

ADDIS ABABA UNIVERSITY CENTER COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

ON

SLAUGHTERHOUSE WASTE MANAGEMNT AND ITS ENVIRONMENTAL IMPACT; THE CASE OF AKSEKER ETHIOPIA CASING PLC AND HALAL FOOD INDUSTRIES PLC., ABATTOIRS IN MODJO TOWN, OROMIA REGIONAL STATE.

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Declaration

I do here by declare to Addis Ababa University School of Graduate Studies that this thesis is a product of my original research work and it has not been submitted to any other university for any academic qualification. Materials and information other than my own were acknowledged dually.

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Abbreviations

BOD: Biochemical Oxygen Demand

BSE: Bovine Spongiform Encephalopathy

DO: Dissolved Oxygen

EIA: Environmental Impact Assessment

EMP: Environmental Management Plan

EPA: Environmental Protection Authority

EPE: Environmental Policy of Ethiopia

ERCA: Ethiopian Revenue and Custom Authority

FAO: Food and Agriculture Organization

FGDs: Focus Group Discussions

GDARD: Guideline from Department of Agriculture and Rural Development

HHs: Head Households

KII: Key Informant Interview

MBM: Meat and Bone Meal

MPPs: Meat Processing Plants

RMAA: Red Meat Abattoirs Association

SWW: Slaughterhouse Wastewater

UKDEFR: United Kingdom Department of Environment, Food Rural Affairs

UNEP: United Nations Environmental Program

WHO: World Health Organization

WMT: Waste Management Theory

Definition of Keywords

Slaughterhouse defined as it is the facility where animals are killed and processed into meat foods. It acts as the starting point of the meat industry, where stock comes from farms/market to enter the food chain (Stevenson, 2001).

Waste can be defined by United Nations Environmental Program (UNEP) Basel convention (1989) as substances or objects which are disposed of, or are intended to disposed of, or are required to be disposed of by provisions of national law**.**

Slaughterhouse waste is defined generally as all waste occurring in a slaughterhouse as a result of slaughtering and the waste generated from the operations of slaughterhouse (Weiers W and Fischer R., 1978).

Waste management defined by Veterinary Dictionary (2014) as the systematic administrations of activities provided for the collection, transportation and processing of wastes. Proper waste management is a desirable asset for human health and it recognizes the need for each individual to participate in the improvement of wastes management, because poor waste management contribute to contamination of the environment and pollution (liquid, gaseous, solid), spread of insects like mosquitoes, flies and many other vectors and pathogens of infections. All these can be easily controlled and prevented through a proper waste management.

Environmental pollution defined by (Allahabad, 2002). as the several emerging pollutants in the environment such as persistence organic pollutants, nanomaterial‟s pollutants, micro plastics, radioactive pollutants, and heavy metals display harmful effects on the human body, animals, and plants. The main types of environmental pollution that lead to harmful effects today are water pollution, soil pollution, and air pollution

Abstract

The study has investigated the slaughterhouse waste management and its environmental impacts in Modjo town on two export abattoirs. The abattoirs conducted for this study were Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. The objective of the study was to assess the waste management practices and to identify the slaughterhouse waste associated in pacts in both studied abattoirs. To carry out the study Descriptive research design has conducted.90 sample sizes has been used for head household survey. Though; qualitative and quantitative data analysis techniques have been used; while primary and secondary data sources were used for the study. The study scope has covered three consecutive years which has from (2018-2020). According to the study result data indicated in the range of study period both abattoirs has produced estimated 4,902.87 ton solid waste and effluent wastes such as 14,629.64m^3waste water and 1,469.22 ton of blood. Similarly; as the findings specified the slaughterhouse waste management practices implemented in both abattoirs were relevant but they are vary in the rendering and biogas production approaches that only implemented in Akseker Ethiopia Casing Plc. abattoir. Whereas the composting, treatment, reuse, burying and landfill, incineration management practices has been employed in both abattoirs. On the other hand according to the study result regarding the environmental and public health impacts that linked with slaughterhouse wastes the perception of the surrounding communities respondents indicated that about 57.4%, 32.3 % and 27.7% of the respondents agreed as the community in the area was suffering with the prevalence of difficulty in breathing/respiratory diseases due to (bad odour), social unrest (disturbance) and coughing diseases respectively. Particularly as identified from the collected data and the observation the complaint was being Akseker Ethiopia Casing Plc. abattoir because of rendering plant operation to process bone and blood meal that polluting the environment. To conclude; these study was conducted on export abattoirs that they are on their ways of understanding and giving due considerations for economic, social and environmental impacts of wastes generated from slaughtering activities and to make this effective in collaboration with regulatory bodies, developing strategies as well legal enforcement of environmental tools as to implement in their premises and environmental trainings are the most recommended ideas.

Keywords: Slaughterhouse, Waste, Effluent, Impact, pollution, environment

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Slaughterhouse is the facility where animals are killed and processed into meat foods. It acts as the starting point of the meat industry, where stock comes from farms/market to enter the food chain (Stevenson, 2001). Abattoir is an example of establishments that generate solid, liquid and gaseous wastes from the activity of animal slaughtering. It is a designated establishment approved and registered by the government or other controlling authority for hygienic slaughtering, inspection, processing, effective preservation, and storage of meat products for human consumption (Alonge cited in Adonu, Dzokoto & Salifu, 2017). The United Nations Environmental Program (UNEP) Basel convention (1989) defined waste as substances or objects which are disposed of, or are intended to disposed of ,or are required to be disposed of by provisions of national law. Additionally; Slaughterhouse waste is defined generally as all waste occurring in a slaughterhouse as a result of slaughtering and the waste generated from the operations of slaughterhouse (Weiers W and Fischer R., 1978). On the basis of usage as food, the byproducts obtained from abattoirs can be categorized into edible and non-edible, however, some of the byproducts have medicinal values and classed under pharmaceutical category. Edible by products generally include all those organs which can be consumed viz. liver, lungs, heart, brain, intestine etc. They are also known as variety meats or 'fancy meat'. All those by products that cannot be consumed directly as food are non-edible byproducts e.g. hides, horns, ears, hooves, nails, bristles etc. All the condemned parts of animal carcass also fall in this category. This demarcation of edible and non-edible byproducts is not universally acceptable as it is largely dependent on customs, traditions, purchasing power, food choices etc. of consumers. In one region, consumption of a particular by product may be a taboo and in other region it may be a delicacy. The yield of edible by-products from animals varies tremendously depending on species, sex, live weight, fatness and methods of collection. In general, the total by-products range from 10% to 30% of the live weight for beef, pork and lamb and from 5% to 6% of the live weight of chickens (Irshad A., 2015). The yield of edible byproducts including blood and organs in cattle averages 12%, in sheep 14%, and, if pork rinds are also included, 14% for hogs.

The consumption of offal is also influenced by disease outbreaks and government policies e.g. brain and spinal cord were out of the list for consumption since the outbreak of BSE (Mad cow disease).

On the basis of live weight of animal the by-products account for almost 60% and out of this 40% are edible and 20% are inedible which has been considered as waste (Chatli MK., 2015).

The United Nations environmental program (UNEP) Basel convention (1989) defined wastes as substances or objects which are disposed of, or are intended to be disposed of or are required to be disposed of by provisions of national law. Abattoir wastes can be classified as solid, liquid and gaseous forms (Bandaw, T. and Herago, T., 2017) and generally, slaughterhouse/abattoir operations produce a considerable amount of organic waste with relatively high levels of suspended solid, liquid, and fat (Adeyemi, I.G. and Adeyemo, O.K., 2007) . Waste generated from slaughterhouse included condemned organs, carcasses, ruminal contents, hair, hoofs, horns, faeces, blood and carcass trimmings which are poorly utilized (Adebowale, O.O., 2019) .Abattoir wastes have the potential to pollute surface waters, underground waters, abattoirs/market environment, and consumables around the abattoir, especially when abattoir wastes are not properly treated and disposed of (Ezeoha S.L and Ugwuishiwu B.O., 2011).

The population growth increases the demand for meat products, livestock, and poultry products. It is estimated that the total world meat production is 220 million tons and is mainly contributed by buffaloes 31%, cattle 31%, sheep 5%, goats 10%, pigs 10%, and poultry 11% (Mozhiarasi, V. and Natarajan, T.S., 2022). It is estimated that about 50–54% of each cow, 52% of each sheep or goat, 60–62% of each pig, 68–72% of each chicken, and 78% of each turkey is utilized for meat and the remaining is disposed of as waste (Alonge DO, 2005) on Animal By-Products (Scotland) Regulations (2003) .They are private modern standard and local slaughterhouses and public slaughterhouses situated in Ethiopia entirely at urban and rural areas. There are 13 export abattoirs and 1 slaughter byproduct processing company in Ethiopia; those have 200,300 ton sheep and Goats meat, and 130,411 ton beef meat production capacity per a year which needed (10,739,125 head) live animals (9,435,015 head sheep and Goats, and 1,304,110 head beef) to use as an input per a year (Mamo, G.D., 2019). The abattoirs selected for this study was the parts of the 13 export modern abattoirs established and operating in Ethiopia.

Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens in 2020 (Central Statistics Agency, CSA, 2020a).

In Ethiopia, the demand for meat supply is increasing over time as a result of increasing human population coupled with expanding urbanization and higher average income of the consumers as well as the meat export demand opportunities along the gulf countries. To meet this demand, millions of animals are slaughtered every year throughout the country.

According to (Yunus, M.K., 2019) a total of 18,599 cattle, 301,332 sheep and 8,948,761 goats were slaughtered and from these, a total of 23,864.73ton solid waste and 76,977.65m3 liquid waste has been generated in between September 2014 -March 2018. Amongst 1 percent of the total solid waste was incinerated, 0.5% was open burned and the left over 98.5% was transported to landfill. In some cases, solid wastes are burred (put in the ground) but that was occurred on the odd occasions. Whereas, liquid waste management practices were highly improved from using primary and secondary treatment systems to reusing for greenery and cleaning purposes increased from 27% to 50%. Furthermore, waste management practices were found to be environmentally unfriend and need some improvement and so far, it seems no sufficient facilities as well legal enforcements that oblige abattoirs to treat and dispose their wastes in a way environmentally friendly.

Therefore; the aim of this study was to investigate the sustainable slaughterhouse waste management and its environmental impacts in Modjo town Oromia Regional state; the case of Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. export abattoirs.

1.2 Statement of the Problem

Slaughtering of animals provides the much needed meat as well as by-products to the stakeholders in the meat value chain. When meat animal is slaughtered and processed, two thirds consist of by-products and wastes that should be properly utilized to reduce losses in abattoirs and ; also as meat by-products are efficiently utilized, the economy and environmental conservation of the counties are impacted directly (Karibe, W., 2019). The study carried out by (Yunus M.K, 2019) also found out that a total of 18,599 cattle, 301,332 sheep and 8,948,761 goats were slaughtered and from these, a total of 23,864.73ton solid waste and 76,977.65m3 liquid wastes has been generated in between September 2014 -March 2018.

The result also shows 1 percent of the total solid waste was incinerated, 0.5% was open burned and the left over 98.5% was transported to landfill.

In some cases, solid wastes are burred (put in the ground) but that was occurred on the odd occasions. But liquid waste management practices were highly improved from using primary and secondary treatment systems to reusing for greenery and cleaning purposes increased from 27% to 50%. Furthermore, waste management practices were found to be environmentally unfriend. Regarding this study there are different relevant researches has been studied on the area of; the environmental implications of abattoir waste in Ethiopia studied by (Yunus, M.K., 2019), Biogas and bio-fertilizer production potential of abattoir waste: implication in sustainable waste management in Shashemene City of Ethiopia studied by (Kefalew, T. and Lami, M., 2021), Waste management practices of Burayu abattoir and its impacts on surrounding community in Burayu town studied for the partial fulfilment degree of masters requirements by (Mamo A.W, 2020) and Livestock slaughterhouses waste management in urban environment in Tehran, Iran by(Golbaz, S.,2017), Slaughterhouse Wastewater Treatment by Integrated Chemical Coagulation and Electro-Fenton Processes conducted by (Bazrafshan, E., 2022).

