UNIVERSITY OF GHANA

THE ROLE OF GREEN PROCUREMENT IN SUSTAINABLE WASTE MANAGEMENT IN GHANA: A CASE STUDY OF ACCRA BREWERY LIMITED

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY IN CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT DEGREE

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DECLARATION

I do hereby declare that this thesis is the result of my own original research and has not been presented by anyone for any academic award in this or any other University. All references used in the work have been duly acknowledged. I bear sole responsibility for any shortcomings in this document.

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CERTIFICATION

I hereby certify that this research was supervised in accordance with procedures laid down by the University.

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DEDICATION

This piece of work is dedicated to the Almighty God, the source of my strength and knowledge. This work is also dedicated to my son, LeBron Atlegang Kapaya, and all my siblings. I appreciate your love, support, and encouragement. I also dedicate this work to my late parents, who always believed in me. May their lovely souls rest in peace.

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May God shine His favors on all of you!

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LIST OF ABBREVIATIONS

ABInBev	Anheuser-Busch InBev
ABL	Accra Brewery Limited
ADT	Assert Dosing Tank
AET	Anaerobic Effluent Tank
BBT	Bright Beer Tank
BF	Biofilter
BOD	Biological Oxygen Demand
BP	Belt Press
BTS	Biological Treatment Section
CDT	Caustic Dosing Tank
CS	Caustic Scrubber
CH_4	Methane
COD	Chemical Oxygen Demand
CO_2	Carbon dioxide
DT	Denitrification Tank
EP	Effluent Pit
EQ	Equalization Tank
FMEUD	Federal Ministry of Environment and Urban Development
GHG	Greenhouse gases

HGBT	High Gravity Beer Tank
IC	Effluent Channel
IP	Effluent Pit
IISD	International Institution for Sustainable Development
KDP	Kieselghur Dosing Pot
KF	Kieselghur Filter
LS	Lamella Setter
MDG	Millennium Development Goals
NRBV	Natural Resource-Based View
NT	Nitrification Tank
O_2	Oxygen
PET	Polyethylene terephthalate
pH	Potential of hydrogen
RP	Rinse pit
SDG	Sustainable Development Goals
TSS	Total Suspended Solids
UASB	Anaerobic slash blanket
UN	United Nations
UNESA	United Nations Economic and Social Affairs
UV	Ultraviolet disinfection unit

VFA	Volatile fatty acids
WHO	World Health Organisation

ABSTRACT

Some environmental impacts such as pollution and widespread of biodiversity loss can be related to the activities of an organisation supply chain. Manufacturing companies such as breweries, instead of investing in environmentally friendly technologies which can help in the prevention of waste at the source, generate large amounts of unnecessary emissions and wastes. The Accra Brewery Limited (ABL) uses a lot of raw materials; it is energy-intensive and generates a lot of waste and emissions. For more sustainable use of products and services, the best environmental tool to be used as a waste prevention strategy could be green procurement. Through a qualitative research approach and a case study, this study attempts to (i) identify waste generated in the brewery (ii) explore sustainable waste management practices adopted by the brewery (iii) examine the role green procurement plays in the sustainable management of waste in the brewery. The study purposively sampled 18 participants from ABL consisting of management and frontline staff. From a thematic analysis of both primary and secondary data, the study found that the solid and liquid waste generated in the brewery are mainly from the brewing and packaging process. The study shows that the brewery uses a wide range of sustainable waste management practices. It also observed that green procurement plays an important role in solid waste, liquid waste and emission level reduction and waste prevention in the brewery. The results indicate that green procurement can help the brewery to achieve sustainable waste management. The study recommends that the organisations in the brewery industry need to adopt green procurement practices in all their operations and processes as green procurement has a role in the prevention and elimination of waste.

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.0 Introduction

This introductory chapter presents the background to the study, the problem statement, the research objectives, the research questions, the significance, scope and limitations of the study, and lastly a section on chapter disposition which highlights the organisation of the study.

1.1 Background

Green procurement and green market expansion are considered to contribute to sustainable development (Fet, Aspen, & Ellingsen, 2013). Currently, the Sustainable Development Goals (SDGs) are considered as a means of ensuring the economic, social and environmental development of the world. 'SDG 6 Clean Water and Sanitation', 'SDG 9 Industry, Innovation, and Infrastructure', 'SDG 12 Responsible Consumption and Production' and 'SDG 13 Climate Action' are the main SDGs which are in line with the topic under study. The main indicators of these SDGs which are in line with the study are (IAEG, 2016):

- **SDG 6.3:** "By 2030, improve water quality by reducing pollution, eliminating dumping and minimising the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally".
- **SDG 9.4:** "By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities".

- **SDG 12.4:** "By 2030, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimise their adverse impacts on human health and the environment" (see Figure 1).
- **SDG 12.5**: "By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse".
- **SDG 12.7:** "Promote public procurement practices that are sustainable, in accordance with national policies and priorities".
- **SDG 13.3**: "Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning".

Figure 1 Sustainable Development Goals

Source: UN (2018)

Waste generation is rising around the world (World Bank, 2012). For example, according to the World Bank 1.3 billion tonnes of solid waste per year, was generated in 2012 by the world's cities which amounted to a footprint of 1.2 kilograms per person per day. By 2025 the

generation of waste is expected to increase by 2.2 billion tonnes (World Bank,2012). Developing countries compared to developed countries are more affected by the mismanagement of waste. These practices result in serious environmental consequences and health problems. When wastes are not properly managed they serve as a breeding ground for disease vectors and generation of methane (CH_4) which contributes to climate change (Subramani, Florence, & Kavitha, 2014). Due to an increase in the quantity of waste and inadequate understanding of waste management, managing waste has become an issue for many developing countries (Guerrero, Maas, & Hogland, 2013). Sustainable waste management is also important for achieving sustainability in Ghana. Sustainable waste management is achieved when there is a reduction of the amount of natural resources consumed when materials taken from nature are reused and when waste created is kept to a minimum.

To achieve a sustainable society, the UN global action plan, Agenda 21, emphasizes greatly on cleaner production, waste minimisation, pollution control, and resource conservation (UNESA, 1992). Due to climate change, pollution, globalisation, and concerns over the security of supplies, societies are becoming more interested in sustainable development. After the Rio declaration, some countries made progress and some structural changes were made to support sustainable development.

