Addis Ababa University

School of Graduate Studies

College of Development Studies

Center of Environment and Sustainable Development

Liquid Waste Management Practices and the Role of Communal Treatment Plant in the Eastern Industrial Park of Dukem town

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The researcher declare that **Liquid Waste Management Practices and the Role of Communal Treatment Plant in the Eastern Industrial Park of Dukem town** is my own work and that all source that I have used or quoted have been indicated and acknowledged by means of complete reference and that this work has not been submitted before for any other degree at any other institutions.

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This thesis has submitted for examination with my approval as a university advisor.

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Name of advisor Signature

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Abstract

Eastern industrial park was constructed for social and economic development, though some of the industries inside the park are polluting the surrounding environment as they were not properly treated and discharged to the environment. Consequently, the paper intended to assess liquid waste management practices and the role of Communal treatment plant. In doing so, the researcher used mixed research employing both qualitative and quantitative data. Both primary and secondary data were used in the study. On the other hand, cluster, purposive and systematic sampling were used to select the required sample while SPSS software was used for quantitative data analysis and thematic analysis was employed for qualitative data analysis. Researcher found out that with the exception of Linda garment and Zhongshun Cement manufacturing the rest sampled companies had primary treatment plant. However, the treatment plant in each company was not efficient in treating the liquid wastes from the companies. On the other hand, based on perception of employees of industries there was no effective liquid waste communal treatment plant and the treatment of liquid waste in the communal treatment plant was not as per the national standard. Besides, there was no benefit of communal treatment plant for the environment in general and the health of local people in particular. Furthermore, there was no sufficient equipment and facilities, best selection of treatment process and good treatment system design in the communal treatment plant of Industrial Park. Formulation and enforcement of legislation and training and motivation of personnel were the factors that highly determine the existence of effective liquid waste management practices. While satisfaction with the financing and investment in equipment and facilities, training and motivation of personnel and agreement on the public education and involvement in the liquid waste management practices are the factors that highly determine the dependent variable the existence of sufficient facilities and equipment for liquid waste management practices. Each company was recommended to have efficient primary treatment plant. Besides, making sample test regularly from the effluents discharged to the communal treatment plant was also recommended by the researcher. Furthermore, the industry park recommended to plant efficient treatment plant with sufficient facilities using modern and efficient technologies that reduce liquid waste pollution.

***Key words**: Liquid Waste, Management Practices, Communal treatment plant and Industrial park*

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Acronyms and Abbreviations

BOD	Biological Oxygen demand
COD	Chemical Oxygen demand
DEFCCA	Dukem Environment, Forest and Climate Change Authority
EEPA	Ethiopian Environmental Protection Authority
EIP	Eco-industrial Park
EIZ	Eastern Industrial Zone
NH3	Ammonia
NO3	Nitrate
PAH	Poly Aromatic Hydrocarbons
PM	Particulate Mass
POPs	Persistent Organic Pollutants
SDPRP	Sustainable Development and Poverty Reduction Program
SPM	Suspended particulate matter
UNEP	United Nation Environmental Program
UNIDO	United Nation Industrial Development Organization

Chapter 1: Introduction

1.1 Background of the Study

Industrial waste is useless waste produced by industrial operations such as manufacturing, fabrication, construction, chemical plants and others. It is harmful pollutant that impacts the environment and water bodies through pollution (Menbere, 2019).

According to Hoornweg and Bhada-Tata (2012), industrial wastes makeup 94% of all wastes and are produced by industrial processes and production. More than half of the population of less developed countries does not have access to sanitation and more than 80% of the waste water generated is directly discharged into surface water bodies (Mekonnen, 2012).

In the past industrial liquid waste pollution were overlooked in the industrial design, manufacturing use, and its disposal (Al-Yousfi, 2004). Beside this, hazardous and toxic wastes were handled in unsustainable way. As a result, severe environmental effects were caused from material production, manufacturing, distribution, usage and disposal of wastes.

Currently, following the development of society and anthropogenic activities such as industrialization, waste management gradually has become a focus area (Liu, 2014).

Nevertheless, rapid population increase and unsustainable industrial development are extremely degrading the urban and semi-urban environment in Ethiopia (FEDRE, 2011 and Menbere, 2019). They are causing enormous damage on natural resources, and hindering efficient and sustainable development due to inadequate waste management and pollution control and resource depletion.

According to Berehanu et al. (2015), has shown, the chemical compositions of industrial effluents have polluted Lake Hawassa. On the other hand, study conducted on Textile Industry in Hawassa, Southern Ethiopia by Mekuyie (2014) has revealed that the textile effluent entering in to Tikur Wuha River have caused toxic effects on consumers through food chain like milk consumption and decreased livestock productivity consuming this water source and grazed around this area. It has also caused toxic effects on aquatic species of the river.

In other side, Belay (2010) studied on the impacts of industrial effluents and found out that chromium was the primary threat in the tanning industry. Mulu et al. (2013) conducted a study on the impact of slaughterhouses effluents on water quality of Modjo and Akaki River

in Central Ethiopia. The result has revealed that there was an adverse impact on the physiochemical and bacteriological characteristics of the receiving rivers as a result of the discharge of these effluents. On the other hand, as study conducted by Mekonnen, (2012) in Bahir Dar, Ethiopia on liquid waste management has shown, there was weak implementation of the regional sanitation regulations .

Although, the Ethiopian government has considered the Eastern Industrial Park as an integral part of Sustainable Development and Poverty Reduction Program (Giannecchini & Taylor, 2018), the liquid pollutants released from the Industries in the park are degrading the environment such as water and soil (Giannecchini & Taylor, 2018). The local communities surrounding the industrial park are also affected by the activities in the industrial park.

However, the national environmental pollution control proclamation No. 300/2002 primarily intends to safeguard the right of citizens to a healthy environment and to enforce law to protect the environment of the nation. The law is aimed in ensuring the management of hazardous waste, and establishing environmental quality standards for water, air and soil; and monitoring pollution. In relation to this, the proclamation offers a basis from which the appropriate environmental standards relevant to Ethiopia can be established, while endorsing violation of these standards as illegally punishable offenses.

Furthermore, Regulation 159/2008a which was established by the Federal Environmental Protection Authority, aimed to avoid industrial pollution and promote compatibility of industrial development with environmental conservation. This regulation presents key obligations to industrial operators. A factory subject to the regulations is obliged to avoid or reduce the generation and discharge of pollutants to a level not beyond the environmental standards. The regulation also obliges industrial operators to manage its apparatus, inputs and outputs in a way that avoids the destruction of the environment and human health. Besides, the regulations urge industrial operators to design and employ an emergency response method of their own. On the other hand industrial operators are obliged in designing and implementing internal environmental monitoring methods and keeping written records of the pollutants produced and the disposal mechanisms.

Although the country formulated different regulatory frameworks that prevent or minimize environmental pollution, even the industrial park which the government considered the model

of sustainable development has been polluting the environment through its liquid waste discharges.

Hence, this study aims to investigate the liquid waste management practices and the contribution of Communal treatment plant in the Eastern Industrial Park of Dukem town.

1.2 Statement of the problem

The influence of human activities on the environment has been increasing since the beginning of the industrial revolution and at current it extends to a much bigger level, at continental and global scale. Emission levels have reached the point where environment linked physical effects are witnessed on a large proportion (Van and Slawinski, 2015).

In addition, according to McMichael et al. (2008), the environmental effects that are related with industrialization in least developed countries remain crucial as they encroach typically on the poor and vulnerable communities. Chemical and heavy metals remains contaminate local foods, urban air pollution brings premature deaths, and waterborne internal organ pathogens cause for the death of children.

In Ethiopia due to population growth and urbanization, industries are swiftly evolving in different parts of the country. Although, these industries have social and economic advantage still they have environmental influence on local communities. As study conducted by Demewoz and Abebe (2017), revealed, human beings have been polluting the environment with their industrial activities. Other study conducted in Addis Ababa by Menbere & Menbere (2019) indicated, the liquid wastes from poorly handled industries such as tanning industries, textile and garment industries, beverage industries and industrial parks were contributing to the pollution of both water bodies and different parts of the City. On the other hand, according to Mekonnen (2012), there was a poor level of knowledge about the current regulations on liquid waste among the experts as well as the community.

Dukem is one of small sized town found in Oromia regional state, which hosts the Eastern industrial park shows this problem (Dukem town Environmental protection, Forest and Climate Change Authority, 2021).

Eastern industrial park was constructed for social and economic development, though some of the industries inside the park are polluting the surrounding environment as they are not properly treated and discharged. For example, the Oromia Environmental protection Bureau, (2020) investigated that concentration of phosphorous (P) in the sample treated waste water

from Dongfang textile industry was 35.8 mg/l which is greater than the national limit that is <5 mg/l. Similarly, the concentration of heavy metals such as Cr, Cd, Zn, Fe, Pb and Cu from the sampled waste water, soil and vegetables are above the maximum level set by WHO (1999).

In addition, from the outlet of the communal treatment plant of the Eastern industrial park dark color wastewater and offensive odor were observed showing the discharge of inadequately treated waste water from the industries. Furthermore, the local communities have been repeatedly complaining of liquid waste pollution from the industries. It was also observed that, this waste water has been used as source of irrigation water utilized by local farmers to grow vegetables. This might have considerable health impacts on the local community.

Various scholars conducted a research in the area of industrial liquid waste pollution dealing with different parameters and they found out that large concentration of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TTS), and PH found in the observed industries (Dadi et al., 2017; Claudio, 2007 and Lo et al. 2012). Itanna (1998) conducted a research on the Metal concentration of some vegetables irrigated with industrial liquid waste at Akaki, and the research found out that some metals such as Cd, Cr, Cu, Hg, Ni and Zn in potato and Cr in onion and red beet were above the maximum limit with less considering liquid waste management practices and the contribution of communal treatment plant. Therefore, this study focuses on filling some of these gaps.

1.3 General Objective

To assess liquid waste management practices and the role of Communal treatment plant in the Eastern Industrial park of Dukem town

1.3.1 Specific Objectives

1. To assess the liquid waste management practices in the selected industries of industrial park
2. To examine the attitude of employees of industries on the contribution of the communal treatment plants and their determinants
3. To assess the factors that affect the effectiveness of the liquid waste management practices

1.4 Research Question

1. How the selected industries managing liquid wastes and what are the existing practices?
2. What are the level of attitudes of employees of industries on the effects of communal liquid waste treatment plant and determinants?
3. What are the major factors that affect the effectiveness of the liquid waste management practices?

1.5 Scope of the Study

The study was limited to the Easter Industry Park in Dukem town. Industries in the Industrial park, the experts in the Environmental protection, Land administration, Social and Labor affairs and Investment office and selected experts of each industries of Industrial park are the population of the study.

It was proposed to assess liquid waste management practices and the role of Communal treatment plant in the Eastern Industrial park of Dukem town. The study incorporated issues such as liquid waste management practice and the attitudes of the employees of industries on the effects of communal liquid waste treatment plant.

1.6 Significance of the Study

The primarily aim of this study was to assess the liquid waste management practices and the contribution of communal treatment plant in Eastern Industrial park of Dukem town.

This will play a vital role for the local authority to take appropriate measures in the effort of solving the negative effect of liquid waste on the environment. It also significantly benefits in providing information for policy makers in developing their local environment management system, particularly, that are related with industries. Besides, the study will serve as a reference for researchers who will conduct researches in the area of liquid waste management practices in the industrial park.

1.7 Limitation of the study

There was limitation of data gathering through contacting the employees of the industries as some of industries formulated COVID 19 protocol that ban physical interaction with other people outside their companies. Besides, industries were not motivated in giving the required data since the study was concerned with industrial liquid management practices.

1.8 Organization of the paper

Chapter one is the introductory part which incorporated the background of the study, statement of the problem, general objective, research question, scope and significance of the study. On the other hand, chapter two comprised different literature review. Chapter three is a research method and methodology. It incorporated components such as introduction, study area, research approach and data source, sampling method, data collection instrument, data analysis, data presentation, validation of the data, model and ethical consideration. Chapter four is result and discussion which consisted of qualitative interview and secondary document review, descriptive analysis of socio-economic and demographic profile of respondents and employees perception about the communal treatment plant and determinants. Multinomial logistic regression analysis also incorporated in the chapter. Chapter five is the last chapter which included summary of the finding, conclusion and recommendation.

Chapter 2: Literature Review

In the following section, different literature review which incorporates concept and definition of words, different theories such as Ecological Modernization and Waste Management Theory and Empirical literature were reviewed.

2.1 Definition of Terms and Concepts

Environmental Management system (EMS): systems that offer the way to meet environmental compliance and regulatory legislation (Academy, 2016).

ISO 14001: is an international standard for EMS while ISO 14001: 2015 is the latest version of ISO 14001 (Bansal & Bogner, 2002)

Waste Recycling: It is the avoidance of materials from a disposed product or package so that they can be used as raw resources for a new product or package. A major issue is that the total product or package will be sent to a landfill, if no recycling is employed (Wright et al., 2011).On the other hand, according to Conrad (1997), recycling waste is a system that reprocesses and re-utilizes of both solid and liquid waste as a resource in the wrong place in the production line.

Zero Waste: According to (Curran & Williams (2012), zero waste is a holistic approach that intended to eliminate instead of managing waste as well as initiating waste alteration from landfill and incineration. It is a kind of philosophy for removing waste at source and at all points down the supply chain. Zero waste is derived from grass roots community and individuals. It is expressed through its essential elements and principles.

Eco-industrial Park (EIP): According to Park et al., (2008), an eco-industrial park (EIP) is an industrial structure which protects natural and economic resources. It reduces production, material, energy, insurance and treatment costs and liabilities.

Industrial park: An industrial park is stated as a unique area on the edge of a city or town where there are many factories and businesses are located (Liu and Jiang, 2018).

Sustainable Development: As to Ortiz et al. (2009) the term ‘sustainable development’ can be expressed as improving the quality of life .This is so, through letting people to live in a healthy environment and enhance social, economic and environmental situation for present and future generations.

Environmental sustainability: as stated by Elliot, S. (2011), environmental sustainability means maintaining natural capital, similar to the definition of environmental capital sustainability.

*Industrialization***:** industrialization is the operational process by which an economy is changed from primarily agricultural to the manufacturing of goods (UNIDO, 2011).

Green Industry: It is a kind of industry that supports sustainable designs of production and consumption i.e. designs that are resource and energy efficient, low-carbon and low waste, non-polluting and safe, and which produce products that are accountably managed throughout their lifestyle (UNIDO, 2011).

Policy: It is a plan or guideline for action (Nill and Kemp, 2009). On the other hand, policy statement is the intent of the government or organization to do something about some issues.

Environmental policy: It is a written statement stating our organization's mission in connection to the management of the environmental influences of its operational processes (WRAP, 2015).

2.2 Theoretical Review

2.2.1 The Waste Management Theory

A waste management theory is a conceptual explanation of waste handling. It gives a definition of all waste-related concepts, and suggests a methodology of waste management.

According to Pongraz (2004), the main aim of this theory is to provide a holistic view of waste management. It also intended to provide an explanation of all waste related concepts and offer a formal conceptual methodology of waste management. The waste management theory assumes that the ways we describe a target prescribe action upon it. This implies that sustainable waste management depends greatly upon how waste is defined.

Every term which is used in a scientific theory should be, precisely, defined. Definition of concepts is a prerequisite for managing wastes scientifically. According to the waste management theory, waste management starts with the expressive definition of waste (Pongraz, 2004).

As to the Commission of European Communities (2001), the community's approach to waste management strategy depends on the leading principle of the waste hierarchy. It gives first choice to waste prevention, then to waste recovery that consists of reuse, recycling and energy

recovery. Lastly, it prefers waste disposal which incorporates incineration without energy recovery and land filling.

The present waste strategy and legislation includes three key elements. These are waste prevention which is directly associated with getting better resource efficiency, controlling consumption patterns, and decreasing the waste that comes from products all the way through their life cycle of production. It uses the point where the products itself turn into a waste. Activities to prevent waste should be done, primarily, at source. That means, finding means of lengthening product life duration, using a lesser amount of resources in products, changing to cleaner, less wasteful production processes. On the other hand, influencing costumer preference and requiring in the market place in favor of a reduced amount of wasteful goods and services (Commission of European Communities, 2001).

Differentiating the hazardous matter that causes the biggest problems in various waste types and supporting alternate with less harmful substances. It is also important to use a different option of product designs that reduce such matter. Focusing on being certain closed-loop structure where the manufacturer is made accountable in promoting the garbage is collected, treated and recycled in a system that reduce the risks and affect the environment (Pongraz, 2004).

2.2.2 Ecological Modernization Theory

The purpose of Ecological Modernization Theory has been to examine the manner modern industrialized societies go with environmental issues. However, the main studies in the tradition of Ecological Modernization give emphasis on environmental transformations in societal practices, institutional designs and social and policy dialogues to maintain societies' sustenance bases (Arthur et al., 2000).

According to Murphy and Gouldson (2000), Ecological Modernization Theory states as a means of solving environmental problems related with industrialism whereas at the same time enhancing economic competitiveness. This is so, through using environmentally efficient technologies, organizational transformation, sustained development and comprehensive implementation of fundamental innovations. It is the only means in practice to realize the purpose of ecological modernization.

On the other hand as to (Murphy and Gouldson, 2000) stated, it is a theory of environmental sociology, which gives a sociological explanation of environmental improvements. It also

advocates that the desire of a national policy of liquid waste management and effective system for sustainability of waste water management. The concept of EM have been employed to explain the means in which environmental constraints come to be seen as an issues that are economically, politically and technologically answerable within the situation of present institutions and power arrangements and sustained economic growth.

However, as stated by Mol & Sonnenfeld (2000), even if political institutions have their own share to poor environmental result in the past, Ecological Modernization Theory claim that they can be readily transformed to better address ecological problem. Advocators of the theory hope that, political actors could be accountable for establishing new and different partnerships to make environmental conservation politically feasible (Berger *et al.,* 2001).

In addition, Ecological Modernization affects all environmental issues as a constraint to avoid inefficiency through better design. It encourages the use of Eco-efficient technologies and the reform of economic and political organization to give incentives that will successfully decouple economic growth from raw materials utilization, waste and environmental loss. Liquid waste is seen as manifestation of inadequacy. Companies use their need to cut costs by innovating to get new means of minimizing their raw material and energy use, avoiding pollution in the course. On the other hand, governments avoid markets failures that initiate environment damage and create incentives to innovate by punishing destructive behavior and rewarding Eco-efficient enhancements (Berger, 2001).

2.3 Empirical Review

2.3.1 The role of perception and attitudes on liquid waste management

According to Irvin & Stansbury (2004), the the experts and key informants perception of liquid waste management has a significant role in deciding their behavior and attitude towards its management and practices. In order to determine an individual's characteristics, it is important to know their beliefs, intentions, and the level of significance they give to liquid waste management.

The perception of one's ability is thought to set a boundary to what to do and finally what can be achieved. Perception affects the manner a person observes himself and the world around him and the manner it tends to govern his behavior. According to Kaoje et al., (2017), key informants attitude and perception are positively correlated with liquid waste management

practices. This recommends that key informants with positive environmental perception tend to implement responsible liquid waste management practices and interact responsibly with the pollutant industries.