Hence; including of these listed researches and the others unlisted here in this study paper there has been more focused on the slaughterhouse waste management and slaughterhouse wastewater treatments either than focusing on the sustainable management and the impacts affect the environment of the community live in the vicinity of the abattoirs.

The other initiation as frequently I visited and saw the modern, export-standard abattoirs in Ethiopia, I observed that the abattoirs are different from the local abattoirs in technology advancement availability and the number of animals slaughtered capacity which going to generate huge amounts of slaughterhouse wastes. Therefore; the study was conducted to investigate the sustainable utilization of slaughterhouse waste products and its environmental impacts; the case of Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. abattoirs , in Modjo town, Oromia regional state.

1.3 Objectives of the Study

1.3.1 General Objective

The general Objective of the study was to investigate sustainable slaughterhouse waste management practices and its environmental impacts in the context of Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. abattoirs in Modjo town Oromia regional state.

1.3.2 Specific Objectives

- To assess the existed slaughterhouse waste management practices in Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. abattoirs.
- To identify the factors influencing sustainable management of slaughterhouse wastes and its associated environmental impacts at the study abattoirs of Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. abattoirs.

1.4 Research Questions

1. What kind of waste management mechanisms are used at the abattoirs?
2. What waste management practices are used in the abattoirs for slaughterhouse waste?
3. What are specific environmental problems are encountered on the communities by slaughterhouse waste products?
4. How the slaughterhouse waste are caused environmental problem?

1.5 Scope and Limitation of the study

The study has limited in the scope of two export abattoirs namely Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. The study area was selected purposively. The study considers the residences live vicinity to the abattoirs within (100meter- 500 meters) distances radius.

1.6 Significance of the study

The result of this study used as an important input for the government institutions and organizations working in the sector at high official level nor municipality level regarding the abattoirs to consider the slaughterhouse waste management issues in their annual and short strategic plan of development endeavor. In doing this the beneficiary customers and target community might get more efficient services in their respective locality (improved health, environment and other issues associated with the slaughterhouse waste products).

The result of this research will bring a significant understanding about the impacts and management practices of abattoirs slaughterhouse waste products wastes to the whole concerned bodies.

Furthermore, the output of this study also believed to given an insight to the environment sectors in particular the hygiene and sanitation departments, policy makers, academic and research institutions, local authorities, the abattoirs owners and the society with regards to the impacts and slaughterhouse waste management practices of Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. abattoirs on Modjo town and the surrounding communities to bring effective solutions.

The study was thought to have significance in contributing to the body of knowledge as well as improved practices in slaughterhouse waste management to the extent of delivering effective policy framework. The study finding enhances existing knowledge by adding the real practice of waste management in the study areas. The implementation would be ensured by sharing the articles and discussing the findings in pertinent opportunities. The findings would be used by the policy sector to enhance public health, environmental pollution, management practices, and policies.

It would serve the policy in particular by offering important insights and suggestions for improving the management of slaughterhouse waste at abattoirs, which would then contribute to better community health and make beneficial the companies. Indeed, the researcher would gain a lot of knowledge & expertise to do more research as a result of this work.

1.7 Organization of the study

This thesis is organized in five major chapters. The first chapter included introduction, statement of the problem, objectives of the study, significant of the study and scope of the study. The second part deals with literature review that includes conceptual and theoretical frameworks of abattoir and empirical studies made in the country and elsewhere in the world. The third chapter presents description of the study areas and methodologies used for the study. The fourth chapter contains the research results and discussions that are emanated from the first and secondary data sources. Finally, chapter five presents conclusion and recommendations that are drawn from the study.

CHAPTER TWO: LITERATURE REVIEWS

2.1 Theoretical Review

2.1.1 Waste management theory

Theory, in its origin, is the state of contemplation as distinct from the state of action (Campbell, N.R.1957). Theories were constructs body of knowledge that helps to explain systems of regularities that cannot be explained with scientific laws (Hempel, 1966). Niiniluoto argues that Present scientific development has developed in such a way that the number of technical applications of science have increased, while the theories themselves are becoming more and more abstract, reaching beyond everyday experiences (Niiniluoto, I., 1980). Constructing Waste Management Theory (WMT) is an effort towards scientification of waste management. WMT is a conceptual description of waste management, providing definitions of all waste-related concepts, and suggesting a methodology of waste management. It is an effort to organise the diverse variables of the waste management system as it stands today that stated in evolving the ‘’Theory of Waste Management’’ book volume II by (Pongrácz E., *et al*, 2004). WMT is considered within the paradigm of Industrial Ecology, and built side-by-side with other relevant theories, most notably Design Theory (Love, 2002).

Design Theory is a relatively, still under development. Following its development offers valuable insights about evolving technical theories. According to (Love T,2002), it is crucial to development theory to integrate with other bodies of knowledge, as well as the clarification of the definitions of core concepts, and mapping out key issues, such as domains, epistemologies and ontologies. At the present stage of WMT development, scientific definitions of key concepts have been offered, and evolving of WMT under the paradigm of Industrial Ecology is in progress. The Theory of Waste Management represents a more in-depth account of the domain and contains conceptual analyses of waste, the activity upon waste, and a holistic view of the goals of waste management and its founded on the expectation that waste management is to prevent waste causing harm to human health and the environment (Pongrácz E., *et al*, 2004).The ‘’Theory of Industrial Ecology’’ (Korhonen, 2004a) found that the description of how the physical flows of materials and energy flow in natural ecosystems can be used for prescription for the vision and the overall goal of industrial ecosystem ecological sustainability.

2.1.2 Definitions of the concept of waste

Regarding the concept of definition and waste there are a number of concepts were forwarded via scholars and regulatory institutions. According to definition is always important in the field of law, but it is particularly important in a system of regulatory control, as it is necessary to define what can and cannot be controlled (Cheyne I. and Purdue M.,1995) Effective definition of core concepts is an epistemologically well-bounded theoretical construct (Love, T., 2000) It follows that a prerequisite of the scientification of waste management, and the evolution of WMT, is offering scientifically adequate definitions of the key concepts of waste management, starting with the descriptive definition of waste. The primary justification of regulating waste disposal was to regulate waste disposal (Tromans, S. EC., 2001).However, the key to sustainable waste management is waste minimisation, in particular the reduction of waste at source (Phillips, P.S., *et al*, 2002). Similarly; according to UNEP Basel Convention of (1989) Wastes defined as substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law. Whereas defined by European Union Waste Framework Directive (2008), as an object the holder discards, intends to discard or is required to discard. According to (Allahabad, 2002).Environmental pollution is defined as the several emerging pollutants in the environment such as persistence organic pollutants, nanomaterial‟s pollutants, micro plastics, radioactive pollutants, and heavy metals display harmful effects on the human body, animals, and plants. The main types of environmental pollution that lead to harmful effects today are water pollution, soil pollution, and air pollution

Waste management also defined by (Veterinary Dictionary, 2014) as the systematic administrations of activities provided for the collection, transportation and processing of wastes. Proper waste management is a desirable asset for human health and it recognizes the need for each individual to participate in the improvement of wastes management, because poor waste management contribute to contamination of the environment and pollution (liquid, gaseous, solid), spread of insects like mosquitoes, flies and many other vectors and pathogens of infections. All these can be easily controlled and prevented through a proper waste management.

2.1.3 Classes of Wastes

According to (Pongrácz E., *et al*., 2004) waste can be categorized into four classes where the affirmation is unambiguously categorizes every waste object. Class 1 (waste emissions) as 'a thing to which the producer has not assigned a Purpose', we indicate the error on the part of the producer, Class 2 (packaging) has fulfilled its purpose, we shall exhaust the possibility of assigning a new purpose (refill).

If waste of Class No 3 is an item of waste, which is not performing in respect to its original Purpose due to irreversible damage in Structure' (a broken equipment), one can opt for a recovery alternative. Finally, the description of waste in Class No 4 as 'an object, which the owner failed to use for its intended Purpose' (leftover food being flushed down) emphasizes the fact that it was the wrongful action of the owner that created waste.

2.2 Empirical Review

The waste generation from slaughterhouse has adverse effect on the surrounding community living in the vicinity of the abattoirs by impacting the air, water body, land and public health if not handling properly. Abattoir waste disposal in many developing countries including Ghana has been a major challenge for years (Fearon J.*et al*, 2013). The research result conducted in Ethiopia by (Bandaw, T. and Herago, T., 2017) identified that abattoir wastes consist of several pollutants such as animal feaces, blood, bone, fat, animal trimmings, paunch content and urine from operations or areas like lairage, stunning or bleeding, carcass processing and by-product processing. These abattoir wastes can be classified as solid, liquid and gaseous forms. Abattoir wastes can have a detrimental effect on the environment, public health, animal health and economy of the country if they are not effectively managed and controlled.

According to some researchers point out that abattoir activities are responsible for the pollution of surface and underground waters as well as air quality which indirectly affect the health of residents living within the vicinity of abattoirs (Odoemelan and Ajunwa, 2008; Patra *et al*., 2007; Raymond, 1977). Wrongful discharge of blood and animal faeces into streams may cause oxygen-depletion as well as nutrient-over enrichment of the receiving system which could cause increased rate of toxin accumulation (Nwachukwu, *et al*., 2011).

Humans may also be affected through outbreak of water borne diseases and other respiratory and chest diseases (Mohammed and Musa, 2012). As point out by (Omole, 2013) most of Ethiopia abattoirs like Nigerian abattoirs are situated close to surface water bodies in order to have access to water supply needed for slaughtered animal processing and to provide a sink for the run-off from meat processing activities.

The studies carried out by (Adelegan, 2002; Osibanjo and Adie, 2007; Weobong, 2001) from Nigeria and Ghana shows that many abattoirs in the respective countries either deposit waste materials in the immediate environs or dispose of them directly into water bodies, some of which serve as sources of water for the abattoirs.

The study findings by (Olowoporoku O.A., 2016), on solid waste (condemn meat, undigested ingesta, bones, horns, hairs and aborted fetuses etc.) disposal in slaughterhouses revealed that 13.0% of the slaughterhouses burn their waste, 65.3% dump their waste on vacant land beside the slaughterhouses, 8.7% of the respondents dump their waste in the bush, 13.0% dump their waste in the drainage.

Further findings by this author also revealed that all the slaughterhouses sampled dump their solid waste on the vacant land in the premises of the slaughterhouses. Undigested ingesta, dungs, bones and horns comprise major proportion of wastes generated in Nigerian slaughterhouses .This could be responsible for the highly pungent odour, infestation of flies and diseases vectors as a result of heaps of waste around the slaughterhouses. On the frequency of the disposal of solid waste from the slaughter slabs revealed that 93.3% evacuate their solid waste from the slaughter slabs daily while 6.7% clear their solid waste from the slaughter slabs twice in a week (Olowoporoku O.A., 2016).

The research findings of (Hegg, 2004) revealed that animal waste management is a crucial component in developing sustainable livestock, poultry, and seafood businesses, both during the production stage and during the processing stage. This can only be done if the precise volume of each sort of waste produced at each manufacturing and processing location, locality, or area is known, allowing for the planning of recycling, containment, or disposal.

2.2.1 Impact of Slaughterhouse waste on Environment and Public health

Environmental pollution has generally become a threat to the existence of mankind and the ecosystem. According to (Adesemoye *et al.,* 2006) report, abattoir activities could be another source of pollution because it has been noted that human activities like meat processing and animal production have a negative impact on the composition of soil and natural water, which pollutes the soil, natural water resources, and the environment as a whole.

Furthermore, according to (Adeyemi I.G. & Adeyemo O.K., 2006 and Elemile OO. *et al*.,2019), waste from slaughterhouses can be harmful because, if not properly reused, it can spread food-borne illnesses and contaminate ground and surface waters with a variety of pathogenic and non-pathogenic organisms. According to the study carried out by (Olawuni PO. *et al*., 2015) in Nigeria Lagos state the finding point out that slaughterhouse revealed that prevalence of flies, cockroaches, mosquitoes and rats were considerably higher around residences at close proximity the slaughterhouse with associated polluting and adverse health effects. Additionally, when abattoirs are situated close to residential areas, the consequences are worse. The study finding by (Bandaw, T. and Herago, T., 2017.) reported that abattoirs often have difficulties in disposing, treating and processing of slaughterhouse wastes in an environmentally acceptable fashion.