The environmental challenges that result from an organisation's supply chain are many and include biodiversity loss, global warming, pollution of waterways and reductions in air quality. Instead of capitalising on technologies which are cleaner to prevent the generation of waste from the source. Manufacturing companies are large producers of unnecessary waste or emissions. (Klassen, 2000).

Relatively speaking breweries generate large amounts of wastes (Igarashi, Boer, & Fet, 2013). It is worthy to note that in the world, beer is one of the most consumed beverages (Olajire, 2012). The global growth in beer production ranges from two to five percent per year led by

Asia, Brazil, and Africa. By-products and wastewater are unavoidably produced during the process of brewing beer (Kerby & Vriesekoop, 2017). If this waste ends up in landfills it produces CH_4 a greenhouse gas at least 20 times more than carbon dioxide (CO_2) (IPCC, 2007). Brewery industries have a very high waste collection frequency mainly because of the large quantities of waste they produce on a continuous basis (Kaseva & Mbuligwe, 2005). The challenges faced by the brewing industry are by-products, solid waste, wastewater, water consumption, energy consumption, and emission despite the technological improvements over the years (Olajire, 2012).

Breweries have tried to make use of the brewery by-products in a sustainable manner, because of increasing environmental regulations and concerns (Kanagachandran & Jayaratne, 2006). Wastes disposal and water management have become an important facet of brewery operations and a significant cost factor (Fillaudeau et al. 2006).

In recent years, the traditional disposal option for solid waste has become more expensive. The old landfills have closed because there have been filled up and the few new landfills are located quite a distance. Therefore, this makes transportation costs to the final disposal area to increase. Therefore, breweries are finding other means to minimise waste generated as these can lead to reduced operational costs. Furthermore, a significant source of revenue can be created when recyclable materials are kept out of the landfills.

In 2002, a call was made by the World Summit on Sustainable Development to encourage policies on purchasing that promote dispersion and development of environmentally sound services and products (Walker & Brammer, 2009). In this regard, international agencies, private companies, and a number of governments have included environmental and social criteria within their purchasing processes in order to achieve sustainable development goals (Nikaji & Worrel, 2012; Brammer & Walker, 2011).

Governments in different countries have been encouraged to use green business approaches to deal with the escalating environmental challenges. This type of green business approach is known as green procurement; sustainable procurement; green purchasing; eco-procurement; environmentally friendly purchase; or environmentally responsible procurement. The terms above refer to selecting environmentally friendly services and products compared to competing services and products (Clement, 2007).

Traditionally procurement focuses on the value for money. Green procurement aims to reduce the adverse impact on the environment by saving costs for firms and society at large by integrating environmental considerations into the procurement process. The most effective way to demonstrate environmental responsibility is to reduce consumption. Green procurement refers to 'the acquisition by diverse organisation of goods and services (as well as utilities and work) to generate value for money over a complete production life cycle with particular regard to organisational benefits as well as social and economic advantages and reduce adverse environmental impacts' (Darnall, Jolley, & Handfield, 2008).

Green procurement has been recognised as an instrument that model the decisions of supply selection, compliance with environmental regulations, pollution reduction, waste management and disposal (Testa et al., 2012). Globally, it has taken over as the new competitive leading edge (Rao & Holt, 2005). The need to improve organisational efficiency, reduce waste, overcome supply chain risk and achieve competitive position has made companies to start considering environmental issues form a competitive viewpoint. In the developing world, green procurement is an unused and unknown tool, but it can be very beneficial to any organisation that uses it.

1.2 Research Problem

Post-millennium development goals (MDGs) regime and the ushering of sustainable development goals have reiterated the need for the private sector to step up its environmental responsibility. As a result, scholars have underscored the need to investigate emerging corporate practices such as, inter alia, corporate sustainable practices, corporate citizenship, green procurement and sustainability mainstreaming. The brewery industry is energy-intensive, natural resource-intensive and water-intensive. However, it has generally been less studied and most specifically the uptake of sustainable environmental practice. Breweries represent a good area to be investigated because they are understudied (Murray & Kline, 2015). Doubtlessly, sustainability has been practised in the brewery industry. There are copious of evidence indicating that within the brewery industry "Spent Grain" henceforth referred to as waste has been directly reused as an animal feed or soil improver (Kerby & Vriesekoop, 2017). Though sustainability has been practised within the industry there is evidence of mismanagement of waste. For example, Khidzir et al. (2010) found that only 15% of waste generated from the brewery industry is sold and recycled as animal feed while the rest is discarded to landfills. The disposal of waste into landfills degrade the environment and releases emissions (Kerby & Vriesekoop, 2017).

In some areas, materials end up in landfills because recycling and reuse are not that advanced. Environmental management problems could occur in the future because salinity may be increased due to a higher rate of organic waste dumped into landfills (Thomas & Rahman, 2006). Flood-endangered areas can harm people if the wastewater is not treated (Grunde, Li, & Merl, 2014). Given the fact that there has been a long history of sustainable environmental practices within the brewery industry and yet evidence of bad disposal of waste exists, it is imperative to investigate the extent to which corporate environmental practices are taken-up within the industry.

Apart from efficient waste management practices, there is increasing uptake of green procurement practices across the industry. With the growing popularity of corporate eco-friendly practices and sustainability movement, brewers all over the world are embracing green procurement practices to mainstream eco-friendly practices across their production and supply chains (Sarhaye & Marendi, 2017; Gatari & Were, 2014; Nderitu & Ngugi, 2014). Despite this, there have been limited studies on the uptake of green procurement in an industry that has embraced the concept. As a result, the underlining motivation driving actors within the industry to embrace green procurement practices including all other eco-friendly practices are less known. Though the drivers of green procurement within the private sector have received some good amount of research focus, one cannot assume that the general finding within the private sector mimics those specific to the brewery industry. Such an attempt might blur micro issues that are typical of only the brewery industry.

This research, which uses a case study from global south (Ghana), is even more important because the few studies on sustainable corporate practise within the brewery industry (e.g green procurement, corporate stewardship) have tended to focus on the global north including, inter alia, the USA (Coggburn, 2004), Canada (Hartshorn et al., 2005), Germany (Gunther & Scheibe, 2006), UK (Hall & Purchase, 2006), and Sweden (Varnas et al., 2009). Relatively, there is little research existing on the brewery industries in Africa.