On the other hand, key informants perception and attitude of liquid waste management defines the entire course of the way key informants comes to understand what is happening on concerning best practices in liquid waste management. Awareness and enlightenment plan through information, education, capacity building, coupled with application and execution of laws and regulations on appropriate liquid waste management (Kaoje et al., 2017).

According to Okechukwu et al. (2012), although insufficient management of liquid waste might be attributed to several factors, it is important to underline the role of community's perception, attitudes, liquid waste handling practices, and their relations with other agents in the liquid waste management system. This is so; they are the major end-users of liquid waste management facilities (Mamady, 2016).

On the other hand, as to Maharaj (1999), community involvement through their attitude and perception is best attained through involvement of users in all parts of the liquid waste management process from planning and design to implementation and decision-making, which produces more efficient and sustainable liquid waste management system. This is so, when communities have impact and control over decisions that affect them directly or indirectly, they have a greater participation in the results and are more devoted to ensure effective achievement.

Community participation through attitude and perception in the wastewater management, which is related with main social concerns, incorporating impacts on community health and safety, impacts on environmental quality, the benefits and risks of liquid waste management. Therefore, having a successful community participation strategy from the planning phase to full operation leads to greater recognition and facilitates in the implementation process of the liquid waste system. In other words, community involvement can promise the social feasibility of the wastewater management practices (Saad et al., 2017).

Even during wastewater is treated through employing advanced technologies and health risks are carefully addressed and controlled. Regardless of all scientific evidence, community perception becomes the cause of the success or failure of wastewater management system. Depending on community perceptions, impressions and attitudes, the development of a

wastewater system can be reinforced or constrained. Negative community perception can avoid well-planned liquid waste management system from moving forward. On the other hand, positive community perception, which drives to greater recognition, is the main component for fruitful implementation of wastewater management. Experience reveals that the local communities have banned a number of wastewater management projects by the governments and water boards in the world because of insufficient community involvement which led to negative community perception (Saad et al., 2017).

2.3.2 Environmental Management system (EMS)

Environmental systems are commonly considered by contemporary business leaders as systems that offer the way to meet environmental compliance and regulatory legislation. However, this view can avoid a properly designed Environmental Management System from attainment of full potential which offers financial, economic, and reputational profit and the observable environmental benefit (Academy, 2016).

As a response to the growing needs brought in environmental legislation during the 1970s and 1980s, several companies began to advance their own set of procedures. The emphasis of these procedures was to guarantee that delegated end-of pipe pollution control technology were in place and working. This demanded permit uses and monitoring reports to be send to the environmental authorities (Zobel, 2005).

According to Andrews et al. (2003), these procedures are sometimes considered to as early EMS prototypes. Ecologically proactive companies took these initial Environmental Management System prototypes a phase further in the 1980s, adding pollution prevention packages and waste minimization aims to compliance guarantee the Environmental Management System standards that were announced in the 1990s more advanced the early Environmental Management System prototypes (Zobel, 2005).

On the other hand, the International Organization for Standardization (ISO) established the ISO 14000 series of standards depending on the need discussed at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 for better environmental quality (Bansal & Bogner, 2002).

According to Fisher (2003), the International Organization for Standardization (ISO) is an international federation of national standards groups from around 130 countries. It was established to support the progress of safety standardization and associated activities. It has

been implemented by several companies around the globe, in order to show to clients and others with which the company deals that it has undergone an all-inclusive analysis of its organizational arrangement which promises quality assurance (Fisher, 2003).

2.3.2.1 Description and implementation of EMS

Depending on the requirements of ISO 14001 an EMS is explained here by stating the implementation process of a system. The corresponding stages in the PDSA-cycle are showed in brackets (Zobel, 2005).

2.3.2.1.1 Planning (Plan)

According to Academy (2016), planning is the formation of objectives, and processes that may convey them, in harmony with the environmental policy founded by the organization

It happen prior to the actual implementation of an EMS, it is regularly essential for an organization to establish the existing situation concerning environmental activities in the organization. To do this, the first environmental review is often made. The review often incorporates identification of environmental feature, applicable environmental regulations and external necessities, existing environmental instructions and procedures. When environmental features have been identified, they are examined to decide which of them have or may have important environmental impact. The primary review is a one-off procedure; however, new environmental features should keep on in identifying and assessing subsequent to the implementation stage. The important environmental aspects form the ground of an environmental policy. This policy is documented and disseminated within the organization and is made accessible to the public. The important environmental aspects are also essential input when setting environmental objectives and targets. The other necessary input are legal and other external necessities, technological choices, business and operational necessities and the opinion of stakeholders. The aims and targets must be quantifiable and reliable with the environmental policy. Enhancement programmes, incorporating designation of accountability, ways and time frame, are set to attain the objectives and targets. After the implementation of EMS, the objectives, targets and advancement programmes are sustainably monitored and where essential corrected. As objectives and targets are attained, new ones are set. The appropriateness of the environmental policy is also deliberately assessed (Rondinelli & Vastag 2000; Zobel, 2005).

2.3.2.1.2 Implementation and operation (Do)

It is the implementation of the planned processes (Academy, 2016). The roles and responsibilities concerning environmental problems are explained and documented. Top management nominates a specific management delegate, who is responsible to make sure that the EMS is sustained in compliance with ISO 14001 and to report the system's performance to top management. All personnel who are engaged in activities that have the capacity to cause considerable environmental impact obtain particular environmental training. Steps for internal communication between functions of the organization are founded and steps for external communication with stakeholders. Procedures and action directions to manage those activities that have considerable environmental impact are set and documented. Furthermore, procedures to detect the possible accidents that may have an effect on the environment and the manner organization should respond to such accidents are founded. After the implementation of EMS, documented responsibility, accountability and procedures should constantly be up-dated (Rondinelli & Vastag 2000; Zobel, 2005).

2.3.2.1.3 Checking (Study)

It is the monitoring and measuring of outcome versus the environmental policy, incorporating complete commitments, objectives, and requirement, and the reporting of them (Academy, 2016).

The operations of the organization that have considerable environmental impact are constantly observed and measured to assess environmental performance. Regulatory conformity is also continuously assessed. Steps for dealing with incompliance concerning necessities in ISO 14001, environmental regulations and procedures in the EMS are set. To decide whether the EMS compliance with the necessities in ISO 14001 and is functioning as planned, internal environmental audits are made at planned intervals. Internal environmental auditors obtain suitable auditor training. An EMS is not regarded appropriately implemented prior to procedures for supervising, dealing with incompliance and internal audits are up and functioning within the organization (Zobel, 2005).

2.3.2.1.4 Management review (Act)

According to Academy (2016), act is the consequent measure taken to ensure continual improvement. It is the final step of the implementation of EMS is a review of the EMS made by higher management. Under this review, the appropriateness, sufficiency and usefulness of the EMS are assessed. This review ought to, following the implementation stage, be

performed at intended intervals. Some of the inputs to the management assessment are results of environmental audits, assessment of regulatory conformity, and the degree to which environmental aims and targets have been met, changes in legal necessities and the environmental aspects of organization and actions of follow-up from previous reviews. The result of the review are, when essential, activities associated to changes in environmental policies, objectives and targets ,however, such measures may also be associated to changes in other elements of the EMS (Zobel, 2005).

2.3.3 Liquid waste treatment technologies

However, according to Mondal (2008), explained there are numerous methods and systems for elimination of color from wastewater generating from various industries. It involves various biological degradation using fungi, bacteria, and enzymes, chemical breakdown mechanisms and physical separation. In the following, different treatment technologies have been explained which are used for treatment of colored effluents.

2.3.3.1 Physical Methods

Physical treatment, on the other hand, concentrates, solidifies, or minimizes the amount of the waste. Physical processes contain evaporation, sedimentation, flotation, and filtration. However, another process is solidification, which is attained by compressing the waste in concrete, asphalt or plastic. Encapsulation generates a solid mass of material that is resistant to leaching. Waste might also be mixed with fly ash, lime and water to form solid, cement like product (https://www.britannica.com/technology/hazardous-waste-management/Treatment-storage-and-disposal accessed on January 23/2021).

According to Porter (1997), different physical methods such as filtration technique such as nanofiltration, ultrafiltration, and reverse osmosis, coagulation technique, and adsorption are employed for effective treatment of colored effluents. Filtration methods are broadly employed for treatment of colored effluents. Nano filtration, ultrafiltration, and reverse osmosis have been employed for reusing water and chemical recovery also. However, the filters employed in these methods mainly depend on the kind of wastewater with variable size of contaminant and thus highly reliant on the choice of filter to be implemented.

2.3.3.2 Biological Methods

Biological treatment is secondary treatment process of waste water by utilizing many diverse kinds of microorganisms in a controlled environment. Various aerobic biological processes are employed for secondary treatment differing mainly in the way in which oxygen is provided to the microorganisms and in the rate at which organisms digest the organic matter (Takata, 2013).

On the other hand, biological treatment of some organic wastes, like those from the petroleum industry, is also a choice. One way employed to treat hazardous waste biologically is called land farming. In this method the waste is wisely mixed with surface soil on a suitable tract of land. Microorganisms that can metabolize the waste might be added, along with nutrients. In certain cases a genetically engineered species of bacteria is used. Food or forage crops are not grown on the similar site. Microbes can also be utilized for stabilizing hazardous wastes on formerly polluted sites; in that case the process is called bioremediation. (https://www.britannica.com/technology/hazardous-waste-management/Treatment-storage-and-disposal accessed on January 23/2021).

2.3.3.3 Chemical Methods

Chemical methods comprise precipitation, oxidation, ion exchange and reduction, and neutralization (https://www.britannica.com/technology/hazardous-waste-management/Treatment-storage-and-disposal accessed on January 23/2021).

Besides, this method mainly comprises the usage of various oxidizing agents such as hydrogen peroxide, ozone, and permanganate for removal of colored materials from wastewater (Metcalf and Eddy, 2003).

According to Zaroual et al. (2006), currently, electrocoagulation has fetched attention being a potential method for treating colored liquid discharges due to its ecological compatibility and adaptable nature. The technique includes the use of direct current source between metal electrodes which are absorbed in the effluent, triggering dissolution of electrode plates into the effluent. The metal ions at optimum pH take to creation of metal hydroxides and coagulated type that weakens the process and aggregate particles hence formed support in adsorbing the soluble pollutants. The process is measured to be a cost-effective one with

minimal increment of chemicals, thereby minimizing secondary contamination and simplifying easy operation.

2.3.2 Experience of different countries in industrial liquid waste management

2.3.2.1 Experience of China

China has the world's biggest and still growing wastewater sector. The fast development of China's liquid waste sector over the past 40 years has showed its global leading treatment capability and innovation ability (Qu et al., 2019).

According to Lyu et al. (2016), fast growing urbanization with the increment of water demand and wastewater release offers a chance for wastewater reuse. The huge volume of wastewater release and low reclaimed water generation mean that liquid waste reuse still has a great capacity in China. Numerous environmental and economic benefits and effective reclamation technologies also offer chances for wastewater reuse. Besides, the entire strategy in China is also motivating for wastewater reuse.

2.3.2.1.1 Driving forces, opportunities and challenges of waste water reuse in China

There are several driving forces can be recognized in practices of liquid waste reuse such as water shortage, economic and environmental consideration and advancement in technology. The advancement of wastewater reuse technologies, policies and regulations issued by governments are similarly the driving causes of increasing wastewater reuse (Lyu et al., 2016).

There are also opportunities of liquid waste reuse such as wastewater and reclaimed water production, urbanization, environmental and economic benefits, wastewater reclamation technology and policy and regulation.

However, there are challenges for increasing wastewater reuse**.** China is still in a primary step of liquid waste reclamation and reuse, and the broad reuse practices have not been employed until 2000 and later. There are several important challenges to increase liquid waste reuse and make it practical and sustainable at the local levels. These are slow pace in implementing urban wastewater reuse programs, formation of integrated water resources management framework and guidelines for wastewater reuse programs, incoherent water quality requirements, the restricted commercial development of reclaimed water and the consolidation of public awareness and cooperation between stakeholders (Lyu et al., 2016).

2.3.2.1.2 Wastewater treatment technologies in China

In treating waste water, China has developed various technologies to treat wastewater, and now has the world's second-biggest liquid waste processing capacity, with about 3,340 liquid waste treatment plants as of 2012. Eighty percent of these plants employs the following three technologies and avoid pollutants from sewerage. The first one is oxidization ditches. It is an improved stimulated sludge biological treatment method employing long solids retention times to avoid biodegradable organic substance which is employed in both municipal and industrial liquid waste treatment. The second one is anaerobic anoxic oxic process. It is a patented low energy, biological denitrification method employing anaerobic early-treatment and settler chamber. The third one is sequencing batch reactors. It oxidizes liquid waste from anaerobic digesters or mechanical biological treatment instruments in batches, with aeration and sludge settlement taking place at the similar time in one tank. Another method of liquid waste treatment is the construction of wetland. It is ecological way of treating wastewater. It also addresses runoff problems and flood water retention. Built wetlands are human made biological environments bringing together hydrology, vegetation and flow paths which make available successful ways of treating soluble solids, biochemical oxygen demand, nitrogen, heavy metals, phosphorus, organic pollutants and pathogens (https://www.china-briefing.com/news/chinas-wastewater-treatment-industry/ accessed at January 29/2021).

2.3.2.1.3 The challenges faced by wastewater treatment in China

After the fast development over the past 40 years, a series of important advancement was made in the liquid waste treatment industry of China, comprising standard and policy system establishment, technology innovations and infrastructure construction.

Around 5333 WWTPs have been constructed until September 2019, with entire treatment ability over 1.9×10^8 m^3 per day. Besides, the wastewater release standard system has been progressively established with a combined release standard and 61 standards linked to particular industry. Moreover, the water quality of the discharge from WWTPs has been enhanced continuously. However, various constraints still lie ahead, particularly in the wastewater concentration, sludge production and water reclamation (Xu et al., 2020).

The discharge concentration, particularly the BOD and COD concentrations of WWTPs in China, was comparatively low. Taking the average value of liquid waste discharge concentration in 2018 as an example, the BOD and COD and concentrations were 184.4 mg/L

and 76.5 mg/L, respectively. The BOD/TN value was 2.55, which was much smaller than the optimal ratio for successful nitrogen elimination (Qu et al., 2019).

Sludge generation is another challenge in China. The activated sludge is still the main method employed in most WWTPs of China, rendering the main removal for the contaminants in wastewater. One of the most vital and unavoidable problems of the activated sludge process is the production of sludge.

Water reclamation is also challenges in China. Because of large population, China was encountering water shortage. In 2018, water accessibility in China was 1971.8 m^3 per capita, which encountered water source susceptible and was close to the defined scarcity threshold of 1700 m^3 per capita per year (Xu et al., 2020).

2.3.2.1.4 The practice of zero liquid waste discharges and standards

According to EU SME Centre Market Access Guide (2019), China also practicing zero liquid discharges ("ZLD"). Its aim is to advance technologies and methods to the point of extreme resource efficiency with nearly no waste output. Zero emissions in the industrial waste water sector are zero liquid release. The aim of a ZLD method is to remove all liquid discharge in a system by minimizing the amount of wastewater that needs extra treatment. There are already various ZLD projects in China like the coal chemical liquid waste water treatment, mine drainage project and utilization in Ningdong mining area, the Guangdong He Yuan Power Plant's 2 x 600 MW Units ZLD project, and the Jincheng Petrochemical Group's 2.4 x 10^4 m^3/d liquid waste zero discharge project.

China also has been using different standards for industrial liquid waste discharge management. The standards associated to industrial wastewater release can be categorized into: industrial standards, local discharge standards, and national discharge standards. National release standards are articulated by the national administrative branch of environmental protection. They are implemented nationwide or to particular regions. Local release standards are accepted and publicized by the governments of provinces, sovereign regions, and municipalities, and are implemented in particular administrative regions.

Accordingly, industrial units require to follow the GB8978, which is a national release standard, to discharge liquid waste. The GB8978 standard offers the maximum permissible discharge concentrations of 69 several water contaminants and the maximum acceptable

discharge potential for particular industries, in accordance with the flow direction of the liquid waste (EU SME Centre Market Access Guide, 2019).

2.3.2.2 Experience of Japan

In Japan, a rational method that incorporates of rules and regulations is applied for projects and programs associating to wastewater management. The existence of sewerage systems and liquid waste treatment facilities is a national prerequisite in development plans. The country was capable to make these facilities a reality and even continuous due to national government support for capital investment and cost-sharing system among national and local governments. The achievement of project application, however, lies on rational use of government grants, determined through a clear stakeholder consensus-building process (Asian Development Bank, 2016).

On the other hand, the voluntary actions taken by Japanese industry is another feature of the Japanese experience. Keidanren an organization consist of local business organizations, leading Japanese companies and national organizations for individual industries designed the Keidanren Voluntary Action Plan on the Environment in 1997. According to this plan, it encourages voluntary initiative by industry to strive for a sound material cycle society, incorporating efforts to minimize the volume of industrial liquid waste. Compared to economic instruments and regulatory instruments, voluntary instruments are normally efficient means to avoid environmental problems. This is due to each business can take actions after widely assessing its own features, tendencies in accessible technologies and the consequences of cost-benefit analyses. As to the Keidanren plan, each business group and each industrial organization set particular numerical targets for the volume of industrial liquid waste water to be recycled and so on (UNEP, 2013).

The experience from Osaka City reveals that long-term public sector participation avoids private waste treatment businesses from entering the market and it also avoids waste generators from having economic reward to minimize the volume of liquid waste they produce (UNEP, 2013).

Therefore, the government requires deciding on the circumstances under which it will avoid intervention from the waste treatment market before it enters the market. The government should also give suitable direction to waste producing business operators before withdrawing

from the waste treatment market. This is so, in order to safeguard a smooth shift from public sector to private sector treatment (UNEP, 2013).

Currently, in large cities in Japan, it has become progressively difficult to obtain final disposal sites for sludge from liquid waste treatment plants. It needs to reduce the total amount of sludge and obtain new approaches to reuse the sludge even after anaerobic digestion. The common start of reduction of amount is a thickening and dewatering course and additional reduction is followed by drying, incineration and melting. In this case, the formation of a reuse technique of sludge as a new resource and material has come to the fore as a main priority for local government sewage works bureaus (Matsuo, 2000).

2.3.3 Environmental management of industrial parks

According to UNEP (1997), industrial parks are known as a source of environmental problems such as pollution, stress on ecosystem, potential hazards, and health problems for local communities. When these harms are coupled by local constraints such as regional water scarcity, the challenge of handling an industrial park becomes an even more complicated task. For instance, industrial parks can worsen current water shortage problems since they deplete local supplies, especially ground water. It also decreasing water tables and letting for salt-water intrusion. They also bring pollution of surface and groundwater because of industrial effluent. Environmental management at park level is hence serious in mitigating and controlling these damaging impacts (Geng & Hengxin (2009).

As to Sinkule and Ortolano (1995) and Conway (1996), the current policies and strategies of environmental management in most Asian countries industrial parks have been mainly guided by national principles for environmental conservation. They are designed from the concepts of eight guiding principles for pollution control, including (i) Environmental Impact Assessment, (ii) ‘‘Three Synchronizations’’, (iii) Pollution Discharge permit System, (iv) Pollution Discharge Fee System, (v) Centralized Pollution Control, (vi) environmental responsibility system (vii) Assessment of Urban Environmental Quality, and (viii) Limited Time Treatment, these measures comprise environmental impact assessment and the system of ‘three synchronizations’.