Due to this reasons there is high risk on environmental pollutions like underground water pollution, air pollution, nuisance, odor, soil pollution and public health risks through transmission of zoonotic diseases to human. Abattoir effluent wastewater has a complex composition and can be very harmful to the environment. For example, discharge of animal blood into streams would deplete the dissolved oxygen (DO) of the aquatic environment. Improper disposal of paunch manure may exert oxygen demand on the receiving environment or breed large population of decomposers (microorganisms), some of which may be pathogenic. Also improper disposal of animal faeces may cause oxygen depletion in the receiving environment. It could also lead to eutrophication of the receiving system and increase rate of toxins accumulation in biological systems (Nwachukwu *et al*., 2011).

The finding addressed by (Mohammed S. and Musa JJ., 2012) stoutly reported that the improper disposal of abattoir effluent could lead to transmission of pathogens to human which may cause an outbreak of water borne diseases e.g. diarrhea, pneumonia, typhoid fever, asthma, wool sorter diseases, respiratory and chest diseases, etc.

The study result of (Ogbonna DN.*et al*., 2002) also emphasis that airborne pollutants and noxious gases produced from decomposed animal waste pile-ups increase greenhouse effects, pulmonary diseases, cardiovascular problems and early deaths. Although; the study result of (Sangodoyin and Agbawhe, 1992) indicated that slaughterhouse waste generally has a high polluting strength. Which the chemical composition of the groundwater approximately 250m distances from the abattoir site was found unsatisfactory as raw water source for drinking purposes.

The finding also additionally stated that the effect of such uncontrolled disposal system renders surface waters and underground water systems unsafe for human, agricultural and recreational use, destroys biotic life, poisons the natural ecosystems, poses a threat to human life and is therefore against the principles of sustainable development.

Therefore; it is suggested by (WHO, 2002) that slaughterhouses pose a risk to public health, and that waste from these facilities should be disposed of by trained personnel at facilities that are kept in good condition.

2.2.2 Slaughterhouse Waste Management Practices

Management for non-hazardous residential and institutional waste in metropolitan areas is typically the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator (Eckenfelder 1989). According to (Adebowale OO., 2019) slaughterhouse generated wastes were separated into solid and liquid waste. The solid waste included condemned meat/organs, horns, hoofs, bones, hair, aborted fetuses, faeces, undigested ingesta and fats and oils. Solid wastes were seen as open dumps within the slaughterhouse.

The study by (Yunus, M.K., 2019) reported that most common waste management practices of the Ethiopian export abattoirs are; letting the liquid effluents to undergo primary treatment and discharge to nearby rivers or drainages where as some of solid wastes are incinerated, some are transported to municipality landfill and in some of the abattoirs, very small portion of degradable solid waste generated are subjected to digesters for the production of biogas energy as a fuel. Conversely, the liquid waste comprised blood, water usually directly from the slaughtering and cleaning processes, suspended ruminal contents and urine.

According to (Aniebo A.O, *et al.* 2011), the estimation of slaughterhouse waste for cattle and goats is as follows: blood/head (12.6kg, 0.72kg), intestinal content/head (8.0 kg, 1.25kg), waste tissue (6.4kg, 0.80kg), and bone/head (11.8kg, 2.06k) correspondingly based on the species of the animal. Therefore, adequate waste management is needed in accordance with the types of waste categories generated in order to use the products as intended.

2.2.2.1 Solid Waste Management practices

Solid waste broadly refers to leftover materials from industrial and agricultural production processes as well as from human activities. It consists of infectious waste, industrial trash, and municipal solid garbage Pollution Control Department (2009). Additionally, solid wastes are produced in abattoirs just like any other type of liquid waste. Animal holding areas, slaughtering and processing areas, waste treatment facilities, rejected hide and skin pieces, meat trimmings, and condemned carcasses are the sources of solid waste in abattoirs.

Then, (Franke-Whittle & Insam H., 2013) revealed that the waste from slaughterhouses is classified as solid waste since it contains inedible animal components such condemned meat and organs, undigested ingesta, ligaments, tendons, bones, horns, hair, and aborted fetuses.

Separate storage spaces for different waste categories and solid wastes are required. By using bucket traps and skips, solid garbage should be kept apart from wastewater streams, as suggested by (Adedipe N.O., 2002). It helps to reduce the volumetric and organic load on the wastewater treatment stream when this approach is used.

For the safety and cleanliness of the abattoir, the unwanted materials should be removed right away from the slaughterhouse. Each slaughterhouse should have the necessary equipment for de-hiding the animals, and the hides and skins should be taken out of the slaughter area right away in a closed wheelbarrow or other similar device. In no circumstances should the skins and hides be spread out on the floor of the slaughterhouse for inspection. Legs, bones, hooves, and other parts of the animal should be removed right away from the killing area using a closed wheel barrow or a spring-loaded floor chute. However, the (RMAA, 2010) stated that the hides and skins should be spread out on the floor of the slaughtering area for inspection.
Whereas; legs, bones, hooves etc. should also be removed immediately from the slaughtering area through a spring load floor chute or closed wheel barrow.

The rumen contents consist of partially digested feed material eaten by animal before slaughter together with digestive juices and microbial flora. It either wasted or composted into manure.

It affects the slaughterhouse's ability to dispose of solid waste (Bhat, P.N. and B.U. Khan, 2009). In the absence of a suitable location, this rumen content may be discarded or decomposed into manure. Also, (Massé, T. and Masse, W., 2000) proposed that the rumen-digested feed material, along with digestive fluids and microbial flora, causes solid disposal problems in slaughterhouses. Generally, (Estonilo, L.A., 2006) recommended that proper disposal, burial, and incineration be used to prevent any potential dangers to the environment and public health that may be caused by these and other solid wastes.

2.2.2.2 Liquid Waste Management Practice

Both liquid and solid wastes are produced during abattoir operations. The liquid waste should be removed using a safe, dependable, and continuous supply of fresh water under sufficient pressure throughout the slaughterhouse grounds.

Abattoir drainage lines must be correctly constructed and placed in order to drain liquid wastes and prevent stagnation that releases foul odors Department of Health, Manila, Philippines (DOH, 1998). Waste water or effluent generated from the abattoir is characterized by the presence of a high concentration of whole blood of slaughtered food animals and suspended particles of semi-digested and undigested feeds within the stomach and intestine of slaughtered and dressed food animals (Coker, A.O., *et al*, 2001).

Furthermore, it was suggested by (Massé, T. and Masse, W. 2000) that the wastewater from slaughterhouses is highly polluted; as a result, it shouldn't be allowed to mix with the municipal drainage system without treatments like anaerobic treatment, in which the effluent is digested without oxygen in a closed digester; aerobic treatment, in which oxygen helps bacteria act to lower the biochemical oxygen demand level; and filter press for sludge dewatering.

In addition ;(Bhat, P.N. and B.U. Khan, 2009) has been report that due to inadequate facilities at the slaughter houses and scattered illegal slaughtering of animals, very few slaughter houses collect blood. Uncollected blood in slaughterhouse becomes a serious sanitary problem. It quickly clots, choking drains, septic tanks, etc. and rapidly decomposes serving as an ideal medium for bacterial growth. Additionally, (Aniebo, A.O., *et al*., 2009) proposed that bleeding locations in the slaughterhouses should be clearly marked, and blood drainage and collection should be carried out right away so that its full potential may be exploited.

Contaminated storm water, waste waters and wash waters should be collected in lagoons and aerated and irrigated without any off-site runoff; clean storm water must be kept away from the contaminated areas and directed to the storm water drainage system. All process areas must have concrete floors graded to wash down drains Guideline from Department of Agricultural and Rural Development of Ethiopia (GDARD, 2009).

2.2.2.3 Gaseous Waste or Odor Management practices

Odor control may be a significant issue, particularly when the abattoir is located near residential areas or in a hot environment (Bello, Y.O. and Oyedemi D.T.A., 2009).All chemical storage areas and chemical-based odor control equipment must be located on impermeable concrete floors with bunding capable of containing 100 per cent of any spillage (GDARD, 2009). Consequently, the slaughter house premises always give a particular stink. In order to avoid this stinking odor proper ventilation of slaughtering halls, washing of the floors with non-poisonous disinfectants and when needed, the use of aerobic deodorants must be provided at each slaughter house.

2.2.3 Appropriate slaughterhouse waste management practices

Waste or byproducts from slaughterhouses must be disposed of or used properly to avoid contaminating the environment and to create valuable goods that could boost the abattoir's and animal owners' profits (Malav OP., *et al*, 2018). Also, (GDARD, 2009) indicated that good abattoir housekeeping, abattoir waste management should be progressively implemented commencing with low cost, low technology practices and thereafter progressing to more sophisticated technologies. Liquid and solid waste products including specific risk material from the slaughter operation need to be handled, transported and disposed of in compliance with relevant regulations and in a manner appropriate for each processing site. Similarly, (Adeyemi and Adeyemo, 2007) mentioned a variety of sound management strategies that, when used in terms of pre-treatment, might lessen the environmental impact of abattoir waste and possibly boost the availability of value-added goods.

Even though; slaughterhouse waste management practice finds different technologies and labour forces to manage effectively. Abattoir waste management practices require various technology or labour force. Therefore, (Bello Y.O. and Oyedemi D.T.A., 2009) indicated that abattoir waste management practices may require additional technology or labor.

These practices may include: primary screening to remove any solids or fats, specific risk management separation with appropriately sized screens, fat/oil removal by flotation and skimming. Other terms cited include primary settling, blood separation, waste effluent balancing, pH correction (chemical correction), aerobic ponds, and anaerobic lagoons.

2.2.3.1 Safe disposal, treatment and processing methods

The most widely used route for disposal of abattoir waste in developed countries is municipal sewers (Baker, J., 1999,). Discharge costs because of the high organic strength of untreated abattoir waste are relatively high. A degree of on-site pre-treatment is therefore preferable. To minimize waste volumes, water conservation and optimum water housekeeping are essential. In addition to good abattoir keeping, abattoir waste management should be progressively implemented commencing with low cost, low technology practices and thereafter more demanding technologies.

This practice requires appropriate facilities for safely managing the abattoir wastes. Furthermore, according to (Adeyemo, 2002), it is crucial to have the proper facilities to ensure the safe disposal of abattoir wastes in a way that will not pose a risk to the environment, animal health, or the public's health. By-product reuse or recycling frequently lowers waste generation. Economically and environmentally sound strategies can be employed to recover valuable materials from waste streams.

The government regulations must be followed in all activities carried out in abattoirs, including the construction of the building itself as well as the drainage, water supply, and waste disposal systems (EPA, 2001). This is in accordance with practices put in place in respect to environmental rule and regulation.

2.2.3.1.1 Bio gas production

Waste disposal is a serious problem in the abattoirs of many developing countries, because they cannot afford expensive mechanical pre-treatment and by-product rendering facilities. In tropical regions, the problem can successfully be tackled by using biogas digesters (Adeyemi and Adeyemo, 2007). As a result of the plentiful biomass wastes produced by slaughterhouses, these resources have the potential to be used to produce biogas through the bio-methenation process, which uses waste from the industry as a feedstock.

The success of the process, especially the effective removal BOD has led biogas plant to be acceptable for slaughter house (Hejnfelt A, and Angelidaki I., 2009). Wastes consisting of rumen and paunch contents, dung, agriculture residue, fat and blood are processed in biomethenation plant.

Power plants have been designed to produce biogas (60% methane, 30% carbon dioxide and traces of hydrogen, carbon monoxide etc.) by digestion of animal waste (Sharma BD, 2003).The biogas can be used for boiler or power generation.