This extant literature on sustainable corporate practices within the brewery industry or within the emerging field of sustainability, circular economy, green procurement, green supply chain, and sustainable consumption is predominantly quantitative (Neupane, et al., 2014; Walker & Brammer, 2012; Walker & Brammer, 2009). Though the use of the quantitative method in these studies allows for generalisation and testing of theory to enhance practice, they fail to account for context-specific issues and micro factors that overtly or covertly moderate corporate organisations to adopt sustainability practices. In other words, existing studies may have

omitted salient organisational level issues that are specific to a given context. For example, Cheng et al. (2018) recommended the use of in-depth case studies built on strong qualitative assumptions in order to make a significant contribution to existing literature. Based on this premise, the study aims to investigate the role of green procurement in sustainable waste management in breweries using a qualitative approach.

1.3 Research Objectives

To address the research problem stated above, this study aims at investigating the role of green procurement in sustainable waste management in Accra Brewery Limited (ABL) in Ghana.

Specifically, the study seeks to:

i. Identify the nature of waste generated in the brewery.
ii. Explore sustainable waste management practices adopted by the brewery.
iii. Examine the role green procurement plays in the sustainable management of waste in the brewery.

1.4 Research Questions

In the context of the research background, problem and objectives stated above, this thesis addresses the following research questions:

i. What type of waste is generated at ABL?
ii. What kind of sustainable waste management practices are adopted by the brewery?
iii. What role does green procurement play in the management of waste in the brewery?

1.5 Significance of the Study

i. Policy

Understanding the green procurement practices adopted by the selected organisation would help policymakers and other stakeholders dealing with the environmental affairs to come up

with programmes and policies that would stimulate the sustainability and growth of the economy. The study would provide relevant knowledge including relevant information for policymakers.

ii. Practice

The study would enable both the public and private sector procurement managers to be proactive in their sustainability practices. It could help organisations to meet environmental goals such as recycling and improving water and energy efficiency. Jobs could be created through the use of green technologies and create markets for recycled products. It would increase social welfare by promoting local suppliers who are committed to local communities and environmental responsibilities. This study is not only important for Ghana, but it may also be an example for other countries.

iii. Research

The study contributes to the existing body of knowledge in the area of green procurement and sustainable waste management. This study provides insight into what the brewery is currently doing in terms of waste management and green procurement practices. By investigating the role of green procurement in sustainable waste management in the brewery, this work may guide future studies on areas to attend to in relation to the gaps and limitations highlighted by the study.

1.6 Scope and Limitation

The study is limited to analysing waste generated in Accra Brewery Limited (ABL); exploring sustainable waste management practices in ABL; examining the role of green procurement in sustainable waste management in ABL. The study used ABL as a case study drawing respondents from the company. The researcher considered this brewery since it is a subsidiary of Anheuser-Busch InBev (ABInBev) the worlds' largest brewer which thrives to achieve

sustainability in all its operations. The researcher selected management staff and frontline workers as the respondents from the procurement, environmental, sustainability waste and production department. The study used a single case study, therefore, it may not be appropriate to make generalisations about the findings. Nevertheless, the findings of this study are very important for knowledge building.

1.7 Organisation of the Study

This thesis is divided into five chapters. Chapter one consists of the research background, research problem, the research objectives and questions, the significance of the study and the organisation of the study.

The second chapter focuses on the literature review. This involves a review of the theoretical and empirical literature, an analysis of the theory adopted for the study as well as an evaluation of empirical studies.

Furthermore, chapter three looks at the methodological approaches which deal with the following areas: the study area, research approach, study design, sampling techniques, sample size, the data collection instrument, data processing, analysis, and ethical considerations. The fourth chapter consists of data presentation, analysis, and discussion of the findings of the research, taking into consideration the research aim and objectives. Lastly, chapter five presents the summary, conclusion, and recommendations for future research.

1.8 Summary and Conclusion

In summary, this chapter lays a background to the research work that seeks to examine the role green procurement plays in sustainable waste management especially the concept of waste minimisation.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This section of the study reviews related theoretical and empirical literature on green procurement and sustainable waste management.

2.1 Definition of Concepts

2.1.1 Waste

The planet is changing due to urbanisation, natural resource depletion, technology development, an increase in population and pollution. Due to industries and technologies in many developing countries, the generation of waste has increased (Kgosiesele & Zhaohui, 2010). Waste is a result of human activities. The changes in people's lifestyles especially those with a higher income, increase the consumption of products that have shorter lifespans and higher volumes. Municipal authorities are burdened by these products as well as changes in food choices which add to the volume of waste (Zhu et al., 2008).

According to Wilson et al. (2006), "waste is anything which is no longer useful and needs to be disposed of". Waste is a material used up or leftover or discarded in the course of domestic, commercial, industrial or other activities. When waste is incorrectly handled, stored, collected and deposited, it can cause a threat to human and animal health or the environment, and it becomes very expensive to remove. The production of greenhouse gases, the release of pollutants into the soil and watercourses and the loss of valuable resources as well as raw materials are a result of disposing waste directly in landfills. Waste must be regarded as a potential resource so it is essential to make good use of it.

2.1.2 Sustainable Waste Management

Economic development, urbanisation, and population have resulted in the growth of concerns in the field of waste management (Tulokhonova & Ulanova, 2013). Sustainable development incorporates the establishment of sustainable waste management practices and the reduction of polluting emissions (Belboom et al., 2013). With reference to sustainable waste management, sustainability is explained as the social, environmental and economic impacts of waste management options (Soltani et al., 2016). Waste management is mainly a method that directs institutions or management to act for sustainability by demonstrating their abilities to protect and use current resources (Orhan, 2011). Therefore, a sustainable society should not generate waste which exceeds the capacity to manage (Cucchiella et al., 2014).

Developing countries are faced with challenges in relation to waste management which includes crude open dumping, low collection coverage, irregular collection services, control of informal waste picking or scavenging activities and the breeding of flies and vermin (Manaf et al., 2009). The main purpose of waste management is to protect human beings and the environment (Stanisvljevic et al., 2015). Therefore, all activities that seek to minimise the aesthetic, environmental and health, environmental impacts on waste are referred to as waste management (Zhu et al., 2008).