According to Geng & Hengxin (2009), these guiding principles are mostly featured by command and control and end-of-pipe methods, concentrating on pollution control and abatement. Asian countries industrial parks are need to integrate these national government

principles into all decision-making related to the environment, encompassing park development plans.

The limitation of this kind of environmental management strategy is that, it is restricted in scope and does not reveal the entire nature of environmental problems. Depending on regulatory mechanisms, compulsory environmental standards and discharge permits like, only serves to address particular environmental aspects. Furthermore, this strategy considers, the country that implement this strategy has a legal and enforcement capacity to make the system work successfully (Geng & Hengxin, 2009).

On the other hand, Hamner (1997) and Yap (2000), understood the need for improvement, most Asian countries governments are gradually exercising new environmental management tools. For example, policy directives nowadays support companies to independently tackle environmental management by applying mechanism such as ISO 14001 Environmental Management Systems. In addition, a procedure for cleaner production protective strategy, such as advancement of cleaner production, has been legislated into the law.

These methods are useful, mainly when used in combination with relatively new strategies like market based economic instruments such as taxes, charges and subsidies to avoid local environmental problems (Chen and Bacareza, 1995).

The ISO 14001 environmental management system standard has been applied to most East Asian industrial parks. The use of ISO 14001 standard flexible and as such, they can be accepted by larger systems where environmental management is required for activities such as planning and design, legislation and supply of services. When applied to an industrial park, it is either the park administration or government that obtains certification. The reason for employing ISO 14001 in an industrial park is that the standard has a role in controlling environmental management. It can also advance the environmental management of governmental system (Geng & Hengxin, 2009).

According to Zhang et al. (2009), growing pressures are being put on firms, from various sources, to involve them in environmental management initiatives. Government regulation and directives is the main initial environmental burden. However, research also finds that community and market have become the decisive elements since they play more active roles in environmental conservation in developed countries.

Some strategic choices can be forced coercively through sanction or threat, like a government legally mandating environmental standards. Government regulation, comprising inspections and implementation actions, is one of the most significant causes affecting a firm's decision making process (Zhang et al., 2009).

2.3.4 Legal framework of Industrial park in Ethiopia

According to Weldesilassie et al. (2017), industrial park legislation is the basic elements for its establishment. It also safeguards its normal operation. The legislation offers the management highest body, the enterprises and the stakeholders with common codes of conduct. It also gives obligatory, authoritative written provides for all sides once disputes occur. The basic concern in park legislation is that 'no matter what the socio – economic system the hosting country exercises, the legislation of the park law ought to follow the present international codes for economic functioning.

Depending on their hierarchy, the legislation of the park can be divided into three levels. These are federal level, regional level and park level. The federal level legislation is the highest park law. It reveals the most functional ideas of the country. This is the industry Park Proclamation 886/2015 in Ethiopian context (Weldesilassie et al., 2017).

The Industrial Park Proclamation has a succeeding regulation that implement to industrial parks established by the Federal government. Article 5 of the Proclamation expresses its core policy objectives. The law has reason for regulating the designation, development and operation of industrial parks. The other objectives comprise the role towards technological and infrastructural advancements. It helps the participation of the private sector in manufacturing and associated investments, the improvement of the country's effectiveness in economic development, creation of job opportunities and the improvement of sustainable economic development (Haileslasie, 2018).

The Proclamation No. 886/2015 and Regulation No. 417/2017 of Ethiopia are the two main legal documents that incorporate the government initiatives on Industry Park Development. The two legal documents have various articles and sub-articles that clearly state the ongoing development must not be at the expense of the natural environment and human health. They also supported the former legal documents associated with environment and human health topics.

According to FEDRE proclamation No. 886/2015 Art 24 sub article 1 stated, the Ministry of Environment and Forest shall establish an office within industrial parks in order to apply, supervise, protects and enforce environmental norms, standards, safeguards, management and mitigation plans within the Industrial Parks. On the other hand, art. 8 sub art. 7 ratify duty of social and environmental concerns provided in several proclamation, regulation, applicable laws, its permit or agreement. This implies that the various factories at eastern industry park should fulfill EIA implementation and other obligations.

On the other hand, according to FEDRE regulation No 417/2017 art.13 set the circumstances under which an industrial park operator. As to this regulation, owners or managers of industrial park should be accountable for removal of liquid and solid wastes. The cleanliness and development of common space and green areas are among the core responsibilities. Consequently, they are responsible for handling both liquid and solid wastes as well as urban greenery within the park.

Besides, art. 5 sub art. 8(c) indicate that responsible body from the industry owner should have a letter from concerned governmental organization expressing the social and environmental impact assessment reports of the project have been reflected and the permission to go ahead.

Moreover, art. 9 sub art. 2 (d) clearly state that Industrial Park should have EIA before the implementation of industrial development in the park. Despite the government of Ethiopia enacted several regulation and proclamation, the discharge of untreated waste water into the environment is common in eastern industry park.

2.3.5 Environmental Policy

Policy is a plan or guideline for action (Nill and Kemp, 2009). On the other hand, policy statement is the intent of the government or organization to do something about some issues. These are legislative statutes, executive orders and decrees, administrative rules and regulations statements and speeches by public officials indicating the government's intentions and goals and what will be done to realize them. An environmental policy is a written statement stating our organization’s mission in connection to the management of the environmental influences of its operational processes (WRAP, 2015).

2.3.5.1 Policies that control hazardous materials and pollution from industrial wastes

As to Altenburg & Assmann (2017), environmental policies intend to protect and sustainably use our natural environment. Deliberately or not, some of these policies bring structural change. For instance, carbon prices shift investments from fossil fuels to renewable energy. Other environmental policies mostly encourage process innovations and in so doing have only little influence on structural change, such as new pollution control technology advances in existing industries.

According to Environmental Protection Authority of Ethiopia (1997, p.15-17), the key policies that control hazardous materials and pollution from industrial waste are out lined as in the following:

> *" a. …to adhere to the preventive principle of reducing and where possible avoiding discharges of matters, biological supplies from industrial plants and personal or public appliances or any extra external sources that could be dangerous, and to disallow the release when they are possibly to be hazardous;*
> *b. To implement the "polluter pays" principle while ratifying the preventive principle as pollution is possibly to happen, and guarantee that polluting enterprises and municipalities and wereda councils supply their own proper pollution control services;*
> *c. To create clear linkages between the control of pollution and other policy areas such as water resources, human settlements, agriculture, health and disaster avoidance and readiness;*
> *d. To supply adequate regulation of agricultural such as livestock and crop micro-organisms and chemicals*
> *e. To ensure that pollution control is commensurate with the longevity, potency, and capacity to increase or minimize of the pollutant;*
> *f. g. To review and develop procedures for public and industrial hygiene, waste disposal, and techniques to allow the cost-effective application of well-defined standards of control, and to issue regulations to apply them…"*

Although Environmental Protection Authority of Ethiopia outlined the key policies that control hazardous materials and pollution from industrial wastes, practically they are not implemented in most of industries in the country. For example: despite policy provision of industrial pollution such as the implementation of the 'polluter pays' principle, polluting industries are not implementing it. This reveals that there are several environmental policies in the country which is practically not implemented.

2.4 Variables, indicators and their measurement

***Investment and financing on Equipment and facilities*:** These facilities are liquid waste collection system which incorporates the cost for purchasing the collection infrastructures like sewerage system used to collect and store liquid waste at the collection points. The transportation cost is the expense spent from the collection point or from the industries to the

treatment plant. The other is the expense of treatment plant, the net costs for appropriate treatment, comprising disposal of hazardous fractions. Each treatment plant treating liquid waste incurs in operational costs: energy costs, labor costs, depreciation of capital investment, other costs associated to the liquid waste management. Besides, the cost of facilities such as mechanical-biological wastewater treatment systems, waste stabilization ponds and reed beds, septic tanks which is made fiberglass or PVC in which waste water is collected and partially treated (The Open University, 2016).

***Level of training and motivation of personnel*:** Training is not seen as an end goal in itself, however, as a significant tool to bring about transformation in an organization's value, manners, and other vital components that are desired to attain sustainable development. Assisting personnel with their ability to transfer what is learned in training to the workplace is a significant step in attaining a company's environmental goal in general and liquid waste management in particular. On the other hand, motivation of personnel is seen as reward and encouragement made to the employees of the organization either financially or in kind (Jung, 2012).

***Formulation and enforcement of legislation*:** Formulation and Enforcement of law incorporates the design of proclamation, regulation, standard, convention and their implementation (European Commission, 2011).

Level of public education and involvement: It is a process in which individuals get understanding of their environment and obtain knowledge, skills, values, and experiences to prevent present and future environmental harms, containing liquid waste minimization. On the other hand, public participation is the range of activities employed by an organization to involve the community in the decision-making process (Franchetti, 2019).

2.5 Conceptual framework

The concept of liquid waste management practices in the industry arose as a result of environmental degradation posed by liquid waste generation (Asiri and Vitharana, 2013). The effective liquid waste management practices in the industries need to consider four main factors. The first one is institutional elements which incorporates rule and regulation , strategies and policies of liquid waste mangement in the organization. The implementation of EMS such ISO 14001 and EMAS in the factories so as to reduce liquid waste pollution and resource optimization. Organizational capacity interms of skilled man power and facilities

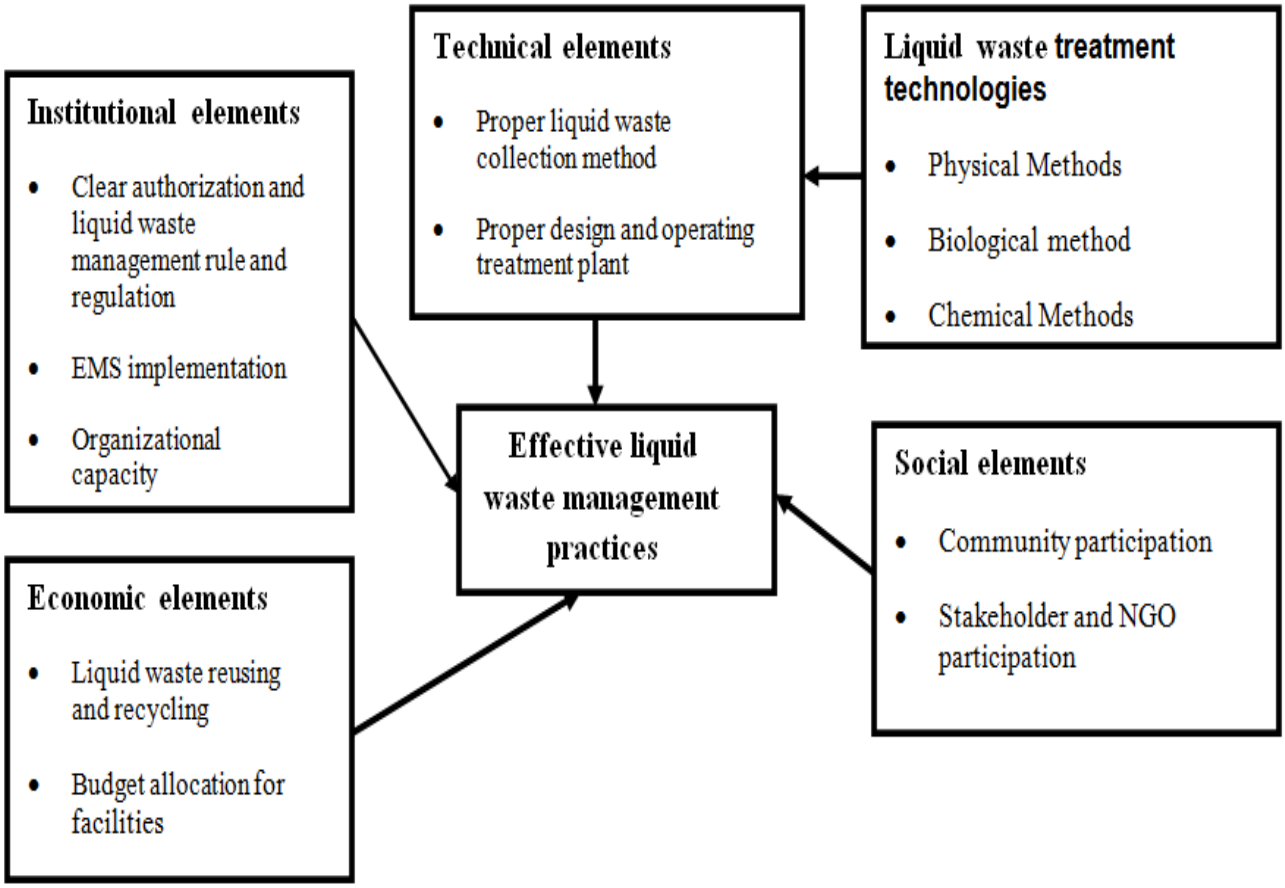
among the institutional components required for liquid waste managements. It also required to incorporate clear authorization of power in waste management.

The second important components in the effective liquid waste management is technical elements. This consist of proper liquid waste collection method, well designed and efficiently functioning treatment plant. It also encompasses liquid waste treatment technologies such as physical, biological and chemical methods.

The third element is economic elements which is crucial in resource optimization through practicing reusing and recycling of wastes. The allocation of budget for facilities and equipment which are essential for liquid waste management in the industry among the components of economic elements.

The fourth component is social elements which consist of community, stakeholder, NGOs and CBOs participation in information sharing and consulting in liquid waste management in the industries.

Figure 2.1 Conceptual framework



Source: Own drown

Chapter 3: Research Method and Methodology

3.1 Introduction

This chapter incorporates the research approach, study area, data source and sampling method.

Besides, data collection instruments such as interview, questionnaires and open-ended questions were discussed in the chapter. Moreover, data analysis, data presentation, validation of the data and instrumentation, model, resource input and ethical consideration were included in the chapter.

3.2 Study Area

The study is located in Dukem town, where it is surrounded in the North West by Galan town, in the South East by Bishoftu, in the South West by a peasant association, Akaki. The town is located at a distance of 37 Km from the capital city, Addis Ababa. The total area of the City is 9,630.3 ha. The GPS location of Dukem ranges $8^{o}45'25"$ N to $8^{o}50'30"$N and $38^{o}51'55"$E to$38^{o}56'5"$E.

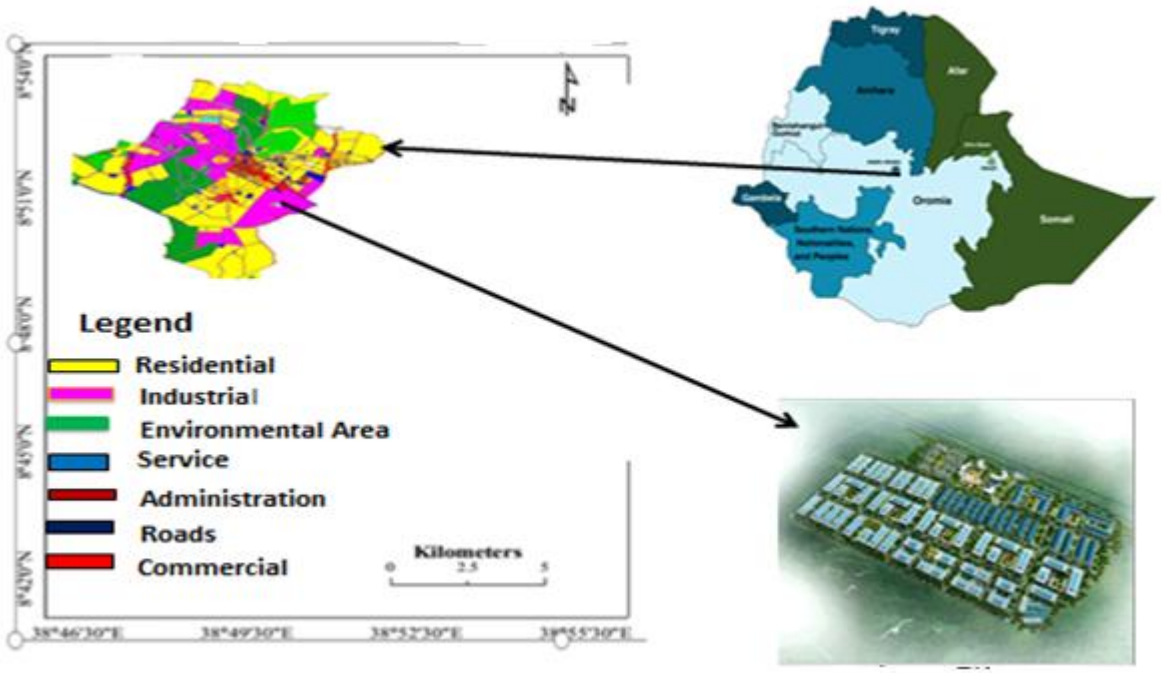
The topography of the town is mainly rugged terrain landform features with ridge and plain in all its land area cover the town. Dukem is almost surrounded with chains of hills like Tedecha and Gimashe, in the North East, and steeper slopes towards Oda Nabe Cultural Center. The hill of the town and its immediate borders in the North East gradually decline from North East to South West. That means the highest altitude in this part of bordering peasant association rises a little more than 2100 meters above sea level. This declines to lower than 1800 meters above sea level in the Southern and South-Western direction.

The climatic condition of Dukem is, dominantly, semi temperate. The highest temperature of it is 29.3 c^{o} in the month of March, April and May while the lowest is 7.1c^{o} in the month of August which is the temperature of Semi temperate or 'Weinadega'. The highest mean annual rainfall is 95 mm and the lowest mean annual rain fall is 48 mm.

The population of Dukem is 58,017 (49.12 %) males and 56,010 (50.88 %) females which is totally 114,027 (Dukem municipality, 2021).

This study was conducted in the Eastern industrial park of Dukem town.

Fig.3.1 location map of the study area



Source: Dukem town Municipality (2021)

3.3 Research Approach

This study employed mixed design using both quantitative and qualitative data. According to Creswell (2017), the main assumption of this form of inquiry is that the combination of qualitative and quantitative approaches offers a more complete understanding of a research problem than either approach alone.

3.4 Data source

Both primary and secondary data were used in the study. Secondary data was collected from different sources such as the town data base, annual report, different journal articles and documented data in the industries, audit report and management plan of industries.

The primary data was collected from experts of selected companies and key informants of selected government sectors such as Urban Land Administration, Environmental protection, Investments and Labor and Social affairs office of the town. Besides, primary data were also collected from key informants of industries of Industrial park such as Dong fang spinning, printing and Dyeing textile manufacturing, Diyuan Ceramics, Zhongshun Cement, East Steal, Lida textile, Linde Garment and TY Wood manufacturing.

