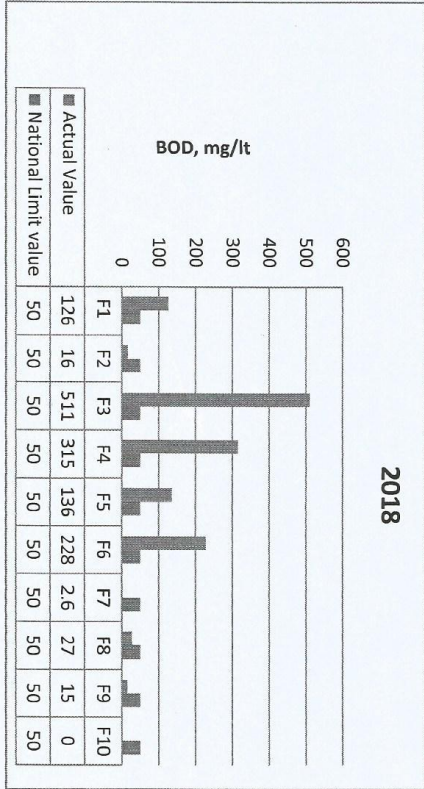
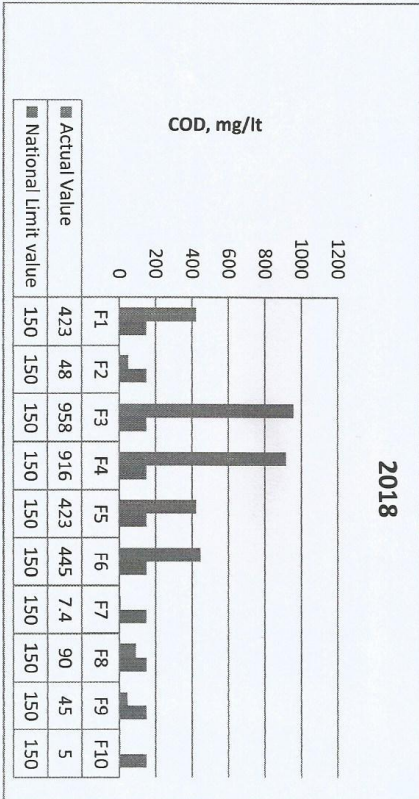


COD

Factory Name	Actual Value	National Limit Value
F1	423	150
F2	48	150
F3	958	150
F4	916	150
F5	423	150
F6	445	150
F7	7.4	150
F8	90	150
F9	45	150
F10	5	150

BOD

Factory Name	Actual Value	National Limit Value
F1	126	50
F2	16	50
F3	511	50
F4	315	50
F5	136	50
F6	228	50
F7	2.6	50
F8	27	50
F9	15	50
F10	0	50



Appendix II: Interview questions for EFCCC focal person

ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

**Survey on policy framework, organizational and operational dimension,
implementation, impact and challenges of adopting Environmental
Management Technology in Ethiopian textile industries.**

Introduction

Dear Respondent,

First of all, I would like to thank you for your willingness to participate in this study. The objective of this questionnaire is to collect the necessary primary data for my research on the topic " Adoption and Impact of Environmental Management Technology in Ethiopia, The Case Of Waste Water Treatment Technologies in Textile Industries": its Practice, Efficiency, Challenges and Implications on green and sustainable development for the partial fulfillment of the requirements for the degree of Masters in Environment and Sustainable Development at Addis Ababa University.

Your genuine responses for these questions are quite vital for the success of this study and therefore you are kindly requested to give your response freely and accurately on the space provided under each question.

Finally, I would like to confirm you that all the information you provide in this questionnaire will be strictly confidential and will exclusively be used for this research purpose only.