Accordingly, (Adesemoye A.O., *et al.,* 2006) showed that anaerobic digestion significantly reduces the amount of landfill gas released into the atmosphere when used as part of an integrated waste management system and produces biogas made up of methane and carbon dioxide. Anaerobic digestion also destroys pathogenic bacteria at much higher levels than aerobic digestion at high temperatures.

Large slaughterhouses are therefore typically found around cities and crowded areas. They produce large quantities of high-quality solid waste, which must be treated in an environmentally friendly way. Waste bio-methanation is advised for the large slaughterhouses. Less room is needed for bio-methanation, which benefits slaughterhouses with limited land. Bio gas produced from this operation may fulfill the energy requirements of slaughter unit and adjoining areas (Malav OP., *et al*, 2018).

Additionally, (Richards *et al*., 1991) suggested biogas is produced by anaerobic digestion with anaerobic bacteria or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material and crops. The embedding of biogas power-plants is the best solution for bio waste utilization. The use of gut contents, manure and solid waste to produce biogas as fuel for heating and lighting would alleviate shortage of fuel and conserve environment.

2.2.3.1.2 Burial

Burial of wastes is one of the safest and most popular abattoir and farmer waste management strategies. However, essential nutrients from the abattoir waste are thrown away during burial. These procedures must be followed in accordance with legal requirements. The landfill must be

covered soon after usage, it must have a way to keep out wildlife, and records of the locations and volumes buried must be kept, according to (Adedipe, 2002) suggestion.

2.2.3.1.3 Controlled incineration

Waste incineration is one of the practices used at the level of abattoirs in abattoir waste management. Abattoir waste incineration must be done carefully in order to reduce environmental pollution. Furthermore, (Somlyody, 1993) noted that controlled In order to safely burn garbage, temperatures must reach 850°C or more, remain there for at least 15 minutes, and all biological material must be converted to ash. In fact, incineration sterilizes the waste by killing most microorganisms, including the prion that causes bovine spongiform encephalopathy (BSE). As long as the incineration is done properly, incineration reduces volume by around 90%–93%, and the ash that is produced is thought to be prion-free. If the right burn is accomplished, there won't be a need for a permit for the ash to be dumped in a landfill or used as a soil supplement for slaughter waste that contains SRM. The high moisture level of raw slaughter waste can result in a negative energy value. The public might not be in favor of incinerators, and some incinerators may have trouble complying with emissions regulations (Somlyody, 1993).

2.2.3.1.4 Composting

Composting is natural biological decomposition process where aerobic organisms break down materials in the presence of oxygen. According to (GDARD, 2009) suggested, the composting of should be done in pits or bunkers instead of stacks and heaps in consideration of environmental and sanitation. Both structures must be roofed or provided with sheds for security against rain.

According to (Juhasz C.and Mihelic R., 2007) indicated that many farmers and approximately 15 to 20 abattoirs are currently composting waste. The cost to compost has been estimated to be approximately one-third the cost of rendering. However, the composting process for full carcasses or significant quantities of waste takes several years is labour intensive and may be ineffective in disposing of hides and bones. The permissible uses of the final product the compost are still uncertain and may depend on the nature of the compost. The compost process is effective to break down the waste, kill some pathogens and produce final compost which is relatively safe.

2.2.3.1.5 Rendering

Rendering is the optimal disposal method so failure to use the rendering industry for the disposal of abattoir waste and mortalities will erode the infrastructure developed to safely handle these materials, resulting in sanitation and environmental challenges in the future United Kingdom Department for Environment, Food and Rural Affairs (UKDEFRA, 2000). It involves mechanical, thermal and/or chemical treatment of solid livestock slaughter waste and/or whole carcasses to produce pelleted soil additives or animal feedstock such as meat and bone meal (MBM) and tallow (fats and oils). MBM is used as a non-ruminant stock feed or fertilizer and the tallow can be used in the pharmaceutical, cosmetic and soap industries, as well as in animal feeds etc. (FAO, 2002).

In the absence of the rendering, the cost of disposal of waste animal material would be very high and would place a significant economic and environmental burden on areas involved in industrial scale slaughtering. This cost may manifest itself through the expensive use of sanitary landfills, incinerators and other similar waste disposal techniques without yielding profit directly out of it leading to the incurrence of opportunity costs (UKDEFRA, 2000).

2.2.3.1.6 Blood processing as animal feed

The (FAO, 1991) reported that between 40 and 60% of the total blood volume in animals is removed through bleeding .Thus, cattle weighing 370 kg yield between 11.1 and 16.7 kg blood, while 30 kg goats yield between 0.9 and 1.4 kg blood. If 20 heads of cattle are slaughtered in an abattoir in one day, between 222 and334 kg of blood are generated.

Accordingly, to eliminate a sizeable pollution hazard and prevent the loss of a valuable protein source, efforts have been made to ensure the utilization of animal blood on a massive scale. According to (Ockerman and Hansen, 1999) indicated a further incentive is the increased profits to be made through adding value to the blood. When processed and incorporated in the livestock feeds, it would provide a valuable source of animal protein and as a fertilizer it would enrich the soil. The blood available from the slaughter houses should be collected and made use of in pharmaceutical industry. Similarly; (Massé W. and Masse T., 2000) stated blood collection on efficient lines will only be possible in modern slaughterhouses as collection has to be done quickly and without dilution with water. Otherwise, processing would be pronged, making moisture removal extremely expensive.

According to (Aniebo A.O.et al., 2009) suggested by passing steam directly in to blood, allow it to dry and pulverize into a meal is simple method of preparing blood meal. Blood meal is a dry, inert powder made from blood used as a high-nitrogen fertilizer and a high protein animal feed. N = 13.25%, P = 1.0%, K = 0.6%. It is one of the highest non-synthetic sources of nitrogen. The source usually originates from cattle as a slaughterhouse by-product (Aniebo A.O, *et al*., 2009).

2.2.4 Slaughterhouse waste management practice regarding standard/law and regulation of the country

Site of slaughter houses in the city should be properly decided, as any wrong location can cause the various problems in the vicinity. The policies of government regarding zoning should be strictly followed. (Singh *et al*., 2014) suggested that the municipality and local government should properly plans for location of slaughter houses. Effluent from the slaughter houses is a major source of pollution, this water if not disposed properly then causes various health & Environmental issues.

Although; (Ogbomida, *et al*., 2016) suggested appropriate wastewater treatment procedures for slaughterhouse in order to prevent the contamination of the environment including surface and ground water. Cost effective implementation of technology & management approaches that separation by screening (solids), protein recovery (blood separation), primary settling etc. should be carried out to reduce the period of delayed degradation.

The study finding by (Mulu A. et al., 2015) reported that there should be also an intervention of appropriate regulatory bodies (EPA) to control environmental issues related to slaughter houses. Consequently, (Singh, et al., 2014) also suggested that the governments enforcing the present by laws strictly related to slaughter houses propose to applicable and a proper licensing system for slaughter houses help in discouraging the unfair means towards it. Hence; as different study results indicated due to lack of appropriate abattoirs slaughterhouse waste management effect environment and public health which required strongly need government intervention through environmental policy and regulatory authorities. The Environmental policy of Ethiopia (EPE) was approved on April 1997, with the general of improving the health and quality of life of all Ethiopians and to promote sustainable social and economic development. The policy also constitutes eleven-sectoral and eleven cross-sectoral policy elements. Regarding the proclamations has been explained as follows;

Proclamation No.299/2002, enacted in 2002, empowered the EPA to prepare procedure, regulations, guidelines and standards to effectively implement and enforce EIA proclamation.

Environmental guidelines are among the tools for facilitating the inclusion of environmental issues and principles of sustainable development into development proposals. To guide mainstreaming of the principles of sustainability into sectoral projects, sectoral environmental impact assessment guidelines such as gridlines on agriculture, transport, industry, tannery and settlements have been prepared. Proclamation 300/2002, Environmental Pollution Control requires developmental activities to consider environmental impacts before their establishment. The proclamation requires on going activities to implement measures that reduce the degree of pollution to a set limit or quality standard. Thus, one of the dictates of the proclamation is to ensure, through inspection, the compliance of on-going activities with the standards and regulations of the country through an environmental audit.

Proclamation 295/2002, Establishment of Environmental Protection Organs establishes the organizational requirements and identifies the need to establish a system that enables coordinated but differentiated responsibilities of environmental protection agencies at federal and regional levels. The proclamation indicates duties of different administrative levels responsible for applying federal law.

Proclamation 159/2008, Prevention of Industrial Pollution Regulation as a follow up to Proclamation 300/2002, this regulation to prevent industrial pollution was developed by the Federal Environmental Protection Authority to ensure compatibility of industrial development with environmental conservation. This Proclamation includes comprehensive industrial pollution standards for a range of industrial and mining activities.

2.2.5 Economic Importance's of slaughterhouse waste management

By-products such as blood and bone meal are ingredients with high protein content are needed in the manufacturing of poultry and pig feed. Promotion of production of blood and bone meal will assist in promoting poultry industry which in turn will contribute to the economy. The use of gut contents, manure and solid waste to produce biogas as fuel for heating and lighting would to a great extent help alleviate shortage of fuel and conserve environment (Gracey, J.F., 2000).

There is decreasing use of chemical fertilizers in African agriculture because of their high cost, unavailability and poor infrastructure for marketing and their detrimental effects on the environment (Dikinya, O. and. Mufwanzala N, 2010). Due to these reasons, farmers in most part of Africa were developing the use of slaughterhouse wastes composting and apply as soil fertilizer. This practice will improve the economic income of that country (Rautaray, S.K., *et al*, 2003). Establishment of factories to produce various products and goods including glue, combs, buttons, gelatin, Waste brushes, lubricants, grease will create employment to urban dwellers and through that contribute to the national economy (Sindhu A.A., *et al*, 2002). In other way; utilization of abattoirs by-products would increase returns from abattoir and meat plant business and help cover some of the operating costs and thus make it more profitable.

Improper waste management has impact on economic, environmental, and health by creating loss of valuable raw material for by-product processing factories; air, soil, and water pollution; as well as infestation of flies and other disease vectors. Therefore, appropriate animal waste management is an important element in creating sustainable livestock, poultry, and fish industries (Hegg, 2004), both at production and at processing stages.