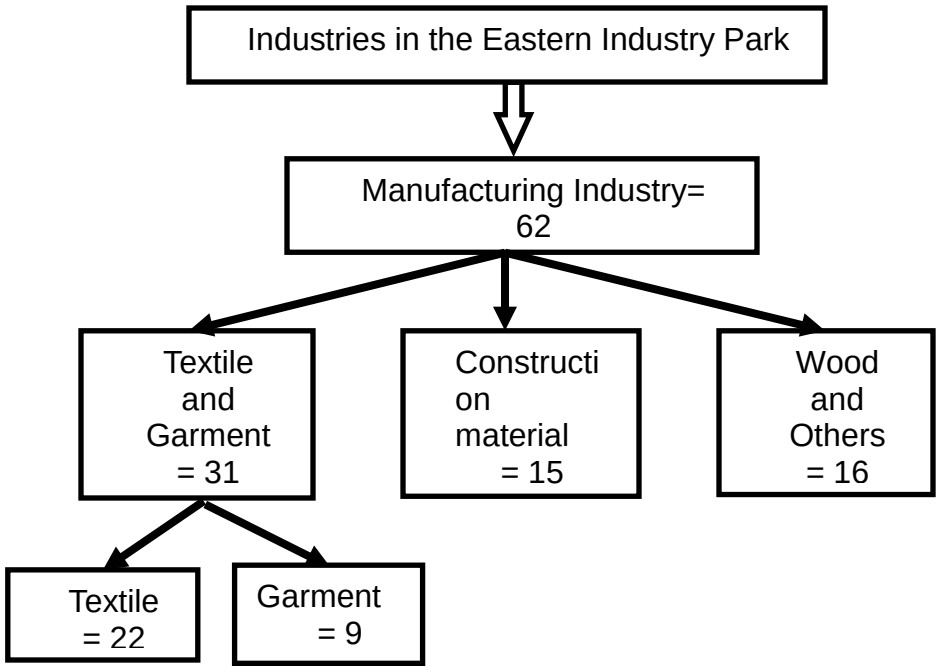
3.5 Sampling Method

In this study, cluster, purposive and systematic sampling were used to select the required sample.

3.5.1Cluster sampling

According to Acharya et al. (2013) a cluster sampling is a two-step process in which the whole population is separated into clusters or groups. It is very valuable when the population is extensively dispersed and it is impossible to sample and choose a representative sample of all the components. In this study, it was used to categorize industries in the industrial park based on their product types. Accordingly, industries in the park categorized as Construction material product manufacturing, textile and garment product manufacturing, wood and others product manufacturing. Out of 62 industries that were operational 31 were textile and garment, 15 were construction materials, 16 were wood and other product manufacturing industries.

Fig.3.2 clustered industries in the Industrial Park of Dukem town



Source: Own drown

3.5.2 Purposive Sampling

According to Etikan et al. (2016) purposive Sampling is the deliberate choice of a member because of the qualities the participant holds. For this study purpose, out of 62 manufacturing industries seven of them were purposively selected i.e. Dong fang spinning, printing and dyeing textile manufacturing, Di Yuan ceramics manufacturing, Zhongshun Cement Manufacturing, East Steal metal manufacturing, Lida textile manufacturing, Linde Garment and TY Wood manufacturing. This was due to the problem aggravate more in the selected industries.

Table.3.1 type and name of industries

Industries in the Eastern Industry park					
Types of Industry		Number	Sample taken	%	Name of Sampled Manufacturing
Construction Material product Manufacturing		15	3	20	Diyuan Ceramics Manufacturing
					East Steel metal Manufacturing
					Zhongshun Cement Manufacturing
Textile and Garment Manufacturing	Textile	22	2	9	Dong fang Spinning, Printing and Dyeing Textile Manufacturing
					Lida textile Manufacturing
	Garment	9	1	11.1	Linde Garment Manufacturing
Wood and Others Product Manufacturing		16	1	6.3	TY Wood Manufacturing
Total		62	7 (11.3%)		

Source: Field Survey (2021)

Besides, purposive sampling was employed to select key informants from government sectors and selected industries from Eastern industrial park. This was done by taking sectors and departments that were working closely with industries, considering, that employees that were working in these sectors and departments and head of the government sector offices including the vice know well about environmental management practices in the industries of the park. Hence, experts and heads of the office from government sector such as Dukem town Land administration, Investment, Environmental protection and Labor and Social affairs office were purposively selected as key informant.

3.5.3 Systematic Sampling

According to Bellhouse (2014) systematic sampling is a sampling method that is employed for its easiness and convenience. In this study, it was used to select the sample experts from purposively selected industries. This was so, through arranging the target experts according to some ordering scheme and then selecting elements at regular intervals through that ordered list. The systematic sampling involved a random start and then proceeds with the selection of every k^{th} element from then on wards. In this case, k= (population size/sample size). The starting point was not automatically the first in the list, but was instead it was chosen randomly from within the first to the k^{th} element in the list.

Questionnaire was administrated to experts of selected industries. On the other hand, structured interview was prepared to key informants from the selected government offices and Industries.

3.5.4 Sampling Frame

The target population of this study was key informants from the selected government sector, selected industries of the park and employees of selected industries of industrial park. Therefore, the sampling frame of the study was the list containing all employees from the selected industries of Industrial park.

3.5.5 Sample size determination

Key informants such as department heads and heads of Investment, Urban land administration, Environmental protection and Labor and social affairs office were selected purposively as presented in Table 3.2.

Table 3:2 purposively selected key informants from government sector offices and industries

Selected key informants	N0 of Sectors	Name of the sectors and industries	Selected sample	Total Numbers
From government sector offices	4	Environmental protection, Urban Land Administration, Investments and Labor and Social affairs office	4	16
From Industrial park	7	Dong fang spinning, printing and Dyeing textile manufacturing Lida Textile Manufacturing TY Wood Manufacturing Diyuan Ceramics Manufacturing East steel manufacturing Linde Garment Manufacturing Zhongshun Cement Manufacturing	5	35
Total				51

Source: Field Survey (2021)

The total number of focal person, department heads and heads of selected office and industries were 51 in number.

Conversely, the total employees in selected seven companies were 2,000 in numbers. However, the total experts in the selected companies were 995 from where the sample size is determined. The sample size of the population was determined using Yamane's (1967) formula. According to him for a 95% confidence level and P=0.5, size of the sample should be using equation 1 formula.

$$n= N/1+N (e^2)\ldots\ldots\ldots\ldots\ldots\ldots\text{equation (1)}$$

Where, N is population size and e is the level of precision. Let this formula be used for our population, in which N= 995 with + 5% precision assuming 95% confidence level and P=0.5, we get the sample size as n= 995/ (1+995 (0.05^2)) = 285. By adding 5% contingency plan 285 + (285) * 5/100= 285 + 14= 299.

Therefore, the total sample size of the study was 299. However, 285 collected from respondents while 14 questionnaires lost.

3.6 Data collection instruments

3.6.1 Interview

Interview was made with key informants from selected government sector that incorporated heads, department heads and experts. Besides, key informants from industries of industrial park were engaged in the interview. This was made through preparing structured interview questions.

In the interview, issues such as the liquid waste management practices and the role of communal treatment plant were raised. On the other hand, the key informant interview was administered using structured interviews.

3.6.2 Questionnaires

For experts' survey, a self-administered survey was distributed to the experts of selected industries. A random sample style approach was used to ensure that the whole experts of selected industries have the opportunity to participate in the study.

The survey examined the perception of employees on the communal treatment plant and the factors affecting liquid waste management practices. The participant age, gender, level of education and position were included in the survey. The purpose of the open-ended questions in the survey was for methodological triangulation.

3.6.3 Open-Ended Questions

The open-ended questions within the self-administered survey related to the liquid waste management practices. The responses were examined and coded to represent a thematic interpretation of responses. The narrative was provided by the participants were used for triangulation purposes to explain and provide meaning. The narrative also allowed participants to express views that they considered weren't adequately covered within the confines of the survey.

3.7 Data Analysis

Both the quantitative and qualitative data were analyzed. The quantitative data was examined first, and then interviews, finally the open-ended questions, for methodological triangulation and to further information and explain the quantitative findings. The quantitative data was analyzed using SPSS software which can help as analyze. On the other hand, the qualitative

data was analyzed using thematic analysis through classifying the interview transcript in to different themes.

3.8 Data Presentation

The data and information gathered were organized and analyzed. Tables, figures, charts and graph were employed for data presentation and the Statistical Package for Social Science (SPSS) for data analysis using descriptive statics and multinomial logistic regression.

3.9 Validation of the Data and Instruments

The researcher approached the validity, reliability, credibility and dependability of the study through a range of techniques. The qualitative data, which included interview transcripts and the open ended questions, were examined independently to ensure that accurate transcripts were used for the interpretation. Triangulation was used to provide credibility through the use of quantitative and qualitative methods.

3.10 Model

In this study multinomial logistic regression model and descriptive statistics such as percentage were applied. The multinomial logistic regression model was used in the study as the categorical variable such as effectiveness of liquid waste management and the existence of sufficient facilities and equipment for liquid waste management were the dependent categorical variable while finance and investment in equipment, training and motivation of personnel and formulation, enforcement of legislation and, public participation and engagement were the independent categorical variables which predict the result. Accordingly, it is used to estimate the probabilities for the *m* categories of a qualitative dependent variable *Y*, using a set of explanatory variables ***X***:

$$\Pr(Y_{ik}) = \Pr(Y_i = k \mid \boldsymbol{x}_i; \beta_1, \beta_2, \ldots, \beta_m) = \frac{\exp(\beta_{0k} + \boldsymbol{x}_i \boldsymbol{\beta}_k')}{\sum_{j=1}^{m} \exp(\beta_{0j} + \boldsymbol{x}_i \boldsymbol{\beta}_j')} \text{ with } k = 1, 2, \ldots, m$$

Where βk is the row vector of regression coefficients of ***X*** for the *k*th category of *Y*

3.11 Ethical Consideration

The research to be conducted with officials at different levels was aided by supporting letters from Addis Ababa University. The researcher collected data carefully in order to ensure confidentiality of information, privacy and personal safety of the respondents. Verbal consent

was obtained from the respondents. The participants were informed about the objective of the research before conducting each interview. Those who were willing to participate were interviewed. The collected data was checked for completeness, clarity and accuracy.

Chapter 4: Results and Discussion

4.1 Introduction

The chapter incorporated result and discussion part. It included topic such as the liquid waste management practices in the selected industries of industrial park, effects of liquid waste from the selected industries of industrial park and liquid waste management practices in the communal treatment plant. It also stated examining the attitude of employees of selected industries on the contribution of the communal treatment plants and their determinants. Besides, description of respondents' socioeconomic and demographic characteristics of residents, assessment of the factors that affects the effectiveness of liquid waste management practices and analysis of Multinomial logistic regression model were included in the chapter.

4.2 Assessing the liquid waste management practices in the selected industries of industrial park

4.2.1 The liquid waste management practices in the selected industries of industrial park

In the following section, based on interview with key informants of selected government sectors and industries, and secondary data liquid waste management practices in the selected Textile and Garment product factories such as Dong Fang Textile, Lida Textile, Linde Garment factories, and Construction companies such as Di Yuan Ceramic, East Steel Metal Production and Zhongshun Cement Manufacturing, and other wood product industry such as TY Wood factory were discussed.

4.2.1.1 The liquid waste management practices in the Dong Fang and Lida textile factory

As interview and secondary data result revealed, liquid waste was the major environmental and human health impacts of the selected textile factories. The main source of liquid waste pollution was dyeing process. The other liquid waste pollution sources were floor washing, domestic use and drainage line leakages (DEFCCA, 2021). The liquid waste from dyeing operation were characterized with several dies, mordant and reducing agent such as sulphides, hydrosulphides and soap were strongly colored, fairly high BOD (Lida and Dongfang textile ESM plan, 2019).

The liquid wastes have been draining to the communal treatment plant of Eastern Industrial park after passing the company's primary treatment plant and finally, utilized by local people for irrigation purpose without proper treatment.

4.2.1.2 The liquid waste management practices in the Linde garment factory

As far as liquid waste management practices in the Linda Garment were concerned, there was no considerable amount of liquid waste that generate from the factory. As interview made with key informants of the factory revealed, there was little amount of liquid waste that generated from the factory. Some of this liquid waste was washed water which was stored in the septic tank of the company and disposed finally.

4.2.1.3 The liquid waste management practice in the Steel factory

The Steel factory consumed large volumes of water as high as 150-200 tons of steel production. The major source of liquid waste was from cooling water. In the steel factory, in certain sections waste water was isolated and treated separately. However, all waste water coming from the steel plant was treated in communal treatment plant found in the Eastern Industry Zone (Steel Environmental Audit report, 2021).

Besides, reusing of water was adopted in several units. The cooling water was in continuous circulation through cooling and recirculating pond as showed in Figure 4.1 below.

Figure 4.1: water re-circulation pond available in the East Steel

Source : East Steel Environmental Audit report (2021)

4.2.1.4 The liquid waste management practice in the Di Yuan Ceramics factory

The liquid wastes from ceramics were washed water of raw materials, oil, greases and water removed or liquid waste from toilet. Some of this waste was reused while others drained to the communal treatment plant.

In the company, tremendous volume of water was used for ceramics manufacturing processing in the factory, particularly, in cooling section. The ceramic industry also used and consumed large volume of water in its production in the process such as glazing, polishing, molds washing and ball grinder preparation (Di Yuan Ceramic Environmental Audit report, 2021).

The liquid waste or mud generated from this ceramic process contained mostly fine particles and clay minerals like kaolin, mica and silt. Some coarse particles and chemicals containing suspended and dissolved heavy metals such as zinc and lead. This waste water not only contained high suspended and total solids but also significant volume of dissolved organics causing in high BOD or COD loads (Di Yuan Ceramic Environmental Audit report, 2021).

In solving the issues of liquid waste pollution, Di Yuan ceramics PLC established a liquid waste primary treatment plant with liquid waste collection pond.

Figure 4.2: treated waste water pond in the Ceramic industry

Source: Di Yuan Ceramic Environmental Audit report (2021)

From polishing of end products that produced large volumes of waste water were generated throughout the process. The liquid waste that incorporated harmful chemicals with negative

effect on human health was polluting the environment. To mitigate the impacts, the company has added powder chemical such as PAC which treated the pounding system (Di Yuan Ceramic Environmental Audit report, 2021).

Figure 4.3 primary treatment of Di Yuan Ceramic

Source: Di Yuan Ceramic Plc. Audit report (2021)

Figure 4.4: water reusing (by cooling system) dehydration system in the plant

Source: Di Yuan Ceramic Plc. Audit report (2021)

In general there were 1,000 litters waste water reused on average per day for cooling reason. The company consumed large amounts of water from molds washing and raw material through reusing process of waste water. The company liquid waste from industry has been met to some extent the national effluent discharge quality standards set by governments.

Consequently, liquid waste primary treatment plant of the company has designed and operated in such a manner to permit the treated waste water meet those recommended standards in the company water treatment plant. However, the primary treatment plant of the company was not that much efficient in treating the liquid wastes (Di Yuan Ceramic Environmental Audit report, 2021).

Consequently, several approaches for managing the waste water have been designed, particularly; minimize the production of waste water instead of treating liquid wastes. In addition, actions in which the waste water can be reduced directly subject to the guide lines of EPA have also been recommended. Furthermore, suggestions were made by the company that ensured resources should be used appropriately and efficiently (Di Yuan Ceramic Environmental Audit report, 2021).

4.2.1.5The liquid waste management practices in the Zhongshun Cement Manufacturing

As far as liquid waste management practices in the Zhongshun Cement Manufacturing were concerned, there was little amount of liquid waste that generate from the factory. As the secondary data and interview made with key informants of the factory revealed, there was little amount of liquid waste that generated from the factory. Some of this liquid waste was washed water which was stored in the septic tank of the company and disposed finally. Besides, the company had no primary treatment plant which intended to treat liquid waste as there was no considerable amount of liquid waste from the company (Zhongshun Cement Manufacturing ESM Plan, 2019).

4.2.1.6 the liquid waste management practice in the TY Wood company

On the other hand, concerning liquid waste management in the Wood Company, there was large volume of liquid waste from TY Wood Company and the primary waste water treatment plant in the TY Wood Company treated the liquid wastes in the company which finally drained to the common wastewater treatment plant of Eastern industry Park. Besides, there were liquid waste reuse practices to fulfill their water consumption in one hand and reduce environmental pollution in the other hand (TY Wood ESM plan, 2019). In the Table 4.1 the liquid waste that were reused and disposed annually from sampled companies were presented.

4.2.1.7 The liquid waste that were reused and disposed annually from the sampled companies

Table 4.1: the liquid waste that were reused and disposed annually from sampled companies were presented

S.N	Sampled Industries	Amount of waste water produced, reused and disposed Annually					
		Unit	Produced	Reused		Disposed	
				No	%	No	%
1	Di Yuan ceramics	M^3	312	140.4	45	171.6	55
2	Lida textile	M^3	750	320	42.67	430	57.33
3	Linde garment	M^3	51	-	-	51	100
4	Dong Fang textile	M^3	1200	553	46.1	647	53.9
5	East Steel	M^3	823	350	42.53	473	57.47
6	TY Wood	M^3	280	120	42.86	160	57.14
7	Zhongshun cement	M^3	230	115	50	115	50
Total		M^3	**3,646**	**1,598.4**	**43.84**	**2,047.6**	**56.16**

Source: Field Survey (2021)

The above Table 4.1 reveals out of 3,646 M^3 of liquid waste produced in the selected companies annually, 43.84 % of them reused while the majority (56.16) % of them disposed. This implies that the majority of wastes were not reused in the sampled industries due to limitation in commitment and technology that make reusing and recycling practical.

There were also other limitations in liquid waste management in the companies. Among others, lack of quarterly effluent monitoring and sending results to EPA and Dukem town administration Environment, Forest and Climate Change Authority, inadequate

implementation of monitoring and follows up in the management of liquid waste, inadequate safety equipment provision, lack of awareness and training for staff, absence of quarterly inspection, lack of establishing quality assurance unit to guarantee timely repairs to leaking oil and waste water pipes (DEFCCA, 2021).

4.2.2 Effects of liquid waste from the selected industries of industrial park

The mixed liquid waste from laundry of the textile companies, washings and flushing from fustigations room were generated. Improper disposal of such generated waste water could result in ground water contamination with chemical as well as biological contaminants. Besides, untreated textile waste discharged to the nearby environment such as through sewerage line can increase toxicity of water which might kill aquatic life, increase soil acidity and affect human health (Lida and Dongfang text ESM plan, 2019).

Another effect from mixed liquid waste discharge and storage can incorporate odor generation, and attraction of files and prevalence of linked vector diseases. If no mitigation and control actions present, the possible effects of the small amount of discharge are predicted to be significant and its incidence might be high (Lida and Dongfang text ESM plan, 2019).

Pollutants such as light alkaline and monocyclic aromatic and hydrocarbons such as benzene, toluene and ethyl benzene from TY Wood factory tend to evaporate from surface spill and biodegrade readily. Other pollutants like heavy metals and Poly Aromatic Hydrocarbons (PAH) don’t evaporate instead they store in sediments, penetrate to the sub-surface formation and remain entrapped into void and pores, and travel large distances. Spillages and leaks from chemicals store have a tendency to contaminate human beings nearby if not managed appropriately (TY Wood ESM plan, 2019).

4.2.3 Liquid waste management practices in the communal treatment plant

The sampled textile industries had inefficient primary treatment plant (Lida and Dongfang text ESM plan, 2019). The other sampled industries from industrial park such as East Steel, Di Yuan ceramics and TY Wood had their own primary treatment plant which was moderately efficient. However, finally their liquid wastes drained to the communal treatment plant. The rest sampled industries such as Linde garment and Zhongshun cement factories since they had no their own primary treatment plant, the companies were using communal treatment plant for liquid effluent discharges.