Researchers' Name: Ameha Tegegne,

Address: Cell phone: +251 911623502,

e-mail: berekahun@gmail.com

8. How efficient are the installed waste management/waste water treatment technologies towards complying with national environmental standards?.....
.....
.....
9. Are there environmental institutional set ups and structures in place up to company level to assist in building capacity of the manufacturing sector for improving environmental performance?.....
.....
10. Is there a laboratory facility in your organization to check the quality of treated waste water from factories?
11. If your answer for Q.No 10 is no, how do you know the quality of treated waste water before discharging to the environment?
12. Who is responsible for enforcing environmental laws and regulations on firms that do not comply with standards?
13. Do you receive reports about environmental performance of the textile industries from any pertinent institution?
14. How close and cooperatively does your organization work with manufacturing industries or pertinent institutions with regards to environmental management and /or pollution?
.....
.....
15. What do you suggest will be good to be done in the future by pertinent institutions and other stakeholders to protect environmental pollution and/or degradation?
.....
.....
.....
.....

Appendix III: Interview questions for ETIDI focal person
ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF DEVELOPMENT STUDIES
Survey on policy framework, organizational and operational dimension,
implementation, impact and challenges of adopting Environmental
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NB. No need of writing your name. Thank you very much ahead for your cooperation!

Researchers' Name: Ameha Tegegne,

Address: Cell phone: +251 911623502,

e-mail: berekahun@gmail.com

7. At what interval does the pertinent environmental regulatory body supervise and/or inspect manufacturing industries for their environmental performance?
8. What type of waste management/waste water treatment technologies are adopted and implemented in the textile factories?
9. Who is responsible for the selection, installation and approval of the treatment technologies installed in the textile factories?
10. Are there any incentives and/or awards for manufacturing industries on successful compliance to national environmental standards/regulations?
11. How do you measure the performance of installed/adopted waste treatment technologies and how efficient are they towards complying with national environmental standards?
12. How close and cooperatively does your organization work with environmental regulatory bodies with regards to environmental management and /or pollution?
13. Do you report about environmental performance of the textile industries to the environmental regulatory body regularly?
14. What are the basic challenges in implementing the adopted waste management/treatment technologies?
15. What do you suggest will be good to be done in the future by pertinent institutions and other stakeholders to protect environmental pollution and/or degradation?

Appendix IV: Open-ended questions for EFCCC experts

ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

**Survey on policy framework, organizational and operational dimension,
implementation, impact and challenges of adopting Environmental
Management Technology in Ethiopian textile industries.**

Introduction

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Researchers' Name: Ameha Tegegne,

Address: Cell phone: +251 911623502,

e-mail: berekahun@gmail.com

.....
8. Have you ever heard of pollution problems caused by textile industries?

.....
9. If your answer for Q.No 8 is yes, how do you access the information about the pollution due to textile industries?

.....
10. Is there a laboratory facility in your organization to check the quality of treated waste water from factories to evaluate their environmental performance?

.....
11. If your answer for Q.No 8 is no, how do you measure the quality of treated water and hence the polluting status of the factories?

.....
12. How do you generally rate the efficiency of waste water treatment technologies in Ethiopian textiles?

.....
13. Who is responsible for enforcing environmental laws and regulations on firms that do not comply with standards?

.....
14. What are the major challenges in implementing the adopted waste management technologies and meet national environmental standards?

.....
15. What do you comment to improve environmental performance of manufacturing industries?

Appendix V: Open-ended questions for factory experts
ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF DEVELOPMENT STUDIES

**Survey on policy framework, organizational and operational dimension,
implementation, impact and challenges of adopting Environmental
Management Technology in Ethiopian textile industries.**

Introduction

Dear Respondent,

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Your genuine responses for these questions are quite vital for the success of this study and therefore you are kindly requested to give your response freely and accurately on the space provided under each question.

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Researchers' Name: Ameha Tegegne,

Address: Cell phone: +251 911623502,

e-mail: berekahun@gmail.com

9. Is there a regular schedule when pertinent environmental regulatory bodies supervise, monitor and evaluate the environmental performance of your factory?
10. What kind of professionals are there in place to run the waste treatment plant?
-
11. What kind of inputs/chemicals do you use in the waste water treatment plant?
-
-
12. Is there a laboratory facility in your company to check the normal/efficient functioning of the treatment plant?
13. If your answer for Q. No 11 is no, how do you know the quality of treated waste water before discharging to the environment?.....
-
14. At what interval do you conduct laboratory test (internally or externally) to check the quality of treated waste water?
-
15. What are the major challenges in implementing the adopted waste management technologies and meet national environmental standards?
-
-
-