Sustainable waste management is achieved when waste generation is minimised when waste is reused, recycled or recovered to produce energy (Singh & Ordonez, 2016). An important factor for sustainable development according to Cherubin et al. (2009) is effective and affordable waste management. Thus, sustainable waste management is crucial to achieving sustainability. Sustainable waste management can be simply defined as the efficient use of the material resource to reduce the amount of waste generated and produced, in a way that contributes to sustainable development goals. Waste reduction or waste minimisation and waste recycling are the most sustainable waste management practices.

The proper approaches used for managing waste are explained with the help of the sustainable waste management hierarchy. The hierarchy is an internationally and nationally accepted guide used in waste management practices for achieving environmentally optimal outcomes (Mariwah, 2012). The five steps of the sustainable waste management hierarchy are shown in Figure 2.1. It orders the sustainable waste management practices from most to least sustainable.

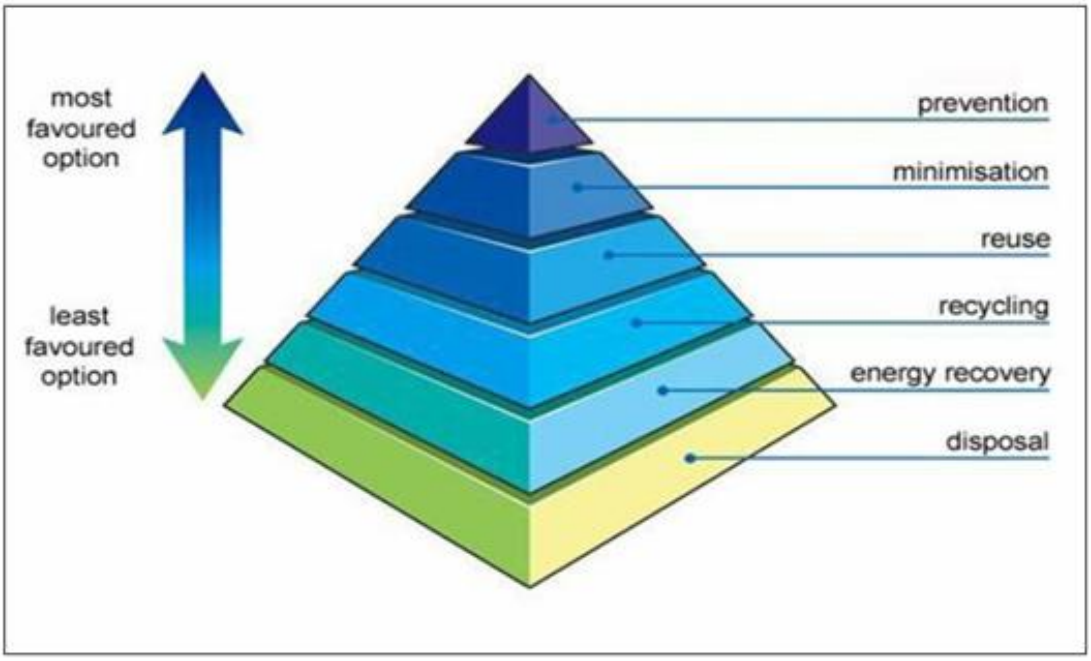

Figure 2.1 Sustainable Waste Management Pyramid

Source: Adu-Boahen et al., (2014)

Figure 2.1 represents the Sustainable Waste Management Pyramid with the least preferred or sustainable option in waste management being disposal into the landfill and the most preferred or sustainable in waste management being waste prevention. Further details are presented as follows:

(i) Prevention

It is the highest point in the hierarchy and the ultimate challenge to zero waste. Waste prevention is most effective in a product life cycle, especially during the product design and production process. It emphasizes that waste needs to be eliminated at the source and people

should think before they can purchase a product or they can simply utilise the available products. The waste management hierarchy shows that the best way of managing waste is through prevention because it cuts down the waste management cost (Singh & Sushil, 2017). Every material good produced has an energy 'price tag', therefore the rate and the volume at which resources are being channeled in the economy needs to be slowed (Adu-Boahen et al., 2014). There is a need to move to the highest end of the hierarchy beyond recycling to reuse, reduce and prevent in order to address climate change agenda and zero waste.

(ii) Minimisation

In this concept, the life cycle impact of a product is minimised or avoided (Gertsakis & Lewis, 2003). Waste minimisation emphasizes that there should be a change in the materials that companies use for the production of their products to make sure the by-products are the least toxic. In order to achieve waste minimisation, the waste hierarchy suggests that the influence of practical decisions is an important aspect at various stages of product life (Suresh & Vijayakumar, 2011).

(iii) Reuse

Fischer (2011) defines reuse as, "usage of discarded products or components without any change done to its function and without any processing". Reuse allows the materials to be used again instead of being disposed of in the disposal system. A lot of items can be reused without any processing done to them. Reuse requires less energy than recycling by designing out waste before it is created (Adu-Boahen et al., 2014). This concept is the most dominant concept in the waste management hierarchy because for further usage of a product new or additional resources are not needed. Therefore, it reduces the cost of developing a product and benefits the environment as it leads to a reduction of new resources in manufacturing a product (Suresh & Vijayakumar, 2011). Reuse does not involve changing the item. For example, typical reuse methods are the deposit refund scheme for glass bottles or polyethylene terephthalate (PET)

water bottles, steel drums that are used as compost bins, old tires that are used in fences or as boat fenders, plastic bags that are used as liners for household waste bins (Zhu et al., 2008)

(iv) Recycling

Recycling is a process of turning a discarded product into raw material and produce a new or the same product (Fischer, 2011). Waste can be recycled in many ways; for example, waste can be converted into electricity (Adu-Boahen et al., 2014). The most commonly used products for recycling include metal cans, glass bottles, paper, and a variety of plastics among others. Organic matter can be recycled to produces compost which improves upon agricultural production as the compost can be used in gardens (Zhu et al., 2008). Marginalised social groups and the poor usually carry out informal waste recycling to generate money and for survival means whereby they resort to waste picking/scavenging (Wilson et al., 2006).

(v) Energy Recovery

Energy recovery is a process whereby some form of waste is generated to form fuel and energy (Cucchiella et al., 2016; Mastellone, 2015; Rada, 2014). These wastes are converted into useful resources either through thermal or biological treatment (Suresh & Vijayakumar, 2011). Incineration and pyrolysis are the thermal processes while anaerobic digestion, closed composting and open composting are the biological processes.