According to Dukem Environment, Forest and Climate Change Authority (DEFCCA), 2021) the communal treatment plant found in the Eastern industry park designed to treat liquid wastes that generate from textile and garment, metal product, construction, food product and wood product based on the standard. However, the common treatment plant hasn't been functioning effectively and efficiently to treat the liquid waste as per the standard.

Figure 4.5: the communal treatment plant

Source: (DEFCCA, 2021)

Currently, around fourteen textile manufacturing, discharging liquid wastes to treatment plant owned by Eastern Industry Park. Each textile industries in the Industrial Park have paid money based on the amount of liquid waste released in m_3 to the common treatment plant of Eastern Industry Park. However, the treatment plant was not efficient in reducing or minimizing the pollution level of liquid wastes that discharged to the environment and harm the health of the community (DEFCCA, 2021).

Besides, the liquid waste which generate from the industries shouldn't been checked through taking sample and examining regularly using laboratory. Hence, the treatment plant discharging liquid wastes to the environment without treating the liquid wastes according to the national standard.

Moreover, the existing treatment plant not only purifying the liquid wastes below the national standard, but also small in size. On the other hand, some of the chemicals that were used for

treatment purpose in the communal treatment plant were expired which is labeled with letter "A" in the Figure 4.6 while others their expired date was not known which is labeled with letter "B" in the Figure 4.6.

Figure 4.6: the expired chemicals (A) and (B) chemical that has treatment plant

Source: Photograph captured by the Author

Oromia General Auditor (OGA) in collaboration with experts of Addis Ababa Environmental protection and Greenery Commission (AAEPGC) and Dukem town Environmental protection, Forest and Climate change Authority (DEFCCA) have made examination on selected industries of industrial park in 2020. Accordingly, sample taken from liquid waste of inlet and the outlet of the treatment plant and made examination using laboratory with certain parameters such as Chemical oxygen demand (COD), Ammonia (NH_3), Nitrate (NO_3), Total-Nitrogen, Total-Alkality, Total hardness, Copper, Nickel, Zinc, Manganese, Silver, Lead and Cobalt the existence of these chemicals in the liquid waste were beyond the national standard (OGA, 2020). It had hazardous chemical beyond the national standard. However, according to FEDRE regulation No 417/2017 art.13 stated, Industrial Park required to manage their pollution level (FEDRE, 2017). The following Table 4.2 presents the result of examination of sample taken from waste water in the treatment plant and its outlet.

Table 4.2: presents the result of examination of sample taken from waste water of in the treatment plant and its outlet

N0	Parameter	Standard (permissible limit)	Field number or code	
			Sample 1	Sample 2
1	Chemical oxygen demand, COD, mg/l	250	183	283
2	Ammonia, NH3, mg/l	20	15	7
3	Nitrite, No3, mg/l	40	1.9	0.2
4	Total-Nitrogen, mg/l	30	27	26
5	Total-Phosphorus, mg/l	10	146	186
6	Total-Alkality, mg/l		0.0001	0.0001
7	Total hardness, mg/l		174	202
8	Copper, mg/l	2	2.1716	2.011
9	Nickel (Ni) mg/l	1	36.49	31.72
10	Zinc (Zn) mg/l	1	1.776	1.890
11	Manganese(Mn) mg/l	5	22.44	20.09
12	Silver, Ag, mg/l	1	2.090	2.406
13	Lead (Pb) mg/l	0.1	2.1716	2.011
14	Cobalt (Co) mg/l	1	79.12	80.18

Source: OGA), AAEPGC and DEPFCA (2020)

As Table 4.2 indicates, the communal treatment plant has been releasing liquid wastes to the environment without proper treatment. Therefore, the liquid wastes were polluting the environment, particularly, the soil and water body.

Besides, local people have been using the contaminated liquid wastes for irrigation purposes and producing vegetables such as cabbage, tomato, green paper and potatoes. The vegetables which were produced using liquid wastes generated from Eastern Industrial Park by local community might harm the health of the people. As the prevailing top ten diseases around industrial park reveals, the pollution might have caused human health hazards such as

problem of respiratory, back bone, blood cancer, asthma and sinus. As these diseases were the top ten prevailing diseases around Industrial Park (Dukem health office, 2021).

Figure 4.7: irrigation practices using waste water discharged from IEZ

Source: photograph captured by the Author

4.3 Examining the attitude of the employees of selected industries on the contribution of the communal treatment plants and their determinants

Under this section, descriptive analysis was performed to explain the personal profile of the respondents. Likewise, descriptive analysis was made on the attitude of the employees of selected industries on the contribution of the communal treatment plants and their determinants.

4.3.1 Description of respondents' socioeconomic and demographic characteristics of residents

In this section, different respondents' socioeconomic and demographic characteristics which included gender, age, educational background, and position of the employees of selected companies were described.

Table 4.3: respondents' gender profile

Sex					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	138	48.4	48.4	48.4
	Female	147	51.6	51.6	100.0
	Total	285	100.0	100.0	

Source: Field survey (2021)

As Table 4.3 shows, out of 285 respondents 138 (48.4%) of them were males and the remaining 147 (51.6 %) were females. This implies that there was gender proportion among respondents.

Table 4.4: respondents' age profile

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-25	140	49.1	49.1	49.1
	26-34	120	42.1	42.1	91.2
	35-54	25	8.8	8.8	100.0
	Total	285	100.0	100.0	

Source: Field survey (2021)

Table 4.4 depicts, out of 285 respondents 140 (49.1%) of them their age range between 18 to 25 years. The other, 120 (42.1%) of the respondents their age range between 26-34 years. The remaining, 25 (8.8%) of the respondents their age range between 35-54 years. This indicates that, the majority of the respondents were employees of selected industries who's their age ranges 18-25 and who were youngsters.

Table 4.5: respondents' educational background profile

Educational back ground					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than high school	120	42.1	42.1	42.1
	high school	95	33.3	33.3	75.4
	Diploma	25	8.8	8.8	84.2
	Degree	45	15.8	15.8	100.0
	Total	285	100.0	100.0	

Source: Field survey (2021)

Table 4.5 reveals, out of 285 respondents 120 (42.1%) were employees of selected industries whose educational background below high school. The other 95 (33.3%) of the respondents were high school completed. The remaining 25 (8.8%) and 45 (15.8%) of respondents were employees of selected industries were diploma and degree respectively. This indicates; the majority of employees who participated in the survey were people with low educational background.

Table 4.6: respondents' position profile

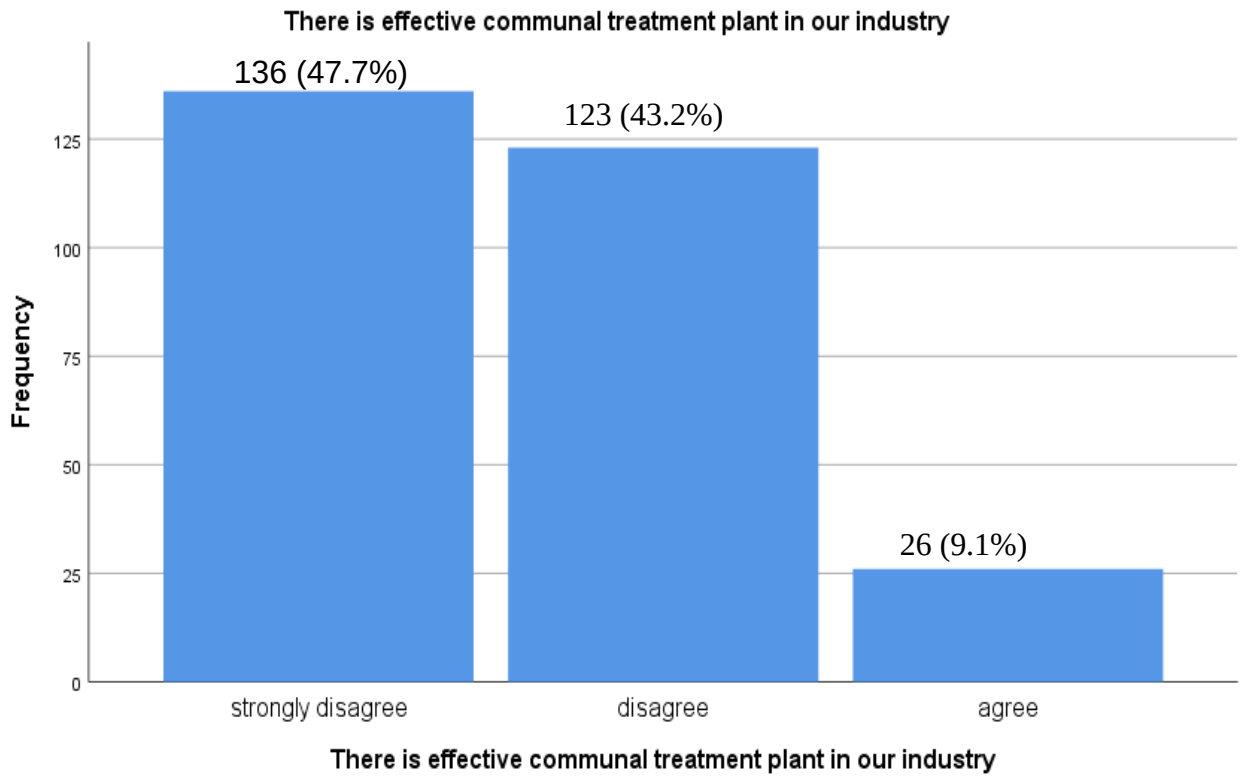
Position					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Expert	245	86.0	86.0	86.0
	team leader	35	12.3	12.3	98.2
	Coordinator	5	1.8	1.8	100.0
	Total	285	100.0	100.0	

Source: Field survey (2021)

As table 4.6 shows, out of 285 respondents the majority 245 (86%) of them were experts. The remaining 35 (12.3%) and 5 (1.8%) of the participants were team leaders and coordinators respectively. This indicates that the majority of the respondents were experts.

4.3.2 The attitude of the employees of selected industries on the contribution of the communal treatment plants and their determinants

Figure 4.8: the effectiveness of communal treatment plant

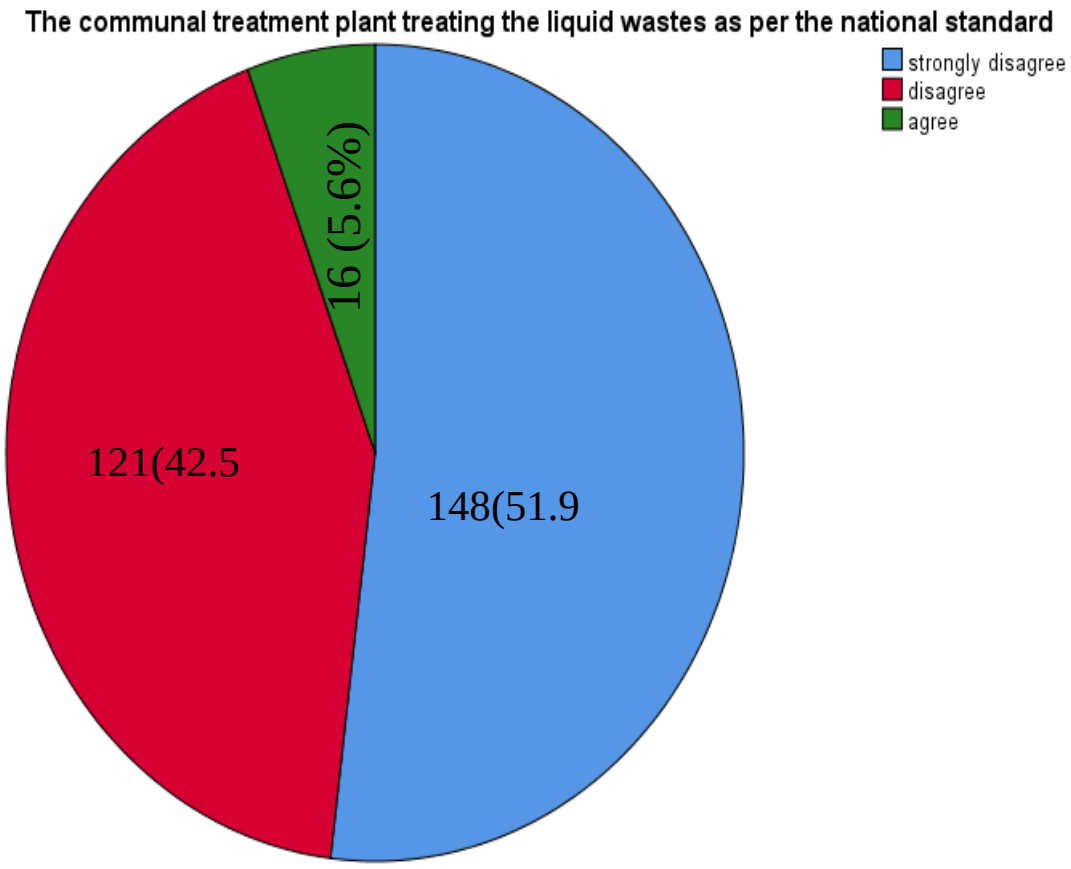


Source: computed using SPSS software by the author

As Figure 4.8 presents, out of 285 respondents 136 (47.7%) of them strongly disagreed in the existence of effective communal treatment plant in the Eastern Industry Park. The other 123 (43.2%) of the participants disagreed in the existence of effective communal treatment plant. The rest 26 (9.1%) of the respondents have agreed in the existence of effective communal treatment plant in the Eastern Industry Park.

The above stated data indicates that the majority of employees of industry strongly disagreed in the existence of effective liquid waste communal treatment plant in the Eastern Industry Park. This shows that there was no effective liquid waste communal treatment plant which intern affected the liquid waste that discharged to the environment. However, according to Environmental Protection Authority of Ethiopia (1997, p.15-17), stated Industry required to have good treatment technology and waste disposal method.

Figure 4.9: the treatment of liquid waste in the communal treatment plant as per the national standard

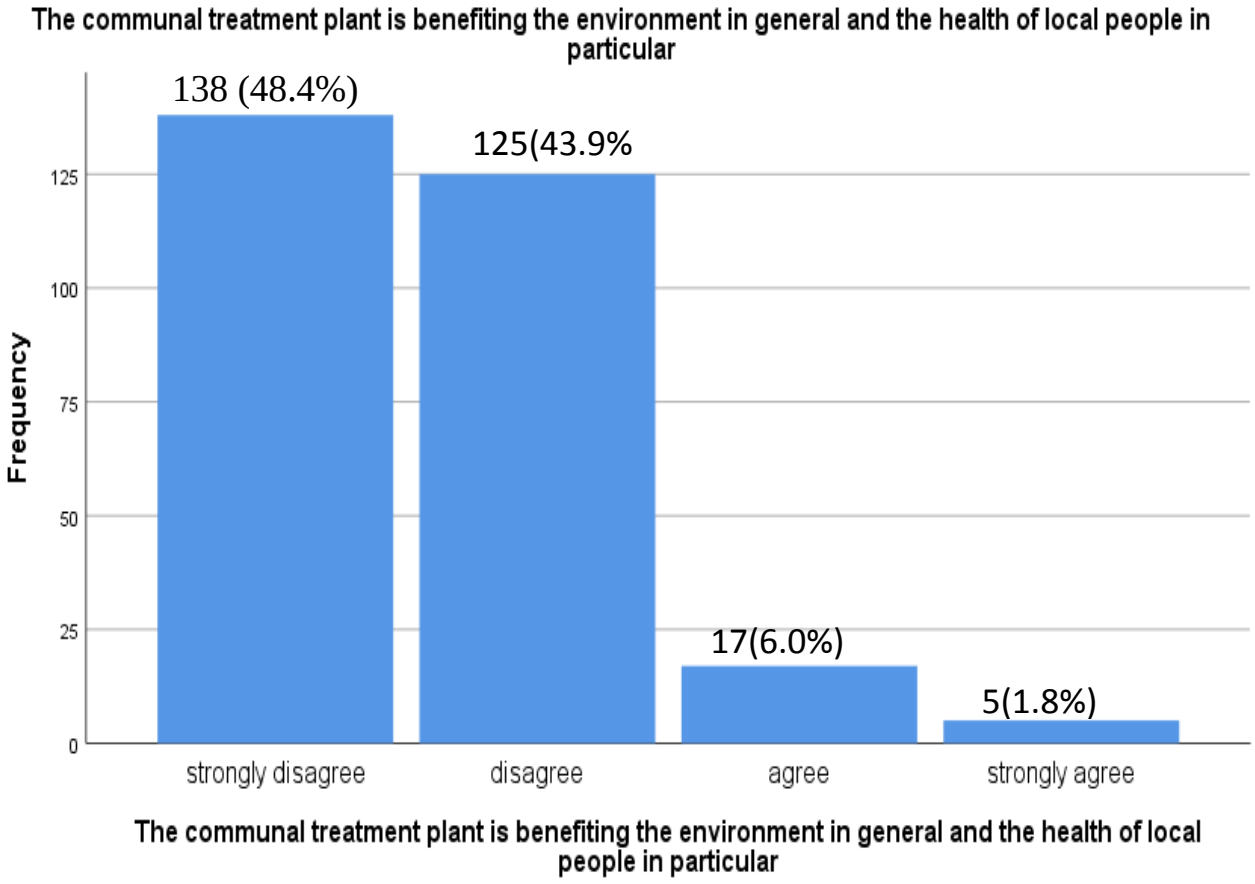


Source: computed using SPSS software by the author

Figure 4.9 depicts out of 285 respondents 148 (51.9%) of them strongly disagreed in the treatment of liquid waste in the communal treatment plant as per the national standard. On the other hand, 121 (42.5%) of the candidates disagreed the treatment of liquid waste as per the national standard. The rest 16 (5.6%) of respondents agreed the treatment of liquid waste as per the national standard.

This implies that the majority 148 (51.9%) of employees of industries strongly disagreed in the treatment of liquid waste in the communal treatment plant as per the national standard. This shows that there was liquid waste pollution as the communal treatment plant was not treating the liquid waste. This was degrading the environment in general and affecting the human health in particular. However, the role of Industrial Park is to improve sustainable development through using clean technology (Haileslasie, 2018).

Figure 4.10: the environmental and health benefit of communal treatment plant



Source: computed using SPSS software by the author

According to Figure 4.10, out of 285 respondents 138 (48.4%) of them strongly disagreed that the communal treatment plant was benefiting the environment in general and the health of local people in particular. The other 125 (43.9%) of the respondents disagreed that the communal treatment plant was benefiting the environment in general and the health of local people in particular. The rest 17 (6.0%) and 5 (1.8%) of the respondents agreed and strongly agreed respectively that the communal treatment plant was benefiting the environment in general and the health of local people in particular.

This indicates that the majority of employees of selected industries strongly disagreed in the benefit of communal treatment plant for the environment in general and the health of local people in particular. The communal treatment plant was simply for the name which means it didn't meet what was intended to meet.