2.2.6 Factors Influencing slaughterhouse waste management

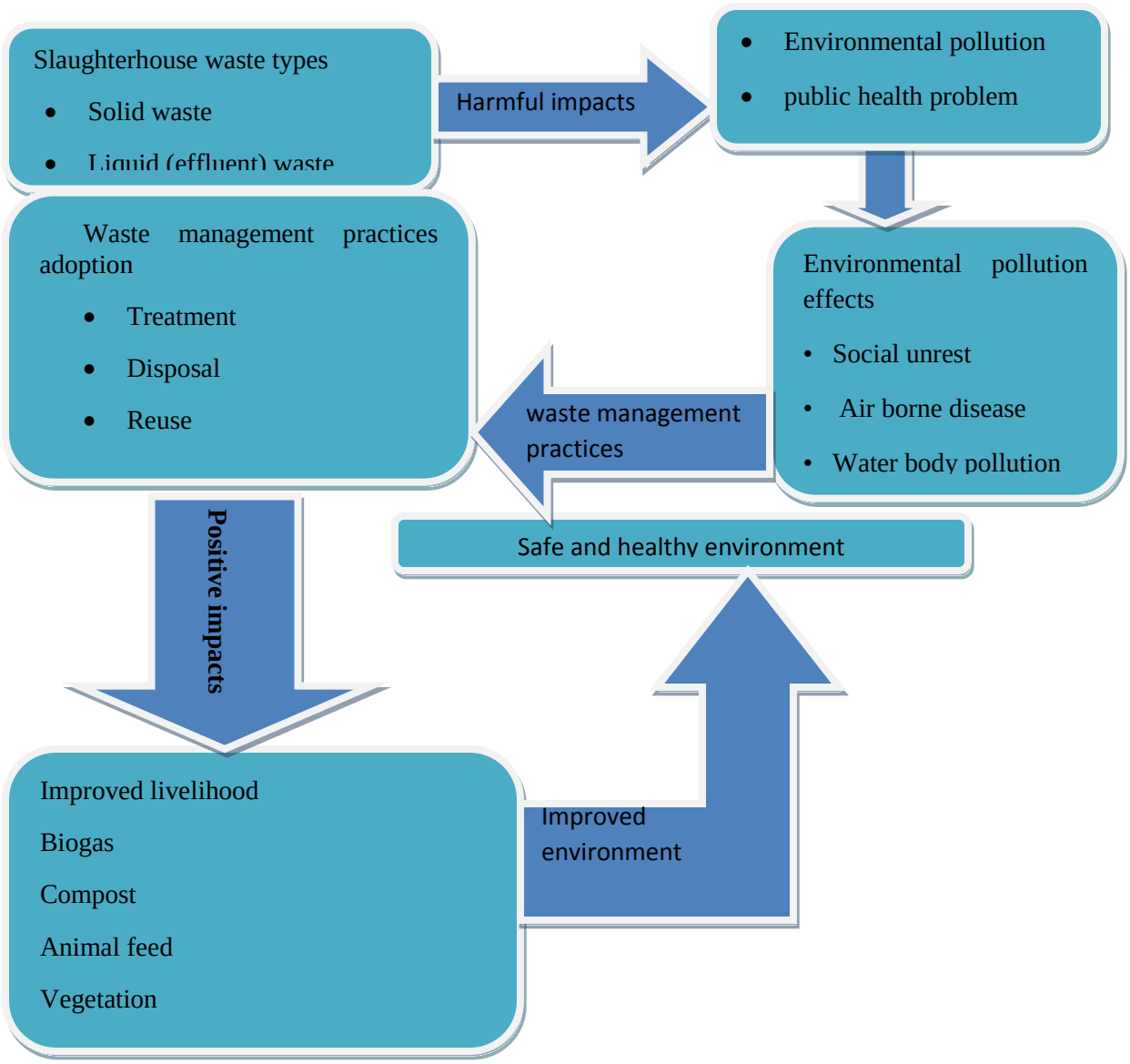
Environmental policy implementation and enhancing regulatory institutions regards waste management in order to safe environment is play significant role. As stated by (Bell, 2002) Most developing countries have long established laws and formal government structures to address their series environmental problem, but few have been successful in alleviating those stated problems associated with waste managements. Additionally; according to (Hwa, 2007) report public participation and education is important in dealing effectively with management of wastes. Indeed according to the report lack of awareness, technical knowledge, legislation, policies and strategies are major factors that could influence for waste management in developing countries.

2.3 Conceptual Framework

The conceptual framework diagram of this study has illustrated in the following figure1. The figure explains the elements of environmental and health impacts of abattoirs waste, management practices of the waste and benefits interconnections. The conceptual framework also indicates the environmental and social physical changes such as; Air pollution, water bodies' contamination, food and waterborne diseases and other health problems.

As revealed in the framework, the detrimental impacts of these adverse factors are environmental pollution which causes social, economic, and environmental and public health problems. The changes due to the adverse impact can be resolved through proper performing of appropriate abattoirs slaughterhouse waste management practice implementation plan and technologies which include, waste collection, transport, treatment, processing, recycling or disposal and monitoring of abattoir waste materials.

In general the conceptual framework of the study describes the fact that positive impacts of waste management practices benefit to improve the environment, soil and agriculture, drink water, animal health and public health of the community such as biogas, irrigation, animal feed and Compost which going to support improvement and foundation of environmental health for favorable life. The conceptual framework diagram of the study fig.1



Source; developed by researcher

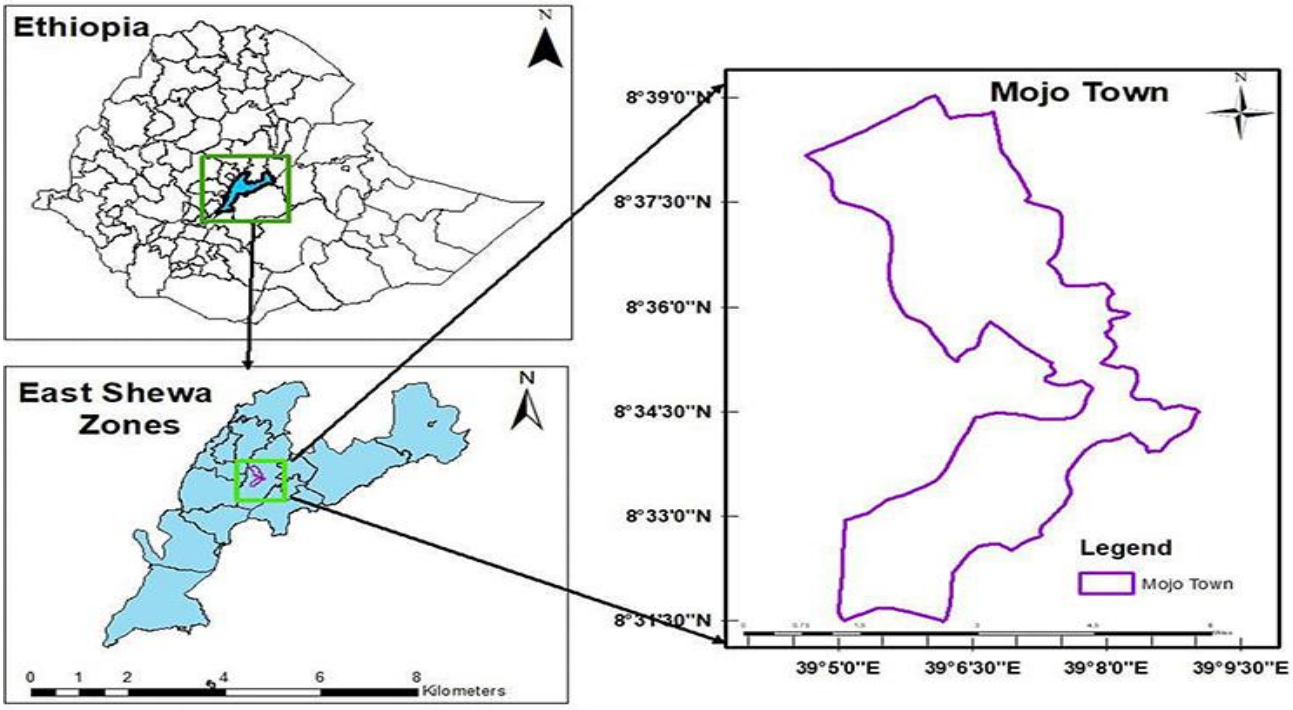
Figure 1 Conceptual Framework diagram of the Study

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Study Area Description

The study was carried out in Oromia Regional State east showa zone Modjo town. The town is found on the east direction of Addis Ababa on the distance of 73km. Modjo town is bounded by Bishoftu town from the west and Adama town from the east. The town also located on the cross-road of Addis Ababa to Adama and Mojo to Hawasa Highway road. Modjo town is found on latitude/ longitude the latitude/ longitude 8 ° 36´ 0´´ N / 39° 7´ 0´´ E with an elevation between 1788 and 1825 meters above sea level (source; metrological agency of the country). According to Ethiopia's centrals statistics agency (CSA, 2008) report the town population size is estimated to 49,521.The town has surrounded by diverse modern industries in addition to the five modern slaughterhouse abattoirs. The town has structured administered into two kebeles. The studied abattoirs such as Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. are located in the town in the different two kebeles.

The Aerial map of the study area (Abate A., et al, 2022)



Source; update from (Abate A., et al, 2022)

Figure2. Aerial Map of the study Area

3.2 Research Methods

3.2.1 Research Design

The research design used was descriptive research design to reach agreement on the waste management practices of Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. abattoirs and its impacts on surrounding environment of the residents located in the radius of 100meter-500meters distance from the studied abattoirs. The method of approach was cross- sectional which has included purposive and random sampling .The purposive approach was employed for the selection of studied abattoirs, while random could be applied for the study sample selection from the total population. This study design offers to the researchers a profile of described relevant aspects of the phenomena of interest from individual, organizational and industry-oriented perspectives. So, this study design empowered the researchers to collect data from a wide range of respondents on the impact of waste management practices in Modjo town determined areas or sites. And this assisted in analyzing the response obtained on how it affects the adjacent community environment and health.

The study was approached a mixed type methods. The first part of the study approach employed through well-structured survey questionnaires approach for (sample households (HHs) respondents and Focus Group discussion for household headed of women and men, elders, public health workers, youth and community representatives). The second method of study approach was key informant interview (KII) and field observation. The KII involved concerned stakeholders such as Modjo town municipality Environment protection, Forest and climate change department, abattoirs staff, public health center of the town, town municipality, kebeles local administrations.

3.3 Source of the Data

Any study's outcome is heavily influenced by the data. As a result, primary and secondary data sources are used to acquire relevant information for this study.

3.3.1 Primary Data

The primary source would be used to obtain in both quantitative and qualitative data. Household surveys should be used to collect quantitative data, whereas FGD, KII, and field observation should be used to collect qualitative data. In this study, data gathering tools such as interviews with pre-determined questions and checklists has been engaged.

3.3.1.1 Household (HHs) survey

Regarding the survey implementation the discussion and agreement was held through briefing of the aim of the study for concerned government bodies, abattoirs staff and community representatives before the survey was conducted. For the survey local languages (Afan Oromo, and Amharic) were approached through translation during surveying. But; the written questionnaires set in English language. The study was mainly based on primary sources of data collected through survey of slaughter houses, sites (abattoir location sites) and household's lives in the vicinity. The study areas' surrounding populations were the most immediately influenced and/or affected by abattoirs' slaughterhouse waste management practice and collecting relevant data based on the study's research purpose and research questions was crucial to launching an effective solution. As a result, the HHs would be chosen methodically depending on their distance from the abattoirs, which would be between 100 to 500 meters with their existences. Structured questionnaires were used to conduct a household survey in accordance with the stated study objectives and research questions. 80 samples of HHs respondents in two kebeles specific sites of Kolba Gode and Kurma Fatole are took part in structured interviews as part of this study. It was primarily carried out to gather information in order to assess the long-term viability of slaughterhouse waste management practices and its potential forwards adverse environmental impacts.

3.3.1.2 Focus group discussions (FGDs)

Entirely the FGDs on existed slaughterhouse waste management practices and its environmental impact implication on Kurma Fatole and Kolba Gode site surrounding communities were summarized by statement as bellows: Despite the fact the importance of focus group discussion in capturing decent ideas on the impact of slaughterhouse waste management practices and its environmental implications by abattoirs is critical.

Participants in the focus group discussion were chosen based on their skill, knowledge, and insight into their beliefs regarding the detrimental effects of slaughterhouse waste management on the environment, with the participation of all household headed of women and men, elders, public health workers, youth and community representatives. Accordingly; there have been three focus group discussions (FGDs) were held with a diverse range of people, including practicing households, elders, women-headed households, health extension workers, community representatives, and youth. Three focus groups with 12-16 respondents were accompanied.

3.3.1.3 Field Observation

Additionally; on the above data collection methods, the personal observation was made by the investigator during the data collection processes and eye witness of the researcher in the course of data collection. Photographs were taken during field observation and might be taken various descriptive notes of what was happening. The study during the observation would be focused on abattoir waste management practices related issues with hygiene and sanitation of the area; to evaluate the overall abattoir facilities and waste management techniques and the impacts of abattoir waste on public health. In the meantime, experts and municipality administrators in the abattoir and kebeles would be briefly interviewed.

3.3.1.4 Key Informant Interview (KII)

The key informant interviewees was employed with the town municipality, Modjo town municipality Environment protection, Forest and climate change department, abattoirs staff, public health center of the town, town municipality and kebeles local administrations whose may have more knowledge of meat byproduct and its adverse effects setup. "Qualitative, in-depth interviews with 5 to 10 people selected for their interviews were provisionally constructed, based on a list of issues to be explored," according to the key informant interviews. Interviewing key informants should be analogous to having a discussion with friends, with the free flow of information and ideas. Interviewing key informants entailed speaking with people who were particularly knowledgeable about a particular area of being under studied platform.

3.3.2 Secondary Source of Data

Secondary data, on the other hand, refer to a type of data that had been previously published and could be obtained from other sources.