(vi) Disposal

Disposal is the least sustainable in the waste management hierarchy. The purpose of waste management is to remove wastes from people's settlements. For most developing countries waste is disposed of in landfills, unlike the developed countries that are moving towards resource recovery. Some types of waste are not easy to reuse and recycle such as hazardous waste; therefore, the last priority is disposal. Landfilling and incineration are the most common disposal methods. Zhu et al. (2008) suggest that people and the environment should be

protected from the negative impacts of wastes by designing and operating the disposal site as a sanitary landfill. He further argues that if the landfill is properly managed, methane gas can be recovered.

2.1.3 Green Procurement

With growing frequency and urgency, developing countries are recognising the need to come up with strict standards for environmental stewardship. There is a spurring issue for countries to improve their environmental operations due to environmental challenges both locally and globally. The demand for countries to adapt to a greener approach is rapidly increasing. Therefore, in response, countries are committing to institute more sustainable practices to avoid the cost of environmental degradation within the context of sustainable development. What countries need is to incorporate environmental strategies and tools into their daily current practices with a minimum effort, one such tool may be green procurement it can be used to reduce environmental pollution (Chin et al., 2015).

Green procurement is an approach that incorporates people, organisation, technology, and processes. Other terms that are used to refer to green procurement are affirmative procurement, eco-procurement, environmentally-friendly procurement, sustainable procurement, environmentally preferable purchasing, and other similar terms. The above-mentioned terms resemble the following:

- Pollution prevention; for example, avoidance of waste, source reduction and waste reduction (sustainable waste management)
- Life-cycle perspective; for example, looking at the costs beyond the purchase prices; and
- Resource efficiency; for example, giving preference to reusable content and considering water and energy consumption.

Green procurement is an approach to integrating environmental criteria into all stages of the procurement process, thus promoting the development and the spread of environmentally sound products by searching for solutions which throughout their whole life cycle have the least possible environmental impacts (Bouwer, et al., 2005). While making procurement decisions, green procurement considers social, economic and environmental parameters (Bag, 2016). Different authors have used different terminologies and have provided several definitions of green procurement. Even though the concept of green procurement is circulating, the notion of greenness in relation to suppliers has not been outlined in-depth (Nagel, 2003).

Zsidsin and Siferd (2001) present a holistic definition of green procurement as "Environmental purchasing for an individual firm is the set of purchasing policies held, actions taken, and relationships formed in response to concerns associated with the natural environment. These concerns relate to the acquisition of raw materials, including supplier selection, evaluation, and development; suppliers' operations; inbound distribution; packaging; recycling; reuse; resource reduction; and final disposal of the firm's products". Large and Thomsen (2011) define green procurement as the inclusion of environmental analysis into actions, programmes and purchasing policies. Zsidsin and Siferd (2001) and Large and Thomsen (2011) provide similar definitions.

Carter and Carter (1998) explain green procurement as a purchasing process in supply chain management activities; for example, environment design and life-cycle analysis that facilitates resource reduction, recycling, and reuse. According to Song et al. (2017), green procurement can be related to the management of green supply processes, such as implementing pro-environmental projects and assessing suppliers to see how well they manage the environment. The green procurement process requires an assessment of a product to be produced in an organisation to test for the environmental consequences of the product life cycle at various

stages of its life cycle. The green products contain recycled content, are reusable, limit toxic by-products, improve energy efficiency and reduce waste.

Amemba et al. (2013) define green procurement as environmental procurement activities such as reduction, reuse and recycling of materials in procurement. Toke et al. (2012) indicate that it can be a participative approach where organisations jointly develop cleaner technology and processes with their suppliers. They suggest that organisations can audit their suppliers to check if they are complying with the environmental requirements and standards so as to achieve green procurement. This study adopts Coddington's (1993) definition which defines green procurement as "the purchasing of products or services which have a lower impact on the environment over their whole life cycle than the standard equivalent".

2.1.3.1 Green Procurement Practices

In the manufacturing industry like the brewery, green procurement encompasses environmentally friendly process design and products, distribution of raw materials, storage, packaging, finished goods and transportation, and product disposal or recovery and packaging of returned discarded after use. Environmentally friendly raw materials should be used to design products. Green et al. (2012b) and Zhu et al. (2012) argue that the products should contain recyclable and biodegradable materials if there is a need to recycle or dispose of the product after use. According to Wong et al. (2012), Hollos et al. (2012) and Shi et al. (2012), the product design should be easy to disassemble for reuse and recycling. Furthermore, Kumar et al. (2012) state that a life cycle analysis should be conducted on the products to assess the environmental impact through its various stages of the life cycles by the firm together with its supply chain partners.

Various researchers argue that the manufacturing process should be in a way that resource consumption and energy, air emissions and generation of liquid and solid waste are minimised

(Wong et al., 2012; Giovanni, 2012; Narasimhan & Schoenherr, 2012). Zurich reported that by switching to recycled content paper, carbon dioxide (CO_2) emissions were reduced by 41.5 tons, energy consumption was reduced by 1.56 gigawatt-hours and 44.2 tons of waste was eliminated and 2,950 cubic meters of wastewater was reduced (Erdmenger, 2000). Green et al. (2012a), suggest that firms should use alternative renewable sources of energy such as wind and solar energy instead of conventional sources such as natural gas, oil, and coal.

The distribution activities, transportation, storage, and packaging should be done in an environmentally friendly way. The critical issues in distribution are identifying safe storage and warehousing. According to Rao and Holt, (2005), environmentally friendly modes of transport should be explored such as waterways and railways rather than air and road transportation. Gunasekaran and Spalanzani, (2012) suggest that firms should ship full truckload instead of less than the truck road for transportation by road. Packaging materials should be lightweight and minimal (Carter et al., 2000) and should have less impact on the environment (Shi et al., 2012) and should be recyclable (Zhu et al., 2012).

Brammer and Walker (2011) stated two elements of green procurement practices as buying locally and buying from small suppliers. Islam et al. (2017) in their study adopted the following buying from small and local suppliers as green procurement practices and adopted the following; the design and packaging of products, products' potential for recycling or reuse, safety, labor rights, carbon reductions in the movement of products to facilities, operational excellence, product innovation, leadership, willingness of suppliers to commit to waste reduction goals, religion, and culture as dimensions of green procurement.