Table 4.7: sufficient equipment and facilities in the communal treatment plant

There is sufficient equipment and facilities in the communal treatment plant of industrial park					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	161	56.5	56.5	56.5
	Disagree	103	36.1	36.1	92.6
	Agree	21	7.4	7.4	100.0
	Total	285	100.0	100.0	

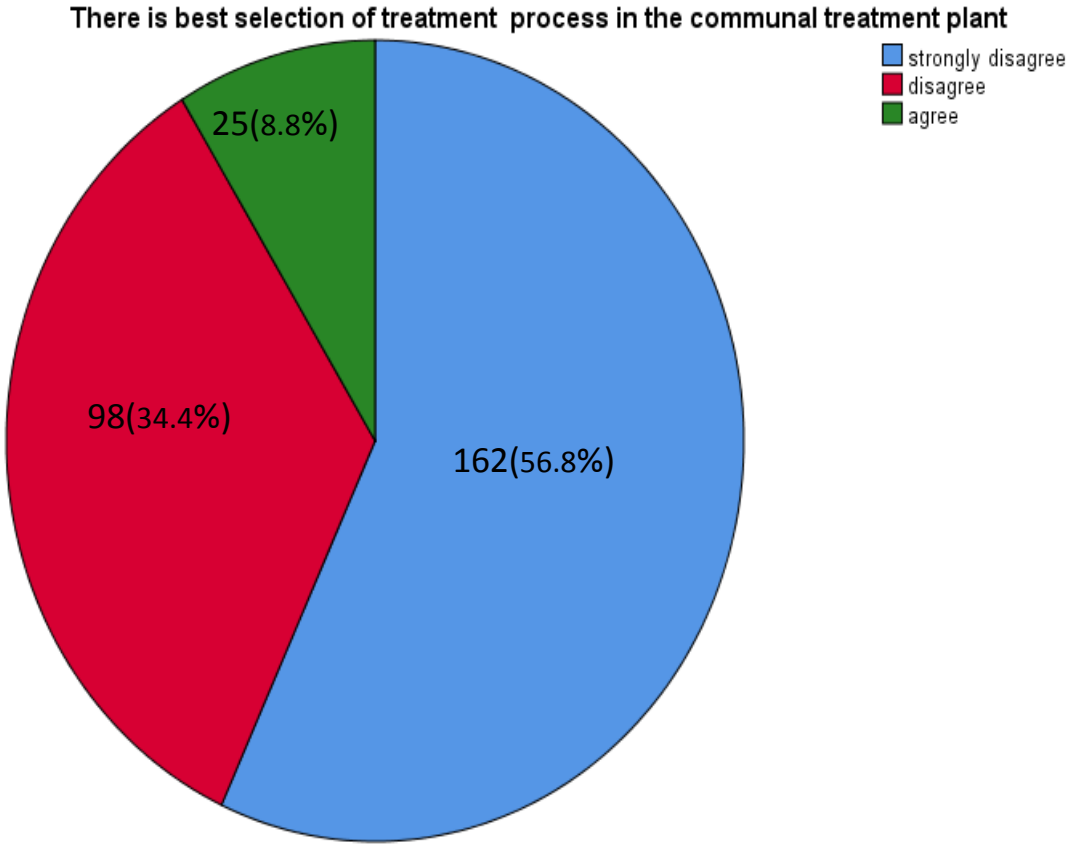
Source: computed using SPSS software by the author

As Table 4.7 presents out of 285 respondents the majority 161 (56.5%) of them strongly disagreed in the existence of sufficient equipment and facilities in the communal treatment plant of Industrial Park. The remaining 103 (36.1%) and 21 (7.4%) of the participants disagreed and agreed the existence of sufficient equipment and facilities in the communal treatment plant of Industrial Park respectively.

This implies that the majority of employees of selected industries of industrial park strongly disagreed in the existence of sufficient equipment and facilities in the communal treatment plant of Industrial Park. Hence, the communal liquid waste treatment plant in the industry park had no sufficient equipment and facilities which made the treatment plant capable in

treating the liquid wastes in order to protect our environment from deterioration. Beside, since there were no sufficient facilities and equipment such as chemicals used for treatment and safety materials not only the environment but also the human health harmed.

Figure 4.11: the selection of treatment process in the communal treatment plant



Source: computed using SPSS software by the author

Figure 4.11 depicts that out of 285 respondents 162 (56.8%) of them strongly disagreed in the existence of best selection of treatment process in the communal treatment plant. The other 98 (34.4%) of the respondents disagreed in the existence of best selection of treatment process in the communal treatment plant. The rest 25 (8.8%) of the participants agreed the existence of best selection of treatment process.

This implies that the majority of employees in the selected industries of Industrial park strongly disagreed in the existence of best selection of treatment process in the communal treatment plant. There was no best selection of treatment process. The treatment process didn't filter the liquid waste from industries instead; it released the effluents without proper treatment.

Table 4.8: the existence of good treatment system design

There is good treatment system design					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	108	37.9	37.9	37.9
	Disagree	146	51.2	51.2	89.1
	Agree	31	10.9	10.9	100.0
	Total	285	100.0	100.0	

Source: computed using SPSS software by the author

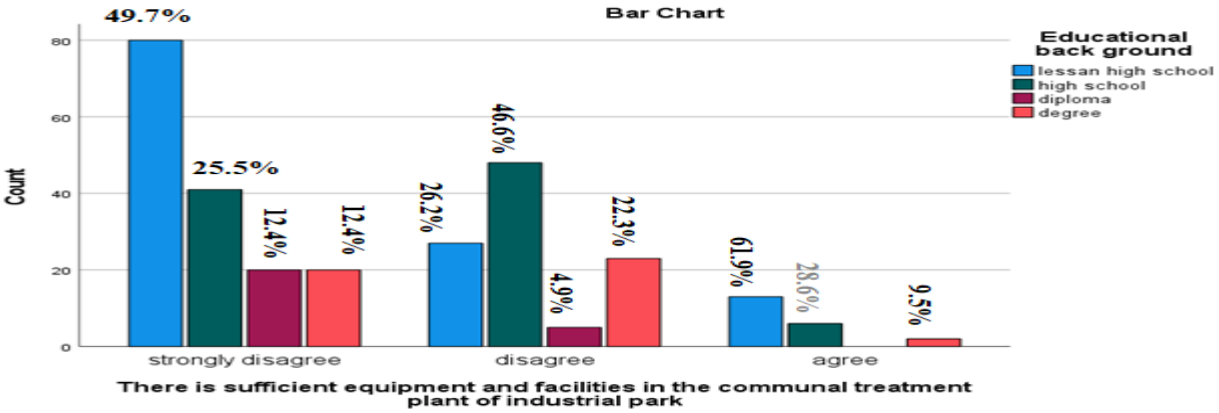
As Table 4.8 reveals, out of 285 respondents 108 (37.9%) of them strongly disagreed in the existence of good treatment system design. However, the majority 146 (51.2) of the participants disagreed in the existence of good treatment system design. The rest 31 (10.9%) of the respondents agreed the existence of good treatment system design in the Eastern Industrial Park.

This implies that the majority of employees of selected industries of Industrial Park disagreed in the existence of good treatment system design in the Eastern Industrial Park. Hence, there was no good treatment system design in the Eastern Industrial Park which in turn affected the quality of treatment process of liquid wastes.

4.3.3 The determinants of the employees perception on the existence of sufficient equipment and facilities in the communal treatment plant

3.3.3.1 Educational status as determinants of employees perception

Figure 4.12: Educational status as determinant factor of employees' perception



Source: computed using SPSS software by the author

According to Figure 4.12, out of the total employees that strongly disagreed in the existence of sufficient facilities and equipment in the communal treatment plant, 49.7% of them were employees whose educational status was lessen high school. The other 25.5% of employees who strongly disagree were a respondent whose educational status was high school. The rest 12% and 12% of employees, who strongly disagree, were a respondent who's their education status was diploma and degree.

This implies that the majority of the respondents that strongly disagreed the existence of sufficient equipment and facilities in the communal treatment plant of Industrial Park were employees of education status lessen high school.

On the other hand, out of the total employees who disagreed the existence of sufficient facilities and equipment in the communal treatment plant, 26.2% of them were lessen high school. The other respondents who disagreed were 46.6%. The remaining 4.9% and 22.3% of the respondents were diploma and degree respectively.

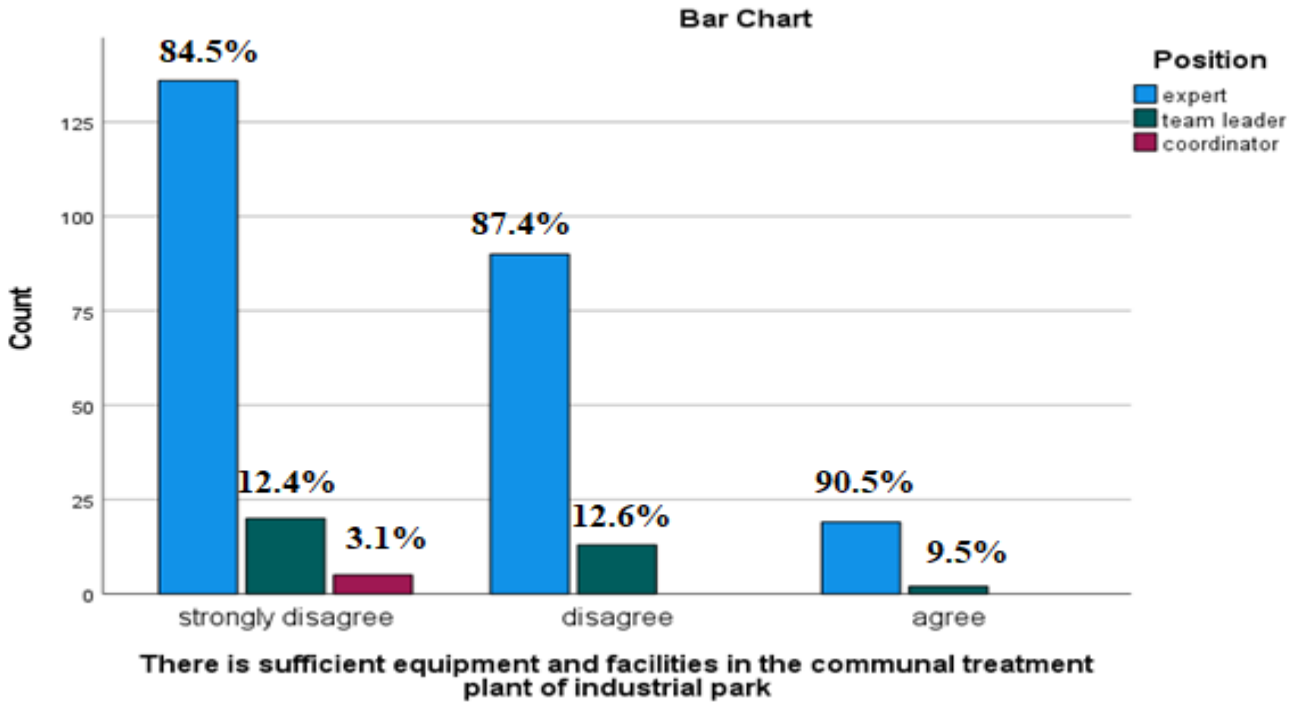
This revealed the majority of employees that disagreed the existence of sufficient facilities and equipment in the communal treatment plant was employees of education status were degree.

In other hand, out of the total respondents who agreed the existence of sufficient facilities and equipment in the communal treatment plant, 61.9% of the respondents were below high school while the remaining 28.6% and 9.5% of the respondents were high school and degree respectively.

This implies that the majority of respondents who agreed the existence of sufficient facilities and equipment in the communal treatment plant were employees who have educational status of lessen high school. Hence, level of education was the determinant factors in the employees' perception on the existence of sufficient facilities and equipment in the communal treatment plant.

3.3.3.2 Employees position as determinants of their perception

Figure 4.13-: Employees position as determinant of their perception



Source: Field survey (2021)

According to Table 4.13 out of the total respondents that strongly disagreed the existence of sufficient equipment and facilities, 84.5% of them were experts while the rest 12.4% and 3.1% were team leaders and coordinators, respectively. This indicates, the majority of experts strongly disagreed the existence of sufficient equipment and facilities in the communal treatment plant of Eastern industry Park.

Out of the total respondents who disagreed the existence of sufficient equipment and facilities, 87.4% were experts while the remaining 12.6% of the respondents were team leader. This shows the majority of experts disagreed the existence of sufficient equipment and facilities in the communal treatment plant.

On the other hand, out of the total employees who agreed the existence of sufficient equipment and facilities, 90.5% of them were expert while the remaining 9.5% were team leader.

This indicates the majority of experts agreed the existence of sufficient equipment and facilities in the communal treatment plant.

Since experts had the majority share in the strongly agreement, disagreement and agreement, position of employees were determinant factors of employees perception in the existence of sufficient equipment and facilities in the communal treatment plant of Eastern Industry Park.

4.4 Assessing the factors that affects the effectiveness of liquid waste management practices

Under this section, multinomial logistic regression analyses were conducted to see the influence of different factors on the existence of effective liquid waste management practices and the existence of sufficient facilities and equipment for liquid waste management. To assess the likelihood that the respondents identify the existence of effective liquid waste management practices and the existence of sufficient facilities and equipment that come mostly determined with four explanatory variables level of formulation and enforcement of legislation, the level of training and motivation of personnel working in the industrial liquid waste management, level of satisfaction with the financing and investment in equipment and facilities of liquid waste management, and level of agreement on the public education and involvement in the liquid waste management practices were considered.

To predict the respondents' perception of the existence of effective liquid waste management practices and the existence of sufficient facilities and equipment, four predictors were incorporated in the model. These are level of formulation and enforcement of legislation, the level of training and motivation of personnel working in the industrial liquid waste management, level of satisfaction with the financing and investment in equipment and facilities of liquid waste management, and level of agreement on the public education and involvement in the liquid waste management practices. The choice of independent variables was relied on common sense and literature. For the constituents of the questionnaire reliability analyses were made and the computed Cronbach's Alpha value is 0.864 which is considered as good reliability.

4.4.1 Analysis of Multinomial logistic regression model

Table 4.9: Summary of the existence of effectiveness of liquid waste management practices and its factors

Case Processing Summary			
		N	Marginal Percentage
The existence of effective liquid waste management practices	Yes	22	7.7%
	No	232	81.4%
	Uncertain	31	10.9%
Evaluating the level of formulation and enforcement of legislation for liquid waste management	Very poor	53	18.6%
	Poor	208	73.0%
	Good	24	8.4%
Ranking the level of training and motivation of personnel working in the industrial liquid waste management	High	34	11.9%
	Low	229	80.4%
	Medium	22	7.7%
Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	Very dissatisfied	46	16.1%
	Dissatisfied	210	73.7%
	Satisfied	29	10.2%
Level of agreement on the public education and involvement in the liquid waste management practices	Strongly disagree	36	12.6%
	Disagree	227	79.6%
	Agree	22	7.7%
Valid		285	100.0%
Missing		0	
Total		285	
Subpopulation		15[a]	

a. The dependent variable has only one value observed in 12 (80.0%) subpopulations

Source: computed using SPSS software by the author

Table 4.9 presents out of 285 respondents 22 (7.7%) of them accepted the existence of effective liquid waste management practices. On the other hand, the majority 232 (81.4%) of the selected respondents rejected the existence of effective liquid waste management practices. The rest 31 (10.9%) of the respondents were uncertain the existence of effective liquid waste management practices.

This indicates that the majority of employees rejected the existence of effective liquid waste management practices. Hence, there were no effective liquid waste management practices which in turn lead to environmental pollution and contamination.

As table 4.9 shows out of 285 respondents 53 (18.6%) of them said the level of formulation and enforcement of legislation for liquid waste management was very poor. However, the majority 208 (73.0%) of the respondents said the level of formulation and enforcement of legislation for liquid waste management was poor. The remaining 24 (8.4%) of the selected candidates said the level of formulation and enforcement of legislation for liquid waste management was good.

This implies that the majority of employees of selected industries from industrial park accepted that there were poor level of formulation and enforcement of legislation for liquid waste management in the Industrial Park. If the level of legislation and enforcement for liquid waste management was poor, there would have been poor liquid waste management in the Industrial park which led to environmental pollution.

As table 4.9 shows out of 285 respondents 34 (11.9%) of them ranked the level of training and motivation of personnel working in the industrial liquid waste management was high. However, the majority 229 (80.4%) of the candidates ranked the level of training and motivation of personnel working in the industrial liquid waste management was low. On the other hand, the rest 22 (7.7%) of the respondents ranked the level of training and motivation of personnel working in the industrial liquid waste management was medium.

The above stated data reveals the majority of employees of industrial park ranked that there were low level of training and motivation of personnel working in the industrial liquid waste management. If the rank of level of training and motivation of personnel working in the industrial liquid waste management was low, there would have been inadequate liquid waste management practices in the Industrial park which brought environmental pollution.

Table 4.9 shows out of 285 respondents 46 (16.1%) of them said the level of satisfaction with the financing and investment in equipment and facilities of liquid waste management was very dissatisfied. The majority 210 (73.7%) of the participants said the level of satisfaction with the financing and investment in equipment and facilities of liquid waste management was dissatisfied. The rest 29 (10.2%) of the respondents said the level of satisfaction with the

financing and investment in equipment and facilities of liquid waste management was satisfied.

This indicates that the majority of employees of industrial park dissatisfied with financing and investment in equipment and facilities of liquid waste management which in turn reduce the performance of liquid waste management in the Industrial Park.

As Table 4.9 present out of 285 respondents 36 (12.6%) of them strongly disagreed on the public education and involvement in the liquid waste management practices. The majority 227 (79.6%) of the candidates disagreed on the public education and involvement in the liquid waste management practices. The rest 22 (7.7%) of the candidates agreed the public education and involvement in the liquid waste management practices.

This shows that the majority of employees of industrial park disagreed on the public education and involvement in the liquid waste management practices. Hence, the issues of the local communities were not considered in the liquid waste management practices in the industrial park.

On the other hand, to get the entire measure of the model, considering the statistics demonstrated in the Model Fitting Information table is important. Accordingly, the model fitting information was presented in the following Table 4.10.

Table 4.10: Model Fitting Information in the effectiveness of liquid waste management practices and its factors

Model Fitting Information				
Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	264.494			
Final	17.815	246.679	16	.000

Source: computed using SPSS software by the author

The "Final" row depicts information on whether the entire coefficients of the model are zero which means whether any of the coefficients are statistically significant. Additional means to consider this result is whether the variables added statistically significantly improve the model as compared to the intercept alone that means without the addition of variables. As it can be seen from the "Sig." column that p = .000, which means that the full model statistically significantly predicts the dependent variable better than the intercept-only model alone.

In this multinomial logistic regression dependent variable is the existence of effective liquid waste management practices. On the other hand, the independent variables are level of formulation and enforcement of legislation, the level of training and motivation of personnel working in the industrial liquid waste management, level of satisfaction with the financing and investment in equipment and facilities of liquid waste management, and level of agreement on the public education and involvement in the liquid waste management practices this is a model which we call it the final model. There is no significance difference between null model and the final model. Null model has no any independent variable while final model has all independent variable in the model.

Here the significance value is .000. If the significance difference is <0.05 it is said that the null hypothesis is rejected. This means the final model fits. Hence, since the value of p = 0.000 which is <0.05 we reject the null hypothesis which mean the final model more significant than the null value or model.