These types of data could tell us the existing documented information relevant to the study objectives that could be raw, semi processed or processed ones such as: Witten Documents, reports and publications on the subject matter, Government policies and strategies, Legal frameworks, Concerned Sector offices and other stakeholders; such as NGOs & other Government Organizations of the Kebeles, municipalities and etc.

3.4 Sampling Technique

The study area or Modjo town is surrounded with diverse industries including the five modern abattoirs. According; to the information founded from the town municipality there two kebeles and a number of villages in each kebele which has nominated by local names. For this study Akseker Ethiopia Casing Plc. and Halal Foods Plc. Abattoirs has been selected purposively due to the reason that the availability of waste management technology and methods and there established areas. The two kebeles containing the two sites namely Kolba Gode and Kurma Fatole's are found in different two kebeles that impose to select the kebele purposively.

3.4.1 Sampling Size Determination

The studied abattoirs were found in the two kebeles and sites. The population found in the two sites was the sample unit for the study. But the researcher decided the sample unit of the HHs in the radius of 100 meter to 500 meters distances located from the studied abattoirs. The total numbers of households in the two sites within decided distances of 100 meter to 500 meters for household survey questionnaire respondents were 100. The sample size determination were determined according to (Israel, 2013)'s established table sample for sample size determination of that ±5 precision level and 95% confidence interval. The random sampling techniques was employed by draw lottery method for avoidance of bias among the household headed of men and women to as much as possible realize the equal chances in the response.

Taro Yamane (1967) sample size determination formula was employed for this study

$$n = \frac{N}{1+N(e)^2}$$, where;

n = sample size for the study

N = represents the population size of the study area (N = 100)

e = sampling error or precision level (0.05)

Thus; n = 100/1+100 $(0.05)^2$

n = 80 sample size for the study (HHs).The sample size of the study area was illustrated in table1.

Table 1.Distributions of Sample size of selected households for the study.

S.no	Study site name	Population size	Sample size
1	Kolba Gode (HHs)	25	23
2	Kurma Fatole (HHs)	75	57
	Total	100	80

Source; from study survey (August-September 2021)

The sample size determination was referenced these scholars as additional guidance that; Israel (2013, 2003)'s sample size determination table and Sekaran (2003) stated that a sample size greater than 30 and less than 500 is appropriate for most questionnaires. The strength of any sample depends more on the careful selection of respondents rather than its size (Boreham *et al*., 2020; Mooi *et* al., 2018).

3.5 Data Analysis Method

3.5.1 Quantitative Data Analysis

Quantitative data types are the numerical data item which has gathered from survey questionnaires and secondary data sources. Before analysis the data organization and coding was implemented.

The data would be analyzed based on the data types using excel software 2010 and SPSS software version 22.0 in order to describing key findings, conditions, states and circumstances disclosed from the data. For quantitative data analysis descriptive statistics analysis would be used for percentage, graphical, mean and tabular form of analysis to indicate the severity and depth of problem observed in the study area and major descriptive techniques would be used to summarize and compare the data.

3.5.2. Qualitative Data Analysis

Qualitative data were mostly non-numerical and usually descriptive or nominal in nature. The qualitative data includes key informant interview, focus group discussion, document review and observation would be gone through interpretative analysis focusing on providing meanings and explanations to the perceptions of the informants so as to dig out issues under investigation. This means the data collected were in the form of words and sentences. It was used to investigate the perception of communities on abattoirs slaughterhouse waste management practices as well as to evaluate overall abattoir facilities and waste management techniques against the applicable laws and regulation of the country.

CHAPTER FOUR: RESULT AND DISCUSSION

In this chapter study results and discussion was interpreted in the following major topics. These included; Demographic characteristics of the HHs respondents, Community perceptions, major findings and there detailed discussion parts.

4.1 Demographic Characteristics of the Respondents

Table 2 .Demographic characteristics of the respondents (n=80)

S.no	Variables	No of respondents	percentage	Mode
1	Sex	49	61.25%	1(male)
2	Age	44	55%	30 years
3	Education level	42	52.5%	2(secondary)
4	Marital status	48	60%	1 married
5	Duration of occupant in the area	29	36.25%	3 years

Source; The study survey result (August and September; 2021)

From the total of 80 households interviewed there are about 61.25% were the male headed and the rest 38.75 % of female headed households. From the result understood that the male headed household ranks first. The mean age of the household respondents were 44 (55%) were 30 years. Regarding the education level of the household respondents attended secondary education were 42(52.5%). Belongs to their marital status around 48 (60%) were married. From the interviewed household respondents around 29 (36.25%) of sample households average mean duration of been living in studied area was 3 years (Table2).

4.2 Community perceptions on the impacts of slaughterhouse waste

Table 3 Likert scale perception of respondents

Respondent perception	Strongly disagree		Disagree		Neutral		Agree		Strongly agree			
	No resp.	%	No resp.	%	No resp.	%	No resp.	%	No resp.	%	mean	Std.
Perception on the presence of abattoirs in the area	5	5.6%	19	21.1 %	4	4.7%	36	41.1%	17	18.9 %	1.87	-
Bad odour	4	4.4%	8	8.9%	6	6.7%	49	57.4%	11	12.2 %	1.7	1.26
Coughing disease	1	1.1%	13	14.5%	29	32.3%	25	27.7%	1	1.1%	3.51	1.92
Skin contagious disease	2	2.2%	36	40%	2	2.2%	12	13.3%	0	0%	3.68	1.6
Social unrest	1	1.1%	8	9%	32	35.5%	29	32.3%	0	0%	3.44	2.04
Physical drink water contamination	3	3.3%	13	14.12%	28	31.2%	19	19.2%	0	0%	3.91	1.87

Source; The study survey result (August and September; 2021)

As the study result indicated that about 36 (41.1%) of household respondents surrounding the abattoir was agree with the presence of abattoir in their area. The mean of household respondents agree with the presence of abattoir in their vicinity is 1.7. As a result of slaughterhouse waste management existent practices, the surrounding communities' environment was exposed to different health impacts. Therefore, as study result shows about 57.4%, 32.3 % and 27.7% of the respondents agreed as the community in the area was suffering with the prevalence of difficulty in breathing/respiratory diseases (bad odour), social unrest (disturbance) and coughing diseases respectively (see table3). On the other hand there were about 40% of the respondents disagreed on prevalence of skin contagious diseases.

In the case of coughing, social unrest and physical drink water pollution or contamination due to the slaughterhouse waste management problem 32.3%, 35.5% and 31.2 % of the respondents has been neutral.

To conclude that; from this result due to the slaughterhouse waste management existed practices in the studied abattoirs the majority of the communities criticized that the problem encountered of bad odour, social unrest (economic and social life disturbance) and frequently coughing prevalence of children's were the major impacts that affect the livelihood of the communities surrounding studied abattoirs vicinity(Table3). Thus, it needs an immediate intervention to mitigate the abattoir waste management problem and maintain the critiques of the surrounding community particularly the communities living at the surrounding of Akseker Ethiopia casing Plc. abattoir where the communities densities high and closely approach of the abattoir.

4.2 Overview of the Abattoirs and Waste generated Estimation

Akseker Ethiopia Casing Plc.is amongst one of the export modern standard abattoirs established and operating the slaughtering activities in the Modjo town by the Indian investors. The abattoir has established in 2010 G.c and operating the slaughtering process in two lines (cattle and shoats (sheep and goat)). The abattoir has been situated in Modjo town in Kolba Gode specific site/ village. The abattoir has daily slaughtering capacity of 2500 goat, sheep and cattle per day which could be estimated more than 600,000 animals in annual. From this capacity the goat shared first ranks while, sheep and cattle proceed respectively. In addition to the slaughtering lines the company has installed medium rendering plant and advanced abattoir waste water treatment plant. The other abattoir conducted for this study was Halal Food Industries Plc. The abattoir has been established in 2011 by Pakistani investors in Modjo town at specific area of Kurma Fatole site/village. It has only shoat (sheep and goat) slaughtering lines. The daily slaughtering capacity was 1500 which has estimated to around 360,000 annual slaughtering capacities. The abattoir also installed partial wastewater treatment plant. In general; the two studied abattoirs has 73km distances from Addis Ababa city to the east direction of the country. The area was the passing center of Addis Ababa to Adama high way and Modjo to Hawas high way. The Addis Ababa to Djibouti rail line and the Modjo dry port are both located in the town where the study was carried out in addition to the main road. Table 4a lists the abattoirs' annual slaughtering results for the three years (2018–2020).

Table 4.Three years (2018-2020) Slaughtered animal heads by type.

Abattoirs name	Average slaughtered animals heads per year								
	2018			2019			2020		
	Goat	Sheep	Cattle	Goat	Sheep	Cattle	Goat	Sheep	Cattle
Akseker Ethiopia Casing Plc.	566664	66666	33333	208512	24531	12265	0	0	0
Halal food industries Plc.	145629	16181	0	219478	24386	0	206550	22950	0
Total Sum	712293	82847	33333	427990	48917	12265	206550	22950	0

Source; survey result data (2021)

In both abattoirs the three years slaughtered animal data were goat =1,346,833, sheep = 154714 and cattle = 45598. In general for the past three years a slaughtered animal totally accounts 1,547,145 heads of goat, sheep and cattle in both of studied abattoirs. The animals contribution were goat meat shared in estimation around 85%, the sheep 10% and cattle 5% respectively that based on the customer demand. Although; according to the annual data of Ethiopia' revenue and custom authority data (ERCA report, 2021).The carcass amounts obtained from the slaughtered animals of (table 5) was stated in table 5.

Table 5.Carcass production performance in the studied abattoirs

Abattoirs name	Produced carcass in (ton)								
	2018			2019			2020		
	Goat	Sheep	Cattle	Goat	Sheep	Cattle	Goat	Sheep	Cattle
Akseker Ethiopia Casing Plc.	4401.7	517.8	258.9	1657.5	195.03	97.52	0	0	0
Halal food industries Plc.	1078.73	119.86	0	1625.8	180.64	0	1530	170	0
Total Sum	5480.43	637.66	258.9	3283.3	375.67	97.52	1530	170	0

Source; survey result (August-September 2021)

From the table 5 concluded that the abattoirs have different in annual performance throughout three years data. Akseker Ethiopia Casing Plc. abattoir Zero performance in the year of 2020 that according to the information gathered from the abattoirs it was on maintenance throughout the year due to the reason the company has performed zero performance. In another case; Halal Food Industries Plc. abattoir has no cattle slaughtering line. Indeed for that matter the data of cattle carcass was shows zero performances in all data years. Furthermore; the abattoirs performance in the production of meat from the three species of animal slaughtered in the studied abattoirs in the past three years data result indicated 7128.45 ton meat has produced and exported by Akseker Ethiopia Casing Plc. whereas; the case of Halal Food Industries Plc. was performed 4705.03 tons of meat.

Hence; abattoirs are the plant were the animals slaughtered for human consumption in the meantime the activities undertaken generates the wastes which might be the source of environmental pollution and public health problems. Accordingly; as the data of slaughtered animal shows the number indicates there has expected huge amount of wastes were generated in the studied years.

Therefore, using the formula developed by (Aniebo AO., et al., 2009) for calculating animal waste, it has been determined how much waste each animal species generates in relation to the different forms of waste contents before discussing the abattoirs' waste management practices in studied abattoirs. In line with this, the country's destination market requirements of live animal or carcass sizes in animal species were taken into account while calculating the waste estimation.

The average weight of an animal requested for meat is 125 kg for cow, 6.5 kg for sheep, and 10 kg for goat carcasses, according to data obtained from Ethiopian revenue and custom authorities and survey results. On the basis of; in light of this, table 6 showed the waste estimation result.