2.1.3.2 Benefits of Green Procurement

Salam (2008), outlines the benefits of green procurement as;

Natural Conservation: Generally green products are manufactured in a sustainable manner from the process of acquiring raw materials, product design and process, transportation, use, and disposal. The products also consume less energy and most importantly natural resources.

Cost-saving: Savings can be made in fuel, water, energy, and other natural resources because fewer resources are required to manufacture green products. Furthermore, the products can be easily reused, recycled and disposed of because they consist of natural materials.

Waste reduction: Green products may use less packaging or contain recycled materials because the products are usually designed with the aim to reduce the amount of waste created.

Decrease hazardous or toxic levels: Green products are less hazardous and toxic and cause less impact on the environment.

According to Kennard (2006), the importance of implementing green procurement in an organisation includes: compliance with environmental and social legislation, cost control, improved reputation, improved external and internal standards through performance assessment, business risk management, and local business community involvement.

2.1.3.3 Challenges of Green Procurement

Environmental initiatives have both advantages and disadvantages. However, disadvantages are not a threat but an opportunity to implement green procurement. Developing countries can benefit from the mistakes and knowledge gained by developed countries. Adapted from the International Institution for Sustainable Development (IISD, 2013) the challenges of green procurement include; price, availability of green products, purchasing habits, lack of corporate commitment, the proliferation of standards, unreliable information, insufficient knowledge, and complex supply chain.

Walker et al. (2008) suggested that there are internal and external barriers to green procurement. The internal barriers include lack of legitimacy and costs while the external

includes poor suppliers' commitment, regulation, and industry-specific barriers. A study by Bouwer et al. (2006) indicated the major barrier is that green products cost more than conventional products. Futhermore, Brammer and Walker (2011), indicate that there is little regard for social or environmental impacts of the cost of the green products in relation to the cost of training employees. Ashenbaum (2008), pointed out that most of the time upper management sees the implementation of green procurement as an additional cost, with little benefit to the organisation, is therefore not a necessary initiative. Several academic studies have found out that the price of green products remains the main barrier to green procurement (Genovese et al., 2013; Zhu & Geng, 2013; Ageron et al., 2012; Giunipero et al., 2012; Walker et al., 2008). Zhu and Sarking (2007), on the other hand, argue that green procurement is often cheaper to implement compared to any other environmentally friendly practices.

A study by Ageron et al. (2012) showed that many authors in the literature mention two major financial barriers which challenge assessment of the amount to invest and evaluating the return on investment. The difficulty arises when companies realise that sustainability is something new. Therefore, costs and benefits cannot be distributed equally between partners because it requires dependency between supply chain partners.

Another barrier that has been identified is poor supplier commitment. Walker and Brammer (2009) highlighted that the main issue with implementing green procurement is supplier engagement. Genovese et al. (2013) and Mathiyazhagan et al. (2013) found out that there is a lack of transparency by suppliers when it comes to environmental issues. It is also difficult to identify a sustainable source of supply and the green procurement initiatives are hindered by the unwillingness of suppliers (Lysons & Farrington, 2012).

Bjorklund (2011) found out that what drives the middle or top management in environmental purchasing is their priorities. Ashenbaum (2008) indicated that it is usually difficult to

implement green procurement without the support of high-level management. Moreover, to implement green procurement staff need to be trained when they are not trained it becomes a barrier to green procurement.

2.2 Theoretical Literature

2.2.1 Theoretical Framework

The study adopts two theories which are the Institutional theory and Natural Resource-based view theory (NRBV).

2.2.1.1 Institutional Theory

The institutional theory explains the reasons why companies adopt certain strategies based on forces outside the company (Scott, 2004). It also explains that companies engage in certain practices under restrictions or forces created by institutions. Therefore, companies' activities would be monitored by such institutions. The institutional theory comprises three key elements, namely normative pressure, coercive pressure and mimetic pressure (DiMaggio & Powell, 1983). When companies are forced by external or internal pressures to abide by certain rules or values (desirable or preferred) or norms (how things should be done), this is called normative pressure. The laws, rules, and sanctions imposed on a company are referred to as coercive pressure. Finally, mimetic pressure emphasizes on imitation and adoption of other successful elements from other companies (Zucker, 1987; Davidsson et al., 2006).

Various scholars have used institutional theory in the area of green procurement and environmental management (Bag, 2017; Zhu et al., 2008; Zhu & Sarkis 2007). Jennings and Zandbergen (1995) explained the reasons why companies adopt certain practices within the environmental context while Sarkis et al. (2010) explored the positive impacts of these institutional pressures on green procurement. As per Bag, (2016) green procurement is a tool that can be used to derive competitive advantage in the business world. Arora and Cason (1995)

stated that pressures from market forces as well as regulators are the reasons organisations inspire to adopt green procurement.

Dubey et al. (2013) explained that organisations adopt green design and green procurement to minimise wastage level and emission level because of increased pressures from regulatory bodies. It also believed that organisations are influenced to adopt green procurement by pressures from competitors, thus attracting more customers and standing out from the rest in the market (Bag, 2016).

2.2.1.2 Natural Resource-Based View Theory

Hart (1995) proposed the Natural Resource-Based View (NRBV) as the integration of environmental concerns into the traditional Resources Base View (RBV) theory. He suggested that environmental constraints need to be incorporated into the operational activities and strategic plans of a company. Jakson et al. (2016) explained how companies can use NRBV to address environmental issues and achieve sustainable competitive advantage. NRBV can be used to understand what companies use to be strategic in order to achieve sustainable development (Hart & Dowell, 2011).

According to the NRBV, green procurement is a tool used to address the relationship between the natural environment and the organisation (Song et al., 2017). Carter and Carter (1998) propose that all activities of supply chain management should be done by the procurement department and the aim of green procurement is to reduce, recycle and reuse resources. Green procurement can be used to establish a system of purchasing principles, methods, and the process putting into consideration the environmental impacts, including selection and evaluation of suppliers, building a good relationship with them and adopting green packages and so on (Zsidisin & Siferd, 2001).

Hart (1995) proposed three methods to facilitate NRBV implementations as follows: pollution prevention, product stewardship, and sustainable development. Table 2.1 shows the method used to facilitate NRBV.