Table 4.11: Goodness-of-Fit in the effectiveness of liquid waste management practices and its factors

Goodness-of-Fit			
	Chi-Square	Df	Sig.
Pearson	7.913	12	.792
Deviance	8.782	12	.721

Source: computed using SPSS software by the author

The first row, labeled "Pearson", depicts the Pearson chi-square statistic. Small chi-square values, which are found under the "Chi-Square" column, reveal a good fit for the model. A statistically significant result (i.e., $p < .05$) reveals that the model does not fit the data well.

However, as we see from the table above that the p-value is 0.792 (from the "Sig." column) which is > 0.05. Hence, it is not statistically significant. According to this criterion, the model fits the data well. Goodness of fit has also null hypothesis. The null hypothesis is the model adequately fits. If the significance value is < 0.05 it is rejected. If it is above 0.05 it is accepted. Since Pearson value is 0.792 which is > 0.05 the data adequately fit the model. In general, from these two tables the model that is developing is good.

Table 4.12: Pseudo R-Square in the effectiveness of liquid waste management practices

Pseudo R-Square	
Cox and Snell	.579
Nagelkerke	.824
McFadden	.714

Source: computed using SPSS software by the author

As to Pseudo R-Square, the four independent variables how much they are showing variation in the dependent variable explained by Pseudo R-Square. The Pseudo R-Square value is between 0-1. Zero means no variation at all while one is a perfect variation shows. The Cox and Snell value is 0.579 which shows much variation.

However, the Nagelkerke and McFadden value is 0.824 and 0 .714 respectively which has great variation as it is closes to 1. Hence, the variables are able to discriminate the existence of effective liquid waste management practices. Therefore, there is no need of additional variable to make the model adequate.

Of much greater significance are the results presented in the Likelihood Ratio Tests, as presented in the following Table 4.13.

Table 4.13: Likelihood Ratio Tests in the effectiveness of liquid waste management practices

Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-quare	df	Sig.
Intercept	17.815[a]	.000	0	.
Level of formulation and enforcement of legislation for liquid waste management	38.943	21.128	4	.000
Level of training and motivation of personnel working in the industrial liquid waste management	31.839[b]	14.024	4	.007
Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	24.849	7.034	4	.134
Level of agreement on the public education and involvement in the liquid waste management practices	21.986[b]	4.171	4	.383

Source: computed using SPSS software by the author

The chi-square statistic is the difference in -2 log-likelihoods among the final model and a reduced model. The reduced model is made by avoiding an effect from the final model. The null hypothesis is that all parameters of that effect are 0.This reduced model is similar to the final model since omitting the effect does not increase the degrees of freedom.

The above Table 4.13 shows which independent variables are statistically significant. As it can be seen in the "Sig." column, level of satisfaction with the financing and investment in equipment and facilities and level of agreement on the public education and involvement in the liquid waste management practices are not statistically significant since p = 0.134 and 0.383 respectively which is greater than 0.05.

On the other hand, the level of formulation and enforcement of legislation for liquid waste management and level of training and motivation of personnel working in the industrial liquid waste management are statistically significant since p = 0.000 and 0.007 respectively which is less than 0.05. Both variables have significant impact on the dependent variable. Hence, the level of formulation and enforcement of legislation for liquid waste management and level of training and motivation of personnel working in the industrial liquid waste management are the key factors that affect the existence of effective liquid waste management practices.

As Tab 4.14 presents, the existence of effective liquid waste management practices has three categories which includes Yes, No and Uncertain and Uncertain taken as the reference category.

Table 4.14: Classification table in the effectiveness of liquid waste management practices

Classification				
Observed	Predicted			
	Yes	No	Uncertain	Percent Correct
Yes	21	1	0	95.5%
No	10	221	1	95.3%
Uncertain	0	7	24	77.4%
Overall Percentage	10.9%	80.4%	8.8%	93.3%

Source: computed using SPSS software by the author

Table 4.14 presents, the percentage of correct prediction observed groups. Accordingly, the correctly classified Yes is 95.5%, the correctly classified No is 95.3% and the correctly classified Uncertain is 77.4%.

On the above, Table 4.14 the classification is adequate. That means the level of formulation and enforcement of legislation, the level of training and motivation of personnel working in the industrial liquid waste management, level of satisfaction with the financing and investment in equipment and facilities of liquid waste management, and level of agreement on the public education and involvement in the liquid waste management practices category are completely classifying the percentage of the existence of effective liquid waste management practices such as Yes, No and Uncertain since the overall percentage of correct classification is 93.3%.

Table 4.15: Summary of the existence of sufficient facilities and equipment for liquid waste management and its factors

Case Processing Summary			
		N	Marginal Percentage
The existence of sufficient facilities and equipment for liquid waste management	Yes	22	7.7%
	No	233	81.8%
	Uncertain	30	10.5%
Evaluating the level of formulation and enforcement of legislation for liquid waste management	Very poor	53	18.6%
	Poor	208	73.0%
	Good	24	8.4%
Ranking the level of training and motivation of personnel working in the industrial liquid waste management	High	34	11.9%
	Low	229	80.4%
	Medium	22	7.7%
Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	Very dissatisfied	46	16.1%
	dissatisfied	210	73.7%
	Satisfied	29	10.2%
Level of agreement on the public education and involvement in the liquid waste management practices	Strongly disagree	36	12.6%
	Disagree	227	79.6%
	Agree	22	7.7%
Valid		285	100.0%
Missing		0	
Total		285	
Subpopulation		15[a]	
a. The dependent variable has only one value observed in 13 (86.7%) subpopulations.			

Source: computed using SPSS software by the author

As Table 4.15 presents, out of 285 respondents 22 (7.7%) of them accepted the existence of sufficient facilities and equipment for liquid waste management. However, 233 (81.8%) of the respondents rejected the existence of sufficient facilities and equipment for liquid waste management. The rest 30 (10.5%) of the participants was uncertain the existence of sufficient facilities and equipment for liquid waste management.

The above stated data revealed that the majority of employees rejected the existence of sufficient facilities and equipment for liquid waste management. This makes the liquid waste management difficult in the industries.

On the other hand, to get the entire measure of the model, considering the statistics demonstrated in the Model Fitting Information table is important. Accordingly, the model fitting information was presented in the following Table 4.16.

Table 4.16: Model Fitting Information in the existence of sufficient facilities and equipment for liquid waste management practices

Model Fitting Information				
Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	264.015			
Final	12.342	251.673	16	.000

Source: computed using SPSS software by the author

The "Final" row depicts information on whether the entire coefficients of the model are zero which means whether any of the coefficients are statistically significant. Additional means to consider this result is whether the variables added statistically significantly improve the model as compared to the intercept alone that means without the addition of variables. As it can be seen from the "Sig." column that p = 0.000, which means that the full model statistically significantly predicts the dependent variable better than the intercept-only model alone.

In this multinomial logistic regression dependent variable is the existence of sufficient facilities and equipment for liquid waste management. On the other hand, the independent variables are level of formulation and enforcement of legislation, the level of training and motivation of personnel working in the industrial liquid waste management, level of satisfaction with the financing and investment in equipment and facilities of liquid waste management, and level of agreement on the public education and involvement in the liquid

waste management practices this is a model which we call it the final model. There is no significance difference between null model and the final model. Null model has no any independent variable while final model has all independent variable in the model.

Here the significance value is 0.000. If the significance difference is <0.05 it is said that the null hypothesis is rejected. This means the final model fits. Hence, since the value of p = 0.000 which is <0.05 we reject the null hypothesis which mean the final model more significant than the null value or model.

Table 4.17: Goodness-of-Fit in the existence of sufficient facilities and equipment for liquid waste management practices

Goodness-of-Fit			
	Chi-Square	Df	Sig.
Pearson	3.615	12	.989
Deviance	5.132	12	.953

Source: computed using SPSS software by the author

The first row, labeled "Pearson", depicts the Pearson chi-square statistic. Small chi-square values, which are found under the "Chi-Square" column, reveal a good fit for the model. A statistically significant result (i.e., p < .05) reveals that the model does not fit the data well.

However, as we see from the table above that the p-value is 0.989 (from the "Sig." column) which is > 0.05. Hence, it is not statistically significant. According to this criterion, the model fits the data well. Goodness of fit has also null hypothesis. The null hypothesis is the model adequately fits. If the significance value is < 0.05 it is rejected. If it is above 0.05 it is accepted. Since Pearson value is 0.989 which is > 0.05 the data adequately fit the model. In general, from these two tables the model that is developing is good.

Table 4.18: Pseudo R-Square in the existence of sufficient facilities and equipment for liquid waste management practices

Pseudo R-Square	
Cox and Snell	.586
Nagelkerke	.840
McFadden	.737

Source: computed using SPSS software by the author

As to Pseudo R-Square, the four independent variables how much they are showing variation in the dependent variable explained by Pseudo R-Square. The Pseudo R-Square value is between 0-1. Zero means no variation at all while one is a perfect variation shows. The Cox and Snell value is 0.586 which shows much variation.

However, the Nagelkerke and McFadden values are 0.840 and 0.737 respectively which has great variation as it is closes to 1. Hence, the variables are able to discriminate the existence of effective liquid waste management practices. Therefore, there is no need of additional variable to make the model adequate.

Of much greater significance are the results presented in the Likelihood Ratio Tests, which was presented in the following Table 4.19.

Table 4.19: Likelihood Ratio Tests in the existence of sufficient facilities and equipment for liquid waste management practices

Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	12.342[a]	.000	0	.
Evaluating the level of formulation and enforcement of legislation for liquid waste management	13.988[b]	1.646	4	.801
Ranking the level of training and motivation of personnel working in the industrial liquid waste management	40.880[b]	28.538	4	.000
Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	21.986[b]	9.644	4	.047
Level of agreement on the public education and involvement in the liquid waste management practices	25.930[b]	13.588	4	.009

Source: computed using SPSS software by the author

The chi-square statistic is the difference in -2 log-likelihoods among the final model and a reduced model. The reduced model is made by avoiding an effect from the final model. The null hypothesis is that all parameters of that effect are 0.This reduced model is similar to the final model since omitting the effect does not increase the degrees of freedom.

The above Table 4.19 shows which independent variables are statistically significant. As it can be seen in the "Sig." column, level of formulation and enforcement of legislation for liquid waste management is not statistically significant since p = 0.801 which is greater than 0.05.

On the other hand, the level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are statistically significant since p = 0.047, 0.000 and 0.009 respectively which is less than 0.05. All the three variables have significant impact on the dependent variable. Hence, the level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are the key factors that affect the existence of sufficient facilities and equipment for liquid waste management practices.

As the following Tab 4.20 presents, the existence of sufficient facilities and equipment for liquid waste management practices has three categories which include Yes, No and Uncertain and Uncertain taken as the reference category.

Table 4.20: Classification table in the existence of sufficient facilities and equipment for liquid waste management practices

Classification				
Observed	Predicted			
	Yes	No	Uncertain	Percent Correct
Yes	22	0	0	100.0%
No	10	223	0	95.7%
Uncertain	0	6	24	80.0%
Overall Percentage	11.2%	80.4%	8.4%	94.4%

Source: computed using SPSS software by the author

Table 4.20 presents, the percentage of correct prediction observed groups. Accordingly, the correctly classified Yes is 100.0%, the correctly classified No is 95.7% and the correctly classified Uncertain is 80.0%.

On the above, Table 4.20 the classification is adequate. That means the level of formulation and enforcement of legislation, the level of training and motivation of personnel working in the industrial liquid waste management, level of satisfaction with the financing and investment in equipment and facilities of liquid waste management, and level of agreement on the public education and involvement in the liquid waste management practices category are completely classifying the percentage of the existence of sufficient facilities and equipment for liquid waste management practices such as Yes, No and Uncertain since the overall percentage of correct classification is 94.4%.

Chapter 5: Summary of the finding, Conclusion and Recommendation

5.1 Introduction

Under this chapter, the main findings of the study were stated. The findings assessed the liquid waste management practices in the selected industries of industrial park. It also examined the attitude of the employees on the contribution of the communal treatment plants and their determinants. Assessment of the factors that affects the effectiveness of liquid waste management practices were also incorporated in the chapter. On the other hand, the conclusion and recommendation of the paper were also forwarded in the chapter.

5.2 Summary of the finding

This section is the summary of the finding which presented the main result that the researcher found out.

Based on interview and secondary data results the researcher pointed out that liquid waste was the major environmental and human health impacts of the selected textile factories of Industrial Park such Dong Fang and Lida. The main source of liquid waste pollution was dyeing process. The other liquid waste sources were floor washing, domestic use and drainage line leakages.

As found out by researcher, the liquid waste from dyeing operation were characterized with several dies, mordant and reducing agent such as sulphides, hydrosulphides, acetic acid and soap were strongly colored, fairly high BOD.

As far as the liquid waste management practice was concerned, the sampled textile companies such as Dong Fang and Lida have been discharging their liquid waste to the communal treatment plant of Eastern Industrial park after passing the each company's primary treatment plant which was not efficient.

As researcher pointed out that, the major source of waste water East steel was from cooling water. As far as liquid waste management practice in the company was concerned, in the steel factory, in the certain sections waste water was isolated and treated separately in the company's primary treatment plant. However, all waste water coming from the steel plant was treated in communal treatment plant found in the Eastern Industry Zone. Besides, reusing of waste water was adopted in several units. The cooling water was in continuous circulation through cooling and recirculating pond.

Researcher found out that, the liquid wastes from ceramics were washed water of raw materials, oil, greases and water removed or liquid waste from toilet. Some of this waste was reused while others drained to the communal treatment plant. The ceramic industry also used and consumed large volume of water in its production in the process such as glazing, polishing, molds washing and ball grinder preparation.

As pointed out by researcher, the liquid waste or mud generated from this ceramic process contained mostly fine particles and clay minerals like kaolin, mica and silt. Some coarse particles and chemicals containing suspended and dissolved heavy metals such as zinc and lead. This waste water not only contained high suspended and total solids but also significant volume of dissolved organics causing in high BOD or COD loads.

As far as liquid waste management in the company was concerned, Di Yuan ceramics established a liquid waste primary treatment plant with liquid waste collection pond. Besides from polishing of end products that produced large volumes of waste water that incorporated harmful chemicals were generated throughout the process. To treat the liquid wastes, the company has added powder chemical which treated the pounding system.

As researcher found out, the company consumed large amounts of water from molds washing and raw material through reusing process of waste water. The liquid waste from the company has met to some extent the national effluent discharge quality standards set by governments. Consequently, the liquid waste primary treatment plant of the company has been designed and operated to some extent in way to permit the treated waste water meet those recommended standards in the company water treatment plant. However, the primary treatment plant of the company was not that much efficient in treating the liquid wastes.

As researcher found out, several approaches for managing the waste water in the Di Yuan Ceramics has been designed, particularly; minimize the production of waste water instead of treating liquid wastes. In addition, actions in which the waste water can be reduced directly as per the guide lines and the company devoted to ensure resources were used appropriately and efficiently.

On the other hand, there was large volume of liquid waste that generated from TY Wood Company. As far as liquid waste management in the company was concerned, the primary waste water treatment plant was used in the Company to treat the liquid wastes which finally drained to the communal wastewater treatment plant of Eastern industry Park.

In general, the majority of wastes were not reused in the sampled industries due to limitation in commitment and technology that make reusing and recycling practical. As found out by researcher, there were also limitations in the liquid waste management in the companies. Among others, lack of quarterly effluent monitoring and sending results to EPA and Dukem town administration Environment, Forest and Climate Change Authority, inadequate implementation of monitoring and follows up in the management of liquid waste, inadequate safety equipment provision, lack of awareness and training for staff, absence of quarterly inspection, lack of establishing quality assurance unit to guarantee timely repairs to leaking oil and waste water pipes.

As far as effects of liquid waste from the selected industries of Industry Park were concerned: the mixed liquid waste from laundry of the textile companies, washings and flushing from fustigations room were generated. Improper disposal of such generated waste water could result in ground water contamination with chemical as well as biological contaminants. Besides, untreated textile waste discharged to the nearby environment such as through sewerage line can increase toxicity of water which might kill aquatic life, increase soil acidity and affect human health. Another effect from mixed liquid waste discharge and storage incorporated odor generation, and attraction of files and prevalence of linked vector diseases. If no mitigation and control actions present, the possible effects of the small amount of discharge are predicted to be significant and its incidence might be high. Pollutants such as light alkaline and monocyclic aromatic and hydrocarbons such as benzene, toluene and ethyl benzene from TY Wood factory tend to evaporate from surface spill and biodegrade readily. Spillages and leaks from chemicals store have a tendency to contaminate human beings nearby if not managed appropriately.

The communal treatment plant found in the Eastern industry park designed to treat liquid wastes that generate from textile and garment, metal product, construction, and wood product based on the standard. However, it hasn't been functioning effectively and efficiently to treat the liquid waste as per the standard.

The selected companies were discharging liquid wastes to the treatment plant owned by Eastern Industry Park. Each sampled industries in the Industrial Park have paid money based on the amount of liquid waste released in m^3 to the common treatment plant of Eastern Industry Park. However, the communal treatment plant was not efficient in reducing or

minimizing the pollution level of liquid wastes that discharged to the environment and harm the health of the community. Besides, the liquid waste which generated from the industries shouldn't been checked through taking sample and examining regularly using laboratory. Hence, the treatment plant discharging liquid wastes to the environment without treating the liquid wastes according to the national standard. Moreover, the existing treatment plant not only purifying the liquid wastes below the national standard, but also small in size. On the other hand, some of the chemicals that were used for treatment purpose in the communal treatment plant were expired while others their expired date was not known. However, according to Modernization theory, the issue of pollution in the industry can be solved through implementation of Eco-efficient technologies (Berger, 2001).

Accordingly, sample taken from liquid waste that has discharged in to treatment plant and from the outlet of the treatment plant and made examination using laboratory with certain parameters such as Chemical oxygen demand (COD), Ammonia (NH_3), Nitrite (No_3), Total-Nitrogen, Total-Alkality, Total hardness, Copper, Nickel, Zinc, Manganese, Silver, Lead and Cobalt the existence of these chemicals in the liquid waste were beyond the national standard. It had hazardous chemical beyond the national standard. As researcher found out, the communal treatment plant has been releasing liquid wastes to the environment without proper treatment. Therefore, the liquid wastes were polluting the environment, particularly, the soil and water body. However, according to FEDRE regulation No 417/2017 art.13, stated the Industrial Park required to control and manage their pollution level (FEDRE, 2017).

Besides, local people have been using the contaminated liquid wastes for irrigation purposes and producing vegetables such as cabbage, tomato, green paper and potatoes. The vegetables which were produced using liquid wastes generated from Eastern Industrial Park by local community might harm the health of the people. The prevailing top ten diseases from Dukem town health center revealed, the pollution might have caused human health hazards such as problem of respiratory, back bone, blood cancer, asthma and sinus (Dukem town health center, 2021).

Based on the attitude of employees of selected industries of Industrial Park, the researcher found out that, the majority of employees of industry strongly disagreed in the existence of effective liquid waste communal treatment plant in the Eastern Industry Park. This shows that there was no effective liquid waste communal treatment plant which intern affected the liquid

waste that discharged to the environment. However, according to Environmental Protection Authority of Ethiopia (1997, p.15-17), stated Industry required to have good treatment technology and waste disposal method.