Table 6.The three years estimated waste generation in both studied abattoirs

Abattoir waste contents	Unit	In three years estimated waste contents		
		2018	2019	2020
Waste tissue	Ton	879.62	518.28	234.5
Blood	Ton	791.73	466.42	211.07
Intestinal content	Ton	1374.38	809.67	366.4
Waste water	M^3	7883.58	4644.29	2101.77
Mixed solids	Ton	549.69	323.83	146.5

Source; survey result (August-September, 2021)

From the table concluded that the waste items generated from studied abattoirs. According to the data illustrated in the table 6 waste water generate from investigated abattoirs was huge in amount which going to required minimization plan through in using appropriate water standards belongs to the water amounts for each slaughtered animal species in the abattoirs. However; the waste items are listed in table 6 the waste of the abattoirs was classified into two major classes; namely Solid and Liquid (effluent) wastes. In this study the amount of solid waste like horn, office trash and other equipment wastes has not included in this stud due to unavailability of full information and registered data.

Even though; the waste estimation illustrated in table 4c are calculated by using the volume of exported meat from each studied export abattoirs in accordance with slaughtered animal type as per the data obtained from survey and referred of (Aniebo AO, et al, 2011 and Amha S, 2008). Indeed solid and effluent (liquid) wastes are the type of wastes generated from the abattoir during the operations. These wastes need appropriate and well controlled management approaches to reduce or avoid the detrimental impacts on the environmental pollution and public health. Thus; Abattoirs often have difficulties in disposing, treating and processing of these wastes in an environmentally acceptable fashion (Mukhwana, B., 2022). In addition; the environmental policy of Ethiopia (EPE) approved on April 1997; under the proclamation of (No. 513/2007) and (No. 159/2008) regarding to liquid and solid waste management strongly recommended that the factories must make sure their liquid waste meets environmental standards, and obtain a permit before discharging any liquid waste (FDRE, 2008).

Also; factory must monitor the composition of its waste, keep records and report periodically to the Environmental Protection Authority (EPA) and effective management and safe transport of solid waste including hazardous wastes should be required.

4.3 Impacts of slaughterhouse wastes

4.3.1 Impacts on Environment and Public health's

Different sources of pollution contribute to issues with the environment and public health. Furthermore, according to (Singh A.L. *et al*., 2014), the environmental and health conditions were the worse for people who resided adjacent to the slaughterhouse. Likewise; if certain safety measures are not performed, abattoir waste, like any other waste, may be harmful to people and the environment. There are many non-meat items and trash that need to be converted into valuable byproducts for additional agricultural and industrial uses that are scattered throughout some slaughterhouses (Osibanjo, O. and Adie, G.U., 2007). Slaughterhouses utilized high amounts of water for hygienic and sanitation activities that generate huge effluent and suspended solid wastes which could be caused major environmental associated problems (Gauri, S.M., 2006). According to Bello and Oyedemi (2009), various diseases, such as pneumonia, diarrhea, typhoid fever, asthma, wool sorter diseases, respiratory and chest disorders, are connected to abattoir activities, particularly if contemporary or adequate waste disposal systems are not used.

To conclude that the secondary sources of data are obtained from published and unpublished sources stated that slaughterhouses are the source of environmental and public health impacts. Accordingly; the result of this study revealed from the perception of the study area community indicated that the adverse environmental and public health associated problems were bad odour, skin diseases, coughing and changes on drink water physical that leads to foaming.

On the other hand, because of the lack of pertinent and reliable data for the selected interview conducted communities, it is impossible to ensure the perception of the community decided in specific areas that distanced from the abattoirs in town health center. The data's and information affordable in the health center of the town was compiled at kebele level or village (mender) level. While the researcher ensured the perception of the community with regard to the change in the physical water foaming and foul odor produced from the abattoirs through on-the-ground observation, notably at Akseker Ethiopia Casing Plc. abattoir.

For the source of bad odour the reason was rendering plant which has been established and operating in the site. As a result, this study finding on the case of environmental pollution, particularly as it related to drinkable water stream physical changes to foaming and respiratory issues as well as foul odors that made people cough, were in line with previous studies' conclusions. According to previous studies findings, "Abattoirs are public health risks and nuisances because they pollute the air, land, and water and attract other disease vectors, and, the wastes generated from the abattoirs can contaminate ground water and change its quality on flavor, odor, and foaming (Osibanjo and Adie, 2007, Chuckwu, O. 2008), while; living closest to the abattoirs triggered the worst environmental and health concerns (Singh, A.L. et al., 2014). Similar to this, abattoir wastes posed a serious threat to the environment (Bandaw, T. and Herago, T., 2017). To sum up, a thorough investigation supported by laboratory testing on each impact variable was necessary to clearly demonstrate the effects associated with slaughterhouse wastes, both in terms of environmental pollution and public health issues.

4.4 Slaughterhouses waste management practices

4.4.1 Akseker Ethiopia Casing Plc. Abattoir waste management practice

This abattoir was established in 2011 in Ethiopia Mojo town and installed two slaughtering line for cattle and shoats (sheep and goat). The information and data collected during the course of this study's execution demonstrate that it has a daily slaughtering capacity of 2500 animals, which equates to an estimated 600,000 animals annually (Abattoir data and veterinary expert report, 2021). Indeed; major solid and liquid wastes were produced by the abattoir. Among the waste items produced by the abattoir operations were mixed solid waste, blood, wastewater, and intestinal contents. Then; office garbage and regularly produced wastes were therefore excluded from this analysis due to a lack of registered and recorded data for the wastes. The waste management practices in Akseker Ethiopia Casing Plc. Abattoir were discussed as follows:

4.4.1.1 Liquid Waste Management Practices

One of the major global consumers of freshwater used in agriculture and livestock is the meat processing industry. Meat processing plants (MPPs) produce large amounts of slaughterhouse wastewater (SWW) because of the slaughtering process and cleaning of facilities.

SWWs need significant treatment for a sustainable and safe discharge to the environment due to the high content of organics and nutrients. Consequently, SWW treatment and disposal are essential for maintaining safe environment and public health.

During observation the waste management practices, regards to liquid waste management such as; blood, urine, abattoir effluent/waste water were flow in different lines from the beginning sources and finally re-used for different purposes in the abattoir. As a result, according to information and data's collected from the abattoir, the liquid waste generated over the course of the last three years was estimated to be 8813.3 m^3 of wastewater and 885.09 tone of blood.

Accordingly; Akseker Ethiopia Casing Plc. abattoir has established well advanced wastewater treatment plant that was operating and produced clean waters that has used for slaughterhouse sanitation and greenery purposes. Therefore, the abattoir practiced flowing of blood and waste waters in different lines from the base of their generation, where the waste waters was flowing to the treatment plants being its line and finally used for different purposes while the blood was flowing to the prepared equipment's for further blood meal processing after passed the necessary steps. The abattoir's liquid wastes were finally controlled using a re-use management approach and biogas productions from the liquid and mixed solid wastes generated from the abattoir.

To conclude; from yearly total liquid waste generated between 2018- 2020 years more than 93% were subject to primary and secondary treatment plants and then reused for greenery and cleaning purpose in the slaughterhouses and particularly the blood was used for the blood meal preparation by rendering plant. Whereas; the rest that estimated less than 7% liquid wastes generated by the abattoir activities were dumped in shielded septic tank adjusted in the corner of the abattoir compound.

Additionally, the abattoir developed well liquid waste management practices that overcame environmental pollution and public health issues. According to the result of management practices there was no liquid wastes discharged to the environment. Though; the perception forwarded by the surrounding community indicated in table 3 regarding the abattoir has not argued with the ground result. On the other hand, the approach should be an effective lesson for other abattoirs carrying out pertinent operations to keep the environment safe and public health issues.

4.4.1.2 Solid Waste Management Practices

Animal holding areas, slaughterhouse and processing areas, waste treatment facilities, undesired hide or skin pieces, and unwanted carcasses and carcass sections are sources of solid waste at abattoirs. Solid waste should be kept separate from wastewater streams via the use of bucket traps and skips. This decreases the volumetric and organic load on the wastewater treatment stream (Adedipe, 2002). According to the data used for this study in the study period between 2018-2020 years there were estimated 3134.09 ton of solid wastes has been generated by the abattoir. The solid wastes categorized in the studied slaughterhouse were mixed a solid which has included trimmed wastes from meat, bones, horns, intestinal contents, dead animals and condemned carcasses. According to the information obtained from the abattoir and conducted observation indicated the bone waste is currently not a problem because they are often sold together with the meat ; specifically (sheep and goat) the hide and skins collecting for local tanneries as immediate the animal being slaughtered without storing. Also; solid waste management practices of the abattoir condemned carcasses are incinerated, buried, composted, rendered and the left over was transported to common land fill. In some cases, insignificant amount of solid wastes was used to bury in the ground but that was occurred occasionally .There are about five solid waste management practices are being used in the abattoirs by which this study was conducted these are:

4.4.1.2.1 Rendering.

This management practices has used for rendering of bone and heads of the animal. The abattoirs manufactured bone meal and blood meal for the additives of livestock feed. Accordingly; the perceptions of the community living close to this abattoir regarding bad odour which has been the source of respiratory problem and coughing was due to this plant operation as ensured from the ground observation the bad smell released from it has disturb the communities live in the area.

However; the technology and the approach has good it should need silent sound regarding the smell released. So the technology should require implementing environmental policy of the country to ensure the environmental safety and public health concerns that addressed in the proclamation 300/2002 aims to mitigate pollution as an undesirable consequence of social and economic development activities.

Furthermore; the regulatory bodies like Environmental protection and climate change sector found in different levels follow up should be necessary to overcome the problem beside the management practices approached in the abattoir.

4.4.1.2.2 Incerination

This management approach was implemented particularly for condemned meat, dead animal and segregated in special cases that associated diseases.

4.4.1.2.3 Burying

This approach was mostly for none slaughterhouse sourced wastes. Even though; sometimes enforced to bury the condemned or unnecessary organs in the ground that prepared in the compound with the taker off.

4.4.1.2.4 Composting

The abattoir was composting the waste tissues and other manures generated in different slaughterhouse section which has linked in the meat processing chains. This approach was implemented by collecting the waste tissues from the waste water treatment section after screened and the manure from lairage, holding pens and meat byproduct organ processing room particularly from rumen organ. Finally the compost was distributing for the surrounding farmers by low costs.

4.4.1.2.5 Landfill

One of the solid or mixed solid management approach practiced in the studied abattoir was landfill. This approach was implemented in common landfill that provided by the Modjo town municipality for five export abattoirs used together and managed as much as possible with the cooperation of town Environmental protection and climate change staffs.



Figure 3 Akseker Ethiopia Casing Plc. Abattoir Picture

4.4.2 Halal Food Industries Plc. Abattoir Waste Management Practices

Halal Food Industries Plc. Abattoir was one of the companies that conducted for this study. The abattoir was established in 2011 with shoat (sheep and goat) slaughtering line with the daily slaughtering capacity of 1500 that estimated to 360,000 in annual. Indeed the major wastes produced by the abattoir were solid and liquid. It has been generated estimated liquid wastes of wastewater 6768.16m^3 and 679.7 ton blood while 2803.69 ton estimated solid wastes in the past three years between (2018-2020) periods of time.

4.4.2.1 Liquid Waste Management Practices

The slaughterhouse used water for carcass washing, sanitation, and cleaning purposes, according to information collected from the Halal Food Industries Plc. Abattoir. This of utilization water would be generated high amounts of waste water which need appropriate management mechanisms. Additionally; the effluent wastes can be cause environmental harm and public health problems.

The abattoir has implemented liquid waste managements that being the identification of the lines from the source of the liquid wastes in line with the blood. Up until it connected with the wastewater treatment facilities, the blood and waste water lines were separate. The wastes were processed at the wastewater treatment facility in five phases before being used exclusively for greenery.

The researcher determined from the observation that it was the cause of the cough and respiratory issue in this case because the blood and waste water were mixed together and other tissues were present. Similarly, the plant was opened and may have been exposed to flying scavengers for scattering the wastes over the area, which may have been the cause of the environmental and public health issues that the nearby community complained about during the study period. Therefore, in order to address the concerns raised by the local populations regarding the effects of the abattoir waste products, a thorough experimental approach to research should be needed. Additionally, the town's environmental protection and climate change agency's regulatory bodies as well as a higher level commission of the sector's collaboration and cooperation on the enforcement of EIA and EMP implementation should be required.