Table 2.1 The Method Used to Facilitate Natural Resource-Based View

Environmental Strategy	**Environmental Driving Force**	**Key Resources**	**Competitive Advantage**
Pollution Prevention	Minimise emissions, effluents and waste	Continuous improvement	Lower costs
Product Stewardship	Minimise life-cycle cost of products	Stakeholder integration	Preempt competitors
Sustainable Development	Minimise the environmental burden of firm growth and development	Shared vision	Future position

Source: Hart (1995)

Pollution prevention means preventing waste, minimising effluents and emissions through continuous improvement of the company's internal operational processes. Minimising the life-cycle cost of products by involving different stakeholders and incorporating environmentally friendly inputs in product development referred to as product stewardship. The concept of sustainability has therefore extended the company's environmental stewardship into a broader and global scale in order to improve their environmental efficiency throughout the entire value chain. Among these methods, product stewardship is suggested as a mediating stage between pollution prevention and sustainable development. Specifically, product stewardship is impacted by the company's pollution prevention outcomes and contributes to the company's sustainable development (Hart, 1995). According to Hart (1995), all these methods put together can respectively and jointly contribute to companies' environmental and business performance.

NRBV highlights that the environment might be a barrier for archiving sustainability and it suggests that manufacturing companies that maintain the environment more than other

companies might generate a more sustainable competitive advantage (Hart, 1995). NRBV is the in-imitative strategic resource that protects it from the competition as these resources are not easy to duplicate or imitate by competitors who acquire similar resources (Hart, 1995). Therefore, organisations that adopt green procurement practices which are easy to duplicate enable them to determine the competitive position with an environmental mindset and environmental conservation (Shi et al., 2012; Wu & Li 2013).

2.3 Conceptual Framework

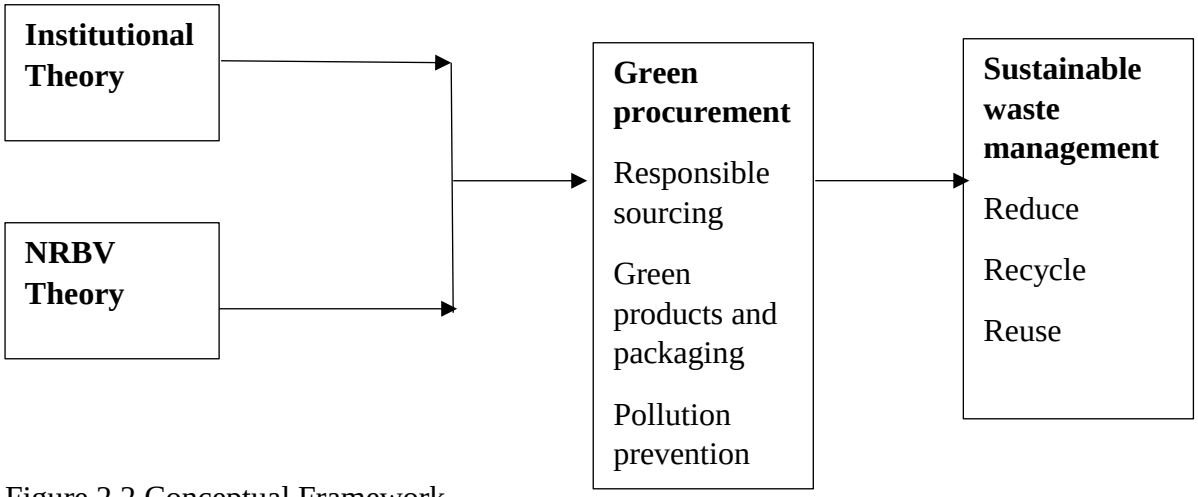

Figure 2.2 Conceptual Framework

Source: Author's own construction (2019)

The conceptual framework illustrates how the institutional theory and NRBV theory pushes companies to adopt green procurement and how green procurement will lead to sustainable waste management. This simply illustrates how green procurement can be incorporated to achieve sustainable waste management in the brewery. It illustrates how green procurement can help minimise the production of waste at every level of the waste hierarchy. This makes green procurement an effective sustainable waste management strategy. Therefore, this study establishes that there is a link between institutional theory, NRBV and green procurement.

The brewery industry produces a lot of waste and emissions. The regulatory bodies pressurize the brewery to adopt green procurement to minimise emissions levels and the amount of waste they generate (Dubey, 2013). According to Bag (2016), institutional pressure from the market, regulators, and competitors influence organisations to adopt green procurement. Bag (2017) constructed the following institutional pressure to explain some of the reasons companies adopt green procurement;

- Organisations are pressurized to adopt green procurement practices by the regional pollution control board.
- Clear guidelines are provided by government regulations in controlling pollution levels.
- The monitoring of the pollution level is done on a regular basis by the pollution control board.
- The penalty fee charged by the pollution control board is decreased by green practices.
- Foreign customers are more sensitive to green practices.
- Sustainable innovations are positively influenced by market orientation.
- Sustainable innovation practices are triggered by intense competition

The brewery can gain a competitive advantage from employing environmental strategies. The environment might be a barrier to achieving sustainability (Hart, 1995). When the brewery aims to reduce its emission level and the amount of waste it produces, the pollution prevention element of NRBV emissions can be cut below the required levels. At every step of the value chain from acquiring raw materials, through production processes to the disposal of used products is the product stewardship element. Product stewardship entails carrying out a life cycle analysis to asses the environmental burden created by the product. Sustainable

development of the brewery depends on pollution prevention and product stewardship. Therefore, incorporating all the elements of NRBV theory will lead the brewery to be environmentally conscious and this will lead them to incorporate green procurement.

Institutional theory justifies why firms adopt green procurement while NRBV explains why firms can derive competitive advantage from employing environmental initiatives.

Green procurement aims to employ effective measures to minimise and eliminate unnecessary waste at the source by the purchasing of products and services that are environmentally friendly. Therefore, it can be considered as a waste management tool. Waste minimisation and disposal can only be achieved by preventing the purchase of hazardous waste thus minimising waste at the source. The basics of waste management can be used to understand how green procurement can be used to achieve sustainable waste management. Avoiding waste generation is the first principle of waste management. Therefore sustainability can be achieved by reducing waste and protecting resources through pollution control and prevention. Therefore, green procurement will minimise the amount of waste dumped at a landfill and minimise the environmental impacts of goods and services of an organisation. For example, the following explains how green procurement can be incorporated into the sustainable waste management hierarchy:

- Prevention: prevent or eliminate by purchasing certain hazardous materials.
- Reduce/minimisation: use local suppliers and reduce distance travelled.
- Reuse: purchase reusable over disposable items.
- Recycle: purchase items or products that can be recycled.