On the other hand, the majority of employees of industries strongly disagreed in the treatment of liquid waste in the communal treatment plant as per the national standard. This shows that there was liquid waste pollution as the communal treatment plant was not treating the liquid waste. This was degrading the environment in general and affecting the human health in particular. However, the role of Industrial Park is to improve sustainable development through using clean technology (Haileslasie, 2018). Besides, the majority of employees of selected industries strongly disagreed in the benefit of communal treatment plant for the environment in general and the health of local people in particular. The communal treatment plant was simply for the name which means it didn't meet what was intended to meet.

In other side, the majority of employees of selected industries of industrial park strongly disagreed in the existence of sufficient equipment and facilities in the communal treatment plant of Industrial Park. Hence, the communal liquid waste treatment plant in the industry park had no sufficient equipment and facilities which made the treatment plant capable in treating the liquid wastes in order to protect our environment from deterioration. Besides, since there were no sufficient facilities and equipment such as chemicals used for treatment and safety materials not only the environment but also the human health harmed.

As researcher found out that the majority of employees in the selected industries of Industrial Park strongly disagreed in the existence of best selection of treatment process in the communal treatment plant. There was no best selection of treatment process. The treatment process didn't filter the liquid waste from industries instead; it released the effluents without proper treatment.

The majority of employees of selected industries of Industrial Park disagreed in the existence of good treatment system design in the Eastern Industrial Park. Hence, there was no good treatment system design in the Eastern Industrial Park which in turn affected the quality of treatment process of liquid wastes. In other way, level of education and employees position was the determinant factors in the employees' perception on the existence of sufficient facilities and equipment in the communal treatment plant.

As researcher found out, the majority of employees rejected the existence of effective liquid waste management practices. Hence, there were no effective liquid waste management practices which in turn lead to environmental pollution and contamination.

As researcher found out, independent variables such as level of satisfaction with the financing and investment in equipment and facilities and level of agreement on the public education and involvement in the liquid waste management practices are not statistically significant since p = 0.134 and 0.383 respectively which is greater than 0.05. However, the independent variables such as level of formulation and enforcement of legislation for liquid waste management and level of training and motivation of personnel working in the industrial liquid waste management are statistically significant since p = 0.000 and 0.007 respectively which is less than 0.05. This indicates both variables have significant impact on the dependent variable the existence of effective liquid waste management practices. Hence, the level of formulation and enforcement of legislation for liquid waste management and the level of training and motivation of personnel working in the industrial liquid waste management are the key factors that affects the existence of effective liquid waste management practices.

On the other hand, the majority of employees rejected the existence of sufficient facilities and equipment for liquid waste management. This made the liquid waste management difficult in the industries.

The level of formulation and enforcement of legislation for liquid waste management is not statistically significant since p = 0.801 which is greater than 0.05. However, level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are statistically significant since p = 0.047, 0.000 and 0.009 respectively which is less than 0.05. All the three independent variables have significant impact on the dependent variable the existence of sufficient facilities and equipment for liquid waste management. Therefore, the level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are key factors that affect the existence of sufficient facilities and equipment for liquid waste management.

5.3 Conclusion

In general, based on interview with employees of sampled industries and secondary data results, the liquid waste management practices in the selected Textile and Garment product factories and Construction companies and other wood product industry were assessed. Accordingly, there were 3,646 m^3 liquid wastes in the selected textile companies such as Dong Fang and Lida textiles, and construction companies such as Di Yuan Ceramic, East Steel Metal Production and Zhongshun Cement Manufacturing, and other wood product industry such as TY Wood Company.

With the exception of Linda garment and Zhongshun Cement Manufacturing the rest sampled companies had primary treatment plant in each company which was not efficient in treating liquid wastes from the companies. Eventually, the liquid wastes from the companies drained to the communal treatment plant of Eastern Industry Park for further treatment. However, the treatment plant itself was not efficient in treating the liquid wastes from the companies as sample test of pollution level with selected parameters from effluents of treatment plant and its outlet exceeds the national standards.

This in turn might affect the local environment in general and the health of people in particular as the local communities have been using for irrigation purposes and producing tomatoes, green paper and cabbages for local market consumption.

On the other hand, based on perception of employees of industries there was no effective liquid waste communal treatment plant in the Eastern Industry Park. The treatment of liquid waste in the communal treatment plant was not as per the national standard. Besides, there was no benefit of communal treatment plant for the environment in general and the health of local people in particular. Furthermore, there was no sufficient equipment and facilities, best selection of treatment process and good treatment system design in the communal treatment plant of Industrial Park.

Based on multinomial logistic regression likelihood ratio test result, out of the four independent variables which are level of formulation and enforcement of legislation for liquid waste management and level of training and motivation of personnel working in the industrial liquid waste management are statistically significant since $p = 0.000$ and 0.007 respectively that is less than 0.05. Both variables have significant impact on the dependent variable 'the existence of effective liquid waste management practices.' Hence, the two independent

variables are level of formulation and enforcement of legislation for liquid waste management and level of training and motivation of personnel working in the industrial liquid waste management are the factors that highly determine the existence of effective liquid waste management practices.

On the other hand, out of four independent variables three of them such as level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are statistically significant since p = 0.047, 0.000 and 0.009 respectively which is less than 0.05. All three variables have significant impact on the dependent variable 'the existence of sufficient facilities and equipment for liquid waste management practices.' Therefore, the independent variables such as level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are the factors that highly determine the dependent variable the existence of sufficient facilities and equipment for liquid waste management practices.

5.4 Recommendation

- There were large volumes of liquid wastes production from sample industries of Eastern Industrial park hence each companies recommended to have efficient treatment plant that help them treat the liquid wastes that discharged to the communal treatment plant.
- Each company recommended making sample test regularly from the effluents discharged to the communal treatment plant.
- The existing communal treatment plant of Eastern Industrial park was no efficient in treating liquid wastes drained from industries of Industrial park, therefore, the industry park recommended to plant efficient treatment plant with sufficient facilities in order to avoid environmental degradation due to pollution of liquid wastes.
- The industries recommended using modern and efficient technologies that reduce liquid waste pollution.
- Some of the chemicals that have been used in the treatment plant was not labeled either in English or local language rather labeled with Chines language which was difficult to read and identify the expire date by local experts, hence, the chemicals that have been used in

the treatment plant should be written either in English or local language so that appropriate evaluation and monitoring will be made by local experts.

- The existing regulatory framework that are related with liquid waste management in the Industrial Park need to be implemented in the sampled industries and the communal treatment plants.

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Annex-1: English Survey questionnaire and interview guide

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Part 1.Personal Information put (√) mark

a. Sex
   Male ☐ Female ☐
b. Age
   18-25 ☐ 26-34☐ 35-54☐ 55-64☐ 64 or over ☐

c. Educational back ground Less than high school☐ High school ☐Diploma ☐ Degree ☐ Master ☐ Other ☐
d. Position Expert ☐ team leader ☐ Coordinator ☐ Head of the office ☐

Part 2 Interview guide for key informants of government sectors and industries on the Liquid waste management practices in the industries

1. Are there liquid wastes in the industries? If your answer is "yes" what are the handling mechanisms?
2. Do the industries implement technology to treat liquid wastes? If your answer is **'yes'** is that efficient enough to treat liquid wastes as per the national standard?
3. What are the existing liquid waste handling techniques and practices in the industries? Are they working effectively?
4. Are they recycling and reusing of industrial liquid wastes in the industry? If your answer is "yes" to what extent effectively practicing_____If no, mention other ways of waste handling?_____
5. Do the industries have primary waste treatment plant? If your answer is "yes" to what extent effectively and efficiently functioning?_____
6. Do the industries utilize hazardous chemicals? _____If so, what are they?_____What are the handling mechanism_____
7. How industrial liquid wastes are collected, transported and treated in the industries?

Part 3 Question on the attitude of the employees of industries on the contribution of the communal treatment plants and their determinants

To what extent do you agree with the following statement? Put (√) mark

S. N	Questions	Strongly Disagree	Disagree	Agree	Strongly Agree
	Communal treatment plant of Eastern Industry park				
1	There is effective communal treatment plant in our industry				
2	The communal treatment plant treating the liquid wastes as per the national standard				
3	The communal treatment plant is benefiting the environment in general and the health of local people in particular				
4	There is sufficient equipment and facilities in the communal treatment plant of industrial park				
5	There is best selection of treatment process in the communal treatment plant				
6	There is good treatment system design				

Part 4 Question on the factors affecting the effectiveness of liquid waste management practices in the industry

In the following question please put (√) mark or encircle on the right choice

4.1 Is there effective liquid waste management practices in your industry? Yes ☐ No☐ Uncertain ☐

If 'yes' what factors positively affecting the liquid waste management in your industry?

_____

If your answer is 'NO' what factors negatively affect the liquid waste management in your industry?

_____

4.2 Is there sufficient facilities and equipment for liquid waste management in your industry? Yes ☐ No ☐ Uncertain☐

If your answer is 'NO' what lack your industry for effective liquid waste management?

_____

4.3 How do you evaluate the level of formulation and enforcement of legislation for liquid waste management in your industry? A. very poor B. poor C. Good D. Very good

4.4 How do you rank the level of training and motivation of personnel working in the industrial liquid waste management in your industry? A. high B. low C. medium

4.5 Do you satisfied with the financing and investment in equipment and facilities of liquid waste management? A. Very dissatisfied B. Dissatisfied C. Satisfied D. Very Satisfied

4.6 What is your level of agreement on the public education and involvement in the liquid waste management practices in your industry? A. Strongly Disagree B. Disagree C. Agree D. Strongly Disagree

Mention other factors that contribute to liquid waste management in the industries?_____

Annex-2: Amharic Survey questionnaire and interview guide

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ክፍ ነ. የግለሰብ መረጃ ይዜንን ምልክት (√) በሳጥኑ ውስጥ ያስቀምጡ

ነ.ነ. ጾታ
ወንድ ☐ ሴት ☐
ነ.2. እድሜ
18-25 ☐ 26-34 ☐ 35-54 ☐ 55-64 ☐ 64 ወይም ከዚያ በላይ ☐
ነ.3. የትምህርት መረጃ
ከሀይስኩል በታች ☐ ሀይስኩል ☐ ዲፕሎማ ☐ ዲግሪ ☐ ማስተር ☐ ሌላ ☐
ነ.4 የስራ ደረጃ☐ ባለሞያ ☐ ግሩፕ መሪ ☐ ኮኦርዲኔተር☐ የቢሮ ሀላፊ ☐

ክፍል 2 የኢንዱስትሪ ፈሳሽ ቆሻሻ ማኔጅመንትን አስመልክቶ ለተመረጡ ለመንግስት ሴክተሮችና ኢንዱስትሪዎች የቀረበ የአፍ መጠየቅ

2.ነ በኢንዱስትሪ ውስጥ ፈሳሽ ቆሻሻ አለ? መልሶ "አዎ" ከሆነ ምንድነው ማሰገጃ ዘዴው?

2.2 ኢንዱስትሪው ፈሳሽ ቆሻሻን ለማሰገድ ቴክኖሎጂን ይጠቀማል? መልሶ **'አዎን'** ከሆነ በአገር አቀፍ ስታንዳርድ ደረጃ ፈሳሽ ቆሻሻን ትሪት (treat) ለማረግ በቂ ነው?

2.3 የኢንዱስትሪ ፈሳሽ ቆሻሻ ማኔጅመንት ቴክኒኮችና ተግባሮች እነማናቸው? ___በሚገባ እየሰሩነው?

2.4 የኢንዱስትሪ ፈሳሽ ቆሻሻን መልሶ መጠቀም (reuse and recycling) ተግባር አለ? መልሶ "አዎን" ከሆነ ምንያህል በትክክል ይፈጸማል?_____መልሶ አይደለምከሆነ፤ ሌሎች የማኔጅመንት ዘዴዎችን ይጥቀሱ?_____

2.5 ኢንዱስትሪዎቹ የመጀመሪያ ትሪትመንት ፕላንት አላቸው? መልሶ "አዎ" ከሆነ ምን ያህል ባግባቡ ይፈጸማል?_____

2.6 ኢንዱስትሪዎቹ አደገኛ ኬሚካሎችን ይጠቀማሉ? _____አዎ ከሆነ, እነማናቸው?_____የአያያዝ ዘዴዎቹስ_____

2.7 በኢንዱስትሪ ውስጥ እንዴት የኢንዱስትሪ ፈሳሽ ቆሻሻ ይሰበሰባል; ይጋጋጥል; እንዲሁም ትሪት ይደረጋል?

ክፍል 3 ስለ ኮሙናል ትሪትመንት ፕላንት አስተዋጾ የኢንዱስትሪ ሰራተኞች አስተያየት

ከታች በተዘረዘሩት ሀሳቦች ምንያህል ይስማማሉ? ይን (√) ምልክት ያስቀምጡ

ተ ቁ	የኢስተርን ኢንዱስትሪ ፓርክን ኮሙናል ትሪትመንት ፕላንት አስመልክቶ የወጡ ጥያቄዎች	የሚስማሙበት ደረጃ			
		በከፍተኛ አልስማማም	አልስማማም	እስማማለው	በከፍተኛ እስማማለው
ነ	በኢንዱስትሪ ፓርኩ ውስጥ ጥሩ የጋራ ትሪትመንት ፕላንት አለ				
2	የጋራ ትሪትመንት ፕላንቱ ፈሳሽ ቆሻሻን በ ሀገር አቀፍ ደረጃን በጠበቀ መልኩ ትሪት ያደርጋል				
3	የጋራ ትሪትመንት ፕላንቱ ላከባቢውም ሆነ ለሰውልጅ ጤና ጥቅም እየሰጠ ነው				
4	በጋራ ትሪትመንት ፕላንቱ ውስጥ የተማላ እቃዎችና አገልግሎቶች አሉ				

5	የጋራ ትሪትመንት ፕላንቱ ጥሩ የማጣራት ፕሮሰስ ያካሂዳል				
6	ጥሩ የሆን ትሪትመንት ፕላንት ዲዛይን ሆኑዋል				

ክፍል 4 ፈሳሽ ቆሻሻን በአግባብ በማሰገድ ላይ ተጽኖ ሊያመጡ የሚችሉ ጉዳዮች ላይ ከዚህ በታች የተዘረዘሩ ጥያቄዎችን (√) ምልክት ወይንም በመክበብ ይመልሱ

4.1 ውጤታማ የኢንዱስትሪ የፈሳሽ ቆሻ ማናጅመንት አለ ብላቹ ታምናላቹ? አዎ ☐ አይደለም☐ እርግጠኛ አይደለሁም ☐

መልሶ **'አዎ'** ከሆነ ምን አይነት ፋክተሮች ናቸው አወንታዊ ተጽኖ ያላቸው?_____መልሶ **'አይደለም'** ከሆነ ምን አይነት ፋክተሮች ናቸው አሉታዊ ተጽኖ በኢንዱስትሪ ፈሳሽ ቆሻሻ ማናጅመንትላይ ያላቸው?

_____

4.2 ለኢንዱስትሪ ፈሳሽ ቆሻሻ ማናጅመንት የሚውል በቂ እቃዎችና ፋሲሊቲዎች በኢንዱስትሪያቹ አሉ? አዎ☐ አይደለም ☐ እርግጠኛ አይደለውም ☐ መልሶ 'አይደለም' ከሆነ ለውጤታማ ኢንዱስትሪ ፈሳሽ ቆሻሻ ማናጅመንት ምን ይጎለዋል?

_____

4.3 ለኢንዱስትሪ ፈሳሽ ቆሻሻ ማናጅመንት የሚውሉ ህጎችን ማውጣትና በኢንዱስትሪ ውስጥ ማስፈጸምን አስመልክቶ እንዴት ትገመግሙታላቹሁ? A. በጣም ጥሩ ያልሆነ B. ጥሩ ያልሆነ C. ጥሩ D. በጣም ጥሩ

4.4 ለኢንዱስትሪ ፈሳሽ ቆሻሻ ማናጅመንት ባለሞያ በኢንዱስትሪው ስለሚደረግላቸው ስልጠናና ማነቃቂያ ምንያህል ደረጃ ይሰጣሉ? A. ከፍተኛ B. ዝቅተኛ C. መካከለኛ

4.5 ለኢንዱስትሪ ፈሳሽ ቆሻሻ ማናጅመንት የሚውል የፋይናስና በእቃዎች ላይ የሚደረግ ኢንቨስትመንት ወጪ ምንያህል ይረካሉ? A. በጣም አረካሁም B. አረካሁም C. ረክቻለው D. በጣም ረክቻለው

4.6 በኢንዱስትሪ ፈሳሽ ቆሻሻ ማናጅመንት የህዝብ ተሳትፎና ግንዛቤን አስመልክቶ ምንያህል ይስማማሉ? A. በጣም አልስማማም B. አልስማማም C. እስማማለው D. በጣም እስማማለው

4.7 ለኢንዱስትሪ ፈሳሽ ቆሻሻ ማናጅመንት ሌላ አስተዋጾ የሚያደርጉ ፋክተሮችን ይጥቀሱ?_____

Annex-3: Code Book

S/N	Variable	SPSS variable name	Coding instructions
1	Identification Number	ID	Number assigned to each survey
2	Sex	Sex	0= male 1= female
3	Age	Age	18-25= 0 26-34= 1 35-54= 2 55-64= 3 64 or Over= 4
4	Educational back ground	Educback	0= Less than high school 1= high school 2= diploma 3= degree 4= master 5= other
5	Position	Position	0= expert 1= team leader 2= coordinator 3= Head of the office
6	There is effective communal treatment plant in our industry	effectivecommutreat	0= strongly disagree 1= disagree 2= agree 3= strongly agree
7	The communal treatment plant treating the liquid wastes as per the national standard	commutreatnationstand	0= strongly disagree 1= disagree 2= agree 3= strongly agree
8	The communal treatment plant is benefiting the environment in general and the health of local people in particular	commutreatbenefiting	0= strongly disagree 1= disagree 2= agree 3= strongly agree
9	There is sufficient equipment and facilities in the communal treatment plant of industrial park	suffequipfacicommuntreat	0= strongly disagree 1= disagree 2= agree 3= strongly agree
10	There is best selection of treatment process in the communal treatment plant	bestseletreatprocecommun	0= strongly disagree 1= disagree 2= agree 3= strongly agree
11	There is good treatment system design	goodtreatsystemdesign	0= strongly disagree 1= disagree 2= agree

			3= strongly agree
12	The existence of effective liquid waste management practices	effecliquidwastemgt	0= Yes 1= No 2= Uncertain
13	The existence of sufficient facilities and equipment for liquid waste management	sufficfaciequipliquidwastemgt	0= Yes 1= No 2= Uncertain
14	Evaluating the level of formulation and enforcement of legislation for liquid waste management	levformuenfolegliquidwastemgt	0= Very poor 1= Poor 2= Good 3= Very good
15	Ranking the level of training and motivation of personnel working in the industrial liquid waste management	levtrainmotipersoliquidwastemgt	0= High 1= Low 2= Medium
16	Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	finaequipfacilliquidwastemgt	0= Very dissatisfied 1= Dissatisfied 2= Satisfied 3= Very satisfied
17	Level of agreement on the public education and involvement in the liquid waste management practices	levagrepubeducinvoliquidewastemgt	0= Strongly disagree 1= Disagree 2= Agree 3= Strongly disagree