4.4.2.2. Solid waste management Practices

Halal Food Industries Plc. Abattoir solid waste management practices are;

4.4.2.2.1 Incineration

This type of solid waste management practice was applied for dead and sick animals according to the information gathered from the abattoir staffs.

4.4.2.2.2 Composting

Composting the manure and screened waste tissues raised from waste water treatment plant and used in compound for planation and transported in another plantation for sister companies found in different areas around Addis Ababa city.

4.4.2.2.3 Burying

This approach was employed occasionally for condemned carcass, organ and gut contents in underground.

4.4.2.2.4 Landfill

The abattoir used this management method during extra slaughtering was employed to find access places it transported some parts of the solid waste to the shared landfill provided by the municipality of Modjo town.

Generally; inefficient and improper management of solid wastes creates potential risks to health and the environment (Biswas AK. *et al*, 2010). Similarly, improper means of solid waste disposal greatly affect surface and ground water quality by leachate, and especially the people residing nearby the dump yards who are relying on the ground water as a source of drinking and domestic applications are greatly affected (Sankoh FP, *et a*, 2013).Though; as discussed under both studied abattoirs regarding the solid waste management practices being the study result that were agreed with the earlier studies that suggested the management of slaughterhouse wastes could be better if properly managed through; Composting, biogas production, incineration, rendering and landfilling method etc. (Velusamy M. and Thillai S. N0., 2022).



Figure 4 Halal Food Industries Plc. Abattoir Picture

4.5 Waste management practices in relation to Ethiopia's national standards and regulations

Most developing countries have long established laws and formal government structures to address their serious environmental problems, but few have been successful in alleviating those problems (Bell, 2002). Though; regulations are the most common approach to environmental problems. Standards, bans, permits and quotas are often favoured by policymakers because they promise certainty of outcome, however, this promise may not be realized. In regards to Ethiopia's environmental policy (EPE) approved on April 1997 aimed to improve and enhance the health and quality of life, to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole to meet the needs of the present generation without compromising the ability of future generations. This policy has encouraged the standards and regulations through establishment of government structures to enforce the implementation of EIA and EMP in industries or any investment sectors before and after established.

Therefore; in the context of both studied abattoirs the EIA and EMP document and plan were prepared and issued by government direct responsible bodies. However; the fully implementation of the regulations has weakness as resulted from the study on the area of utilizing waste products in sustainable and advanced mechanism. So, enforcement and encouraging through training, follow up should be needed by local and high level regulatory bodies.

4.6 Factors influencing the Slaughterhouse waste management

Numerous elements, some on the positive side and some on the negative, had an impact on the slaughterhouse's waste management. The availability of technology, the availability of qualified technicians, and the capacity of the slaughtered animal were found to be the elements that had the greatest influence on the study results conducted in both abattoirs. Accordingly, the proximity of the abattoir to community dwellings, which could cause social disturbance and negatively impact the quality of life for those who live nearby, was a factor in Akseker Ethiopia Casing Plc. decision .'s abattoir's to manage the waste generated by its operations.

In light of this frightening situation, the abattoir made every effort to manage the wastes properly. The other was the availability of cutting-edge wastewater treatment facilities and rendering plants, which utilized wastes. Secondly; having access to value-added byproducts from abattoirs including extracted tallow, bone meal, and blood meal at local market .All of these elements have an impact on how the abattoir manages its waste. As the context of Halal Food Industries Plc. abattoir the lack of advanced such as rendering plant, wastewater treatment plant and the lack of experienced technicians towards slaughterhouse waste managements as the study results indicated. On the other hand, the enforcement of laws and regulation which both studied abattoirs having the environmental protection standards and guidelines which derived from the environmental policy of the country approved since 1997.

Therefore; the study result regards to the factors that influence the waste management was approved with the factors identified by (Hwa, 2007) that public participation and education is important in dealing effectively with management of wastes. Certainly; according to the report lack of awareness, technical knowledge, legislation, policies and strategies are major factors that could influence for waste management in developing countries) that the waste management factors were . The other was (Bell, 2002) study result statements that most developing countries have long established laws and formal government structures to address their series environmental problem, but few have been successful in alleviating those stated problems associated with waste managements.. Though; the abattoirs conducted for this study were having lack of fully engagement by the environmental policy derived regulations regarding appropriate waste manages. In general the awareness, education and enforcement of environmental protection regulation and laws are needed intervention of regulatory bodies as well as in the collaboration with national livestock development institute.

CHAPTER FIVE; CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The study was carried out on Akseker Ethiopia Casing Plc. and Halal Food Industries Plc. abattoirs. Both abattoirs are found in Modjo town Oromia Regional state. Descriptive research design was conducted for this study. The study was carried out on the slaughterhouse waste management and its environmental impacts to assess the management practices implemented and identify the environmental impacts associated with the generation of waste by studied abattoirs. To carry out this study 90 sample size head households (HHs) were conducted through survey questionaries' additionally key informant interview, Focus group discussion, and ground observation data collection method were employed. The qualitative and quantitative data analysis implied. The quantitative data's were analyzed by Software package for social students (SPSS) version 22.0. In regarding to the findings the study scope was covered three consecutive years that included from 2018-2020 years G.C. The abattoirs slaughtering performance in the scope was 1,547,145 heads of goat, sheep and cattle's. From the slaughtered number of animal there were about estimated 11833.48ton meat was produced. Indeed in both abattoirs from the slaughtering operation there were estimated 4902.87 ton solid waste (mixed solid waste) and 14,629.64 m^3 wastewater and 1469.22 ton amounts of blood was generated. According to the study result waste water treatment, rendering, composting, burying, incineration and landfill was the waste management practices implemented in the studied abattoir. In respects to the impacts that associated with the slaughterhouse wastes from the interviewed respondents about 57.4%, 32.3 % and 27.7% of the respondents agreed as the community in the area was suffering with the prevalence of difficulty in breathing/respiratory diseases due to (bad odour), social unrest (disturbance) and coughing diseases respectively. According to the researcher of insight obtained from ground observation specifically bad odour was released particularly at Akseker Ethiopia Casing Plc. Abattoir from the operation of rendering plant. In general these studied abattoirs are modern standardized export abattoirs. They are on their ways of understanding and giving due considerations for economic, social and environmental impacts of wastes generated from slaughtering activities and to make this effective in collaboration with regulatory bodies, developing strategies as well legal enforcement of environmental tools as to implement in their premises and environmental trainings are the most crucial points.

5.2 Recommendations

Depend on this study result the following recommendations are forwarded as follows;

- Enforcement of advanced technology forwards slaughterhouse waste management should be required by decision making bodies.
- Biogas production waste management method through anaerobic digestion technology is greatly suggested to produce biogas as fuel for heating and lighting, which will be a great extent to help alleviate shortage fluctuation of electrical energy and conserve environment so as it is practicable and fully competitive with other treatment options for the wastes generated from abattoirs.
- Waste management practice by value addition particularly for blood and bone for making bone and blood meal feed additives in livestock production is advisable in abattoirs waste management plan and strategies that enhance the additional income generation rather than costing for disposal of the wastes.
- Regulatory and development institutional collaboration and cooperation in awareness creation, follow-up and corrective action should be important by Environmental protection and climate change agency and livestock development institute sectors.
- For environmental and sanitation reasons, biodegradable solid wastes and sludge from wastewater treatment systems are recommended to composting which can be done in pits.
- The study was mostly focused on the survey approaches that tried to identify the impacts through the perceptions reflected from the surrounding community and ground observation but this is not enough wisely conducting detailed experimental research approach was needed.
- To sum up developing comprehensive management system for abattoir waste including blood wastes can be further utilized as blood meal, wastewater can be treated and reused for greenery, irrigation and cleaning purposes and intestinal contents can be used for biogas generation and the derived from it also used for natural fertilizer to reduce environmental pollution and public health issues.

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Appendixes : Questionnaires

Guiding questions for all data methods:

Slaughterhouse waste management and its environmental impact implication on surrounding community; the case of Akseker Ethiopia Casing plc , and Halal food Industries plc., Abattoirs at Modjo town Oromia regional state .

SECTION I. Survey interview questionnaires

Instructions: Interviewers are recommended to extend a pleasant welcome to participants and explain that the study's aim is entirely academic. Thank you in advance for your willingness to participate in the interview: Allow the time based on the respondent condition:

Notes

The interview used local languages which translated from English

Abattoir's code ----------

Started time ---------- Ended time ----------

1. Personal data (Residents household head)

1.1. Gender of the respondent: Male ☐ Female ☐

1.2. Education level:

Primary (less than grade 8th) ☐ secondary (9-12th grade) ☐

TVET (level) ☐ 1st degree and above ☐

1.3. Marital status: single married divorced widow

1.4. Length of time (month/year) lived in the area? ----------

2. Sample residents interview

The consequence impact implications of slaughterhouse on the surrounding community according to the respondent;

i. What is your feeling on the presence of the abattoir on the area?

Happy ☐ feeling bad ☐ feeling fair none ☐

ii . Is there the any impacts exist due to the abattoir presence here?

Yes ☐ No ☐

iii. If yes what of impacts happened in the area? Explain:

---

iv. Do you think slaughterhouse sourced waste have adverse impact on the health and environment?

Strongly- agree ☐ Agree ☐ strongly disagree ☐ dis-agree☐

v. What consequence effects happened due to the impacts of wastes in your neighbor's or family? List

a.---

b.---

c.---

d.---

e. ---

f. ---

vi. What do you recommend to overcome the problem for the abattoir owners?

a. ---

b.---

c. ---

3. Conducted abattoirs staff interview

3.1. What is the source of waste in your abattoir?

3.2. Do you categorize the wastes?

Yes ☐ No ☐

3.3. If yes describe the categories of the waste?

3.4. Did you establish slaughterhouse waste management mechanism? If yes what types of existed management practices implemented? Explain?

3.5. Is the implemented practices enough for abattoir and environmental safe? If yes or no your answers explain the reason?

3.6. Did you registered and record the amount of wastes generated from your abattoir for the past three years (2018-2020) the amount of estimated waste according to the waste categories?

3.7. What estimating mechanisms your abattoir used for waste amount estimation? with explanation

3.7. Did you have environmental policy guidelines and tools in your abattoir? How do you implementing it? with explanation

3.8. What feedbacks do you have from the surrounding community regarding your waste management approaches?

Good ☐ V. Good ☐ Fair ☐ Bad ☐

3.9. what do you suggest about the waste management impacts on the surrounding community health and environment? How could it overcome?

SECTION II: Key Informant Interviews

1. How do you explain the existed waste management practices implementing in the abattoirs?

2. What types of waste types discharged from the abattoir to the surrounding community?

3. Does the abattoir have environmental policy in relation to the standards (including EIA and EMP)?

4. How do you evaluate the waste management system implemented in the abattoir regards the commanded by the environmental policy plan?

5. How do you describe the impact implications of abattoirs sourced wastes on the natural environment of the surrounding community?

6. How do you explain regarding abattoirs waste management efficient and effectiveness?

7. What mechanisms implemented regards proper abattoir slaughterhouse management relation established technologies efficiently using by the abattoir?

8. Do you have suggestion for appropriate waste management that abattoirs going to implement it?

9. What suggestions do you have for the government's role in utilizing byproducts and managing waste from the slaughterhouse?

SECTION III: Focus Group Discussion Guide

1. Profile of Focused Group

1.1. Kebele _____ specific village or area _____

1.2. Total Number of group members‟ _____ (Male _____, Female_____)

1.3. Marital status of groups in figure; Married _____, Single _____, Divorce _____ Widow _____

2. Do you have awareness on the concept of abattoirs wastes?

Yes ☐ No ☐

3. What do you feel about the existence of tis abattoir in your area?

Agree ☐ Disagree ☐ Strongly-agree ☐ Strongly -disagree ☐ Neutral ☐ None ☐

4.Is there any problems encountered on your area? What types of problems your family and neighbor's faced? Explanation

5. What do you guess about the source of the problem encountered? Explanation

6. Do you have suggestion to minimize or avoiding the problems?

Thank You