Therefore, green procurement can help to minimise the production of waste at every level of the sustainable waste management hierarchy. Thus, green procurement is an effective waste minimisation strategy.

2.4 Empirical Literature

2.4.1 Waste Generation and Management in the Brewery Industry

There are different kinds of waste generated in the brewery industry: waste generated during special events such as staff parties, waste generated during the brewing process, waste generated during packaging and waste produced from the food services. Energy use, emissions, liquid, and solid waste, are the environmental challenges associated with the brewing process (Olajire, 2012).

The main process of beer making is mashing, boiling, and fermentation and lastly packaging the beer into bottles and casks. Figure 2.3 shows the technological process in breweries and the main waste generated. Lewis and Young (2001) explained the process of making beer. The first process begins with malted grain. The milling process turns the grains into a coarse powder. Then the malt is mixed with hot water in a vessel called mash tun. In the mash, tun wort is produced which is a liquid. Then it is cooled. After the cooling process, the next process is the fermentation process. During which the yeast turns the grains into alcohol. The liquid is now beer, and it is filtered to remove the yeast. The finished beer is then bottled and pasteurized to kill the remaining yeast and microorganisms.

Further details of waste generated and waste management in the breweries are presented below:

2.4.1.1 Liquid waste/ Wastewater

The brewing process requires a large amount of water and it produces wastewater with suspended solid content and high biochemical oxygen demand. Water is the primary ingredient in the production of beer. A significant volume of water is required in the production of beer which includes blending and fermentation of malt, maize and sorghum grits using yeast (Enitan et al., 2015). In the brewery operations, wastewater is the most significant waste product.

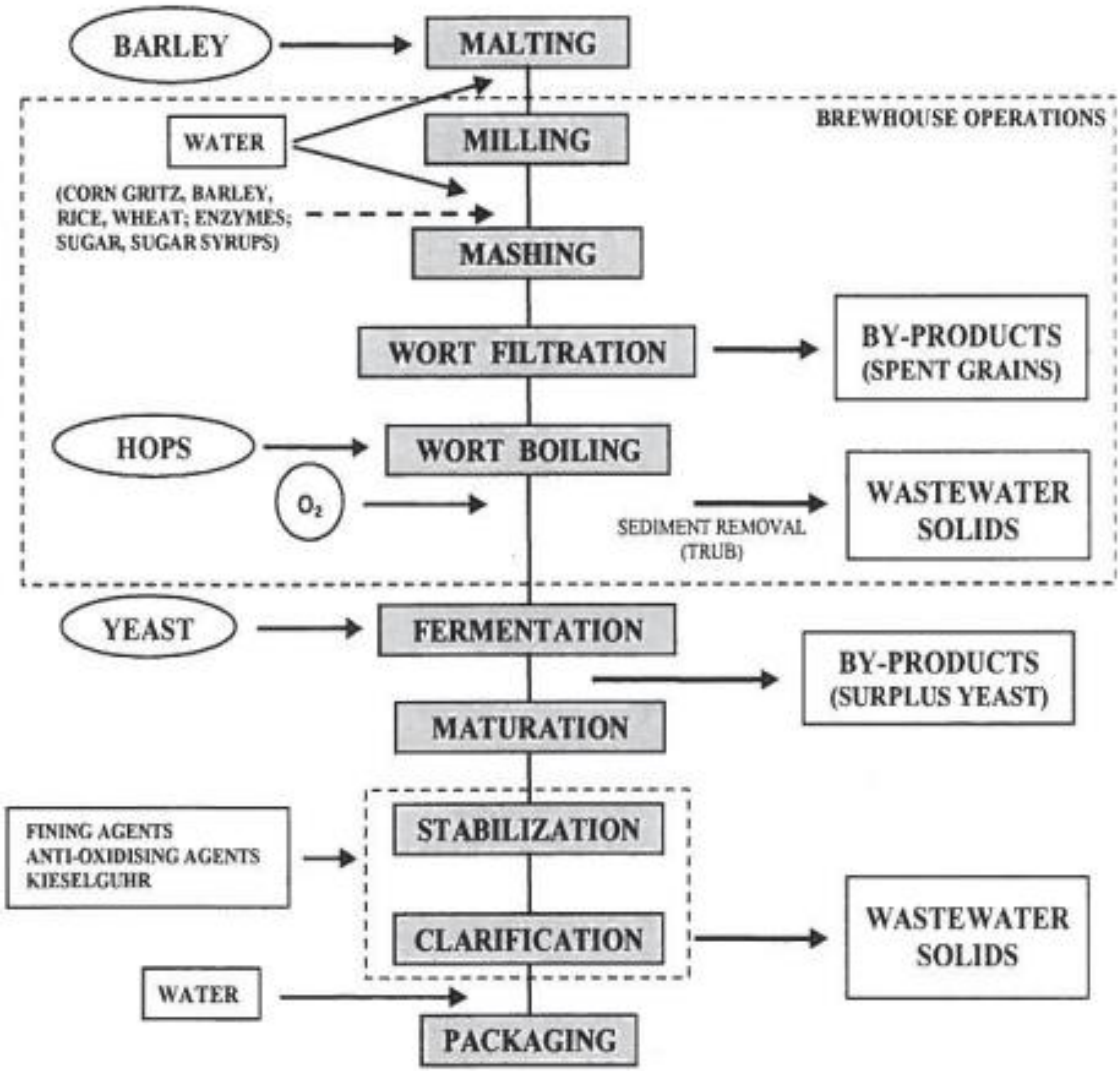

Figure 2.3 The Brewing process and the main waste generated

Source: Varman and Sutherland (1994)

Different stages of production results in wastewater. Regardless of technological improvements being made, approximately 3-10 liters of waste effluent has been estimated to generate per liter of beer produced in breweries (Zhu, Sarkis, & Geng, 2005). Wastewater is also produced during the brewing process, discharges from equipment, cleaning of floors, tanks, pipes, containers and pipes (Arantes et al., 2017).

The water usage and production determines the quantity of brewery wastewater. It has a high organic content and biodegrades easily (The Brewers of Europe, 2002). The main

characteristics of brewery wastewater include Biochemical Oxygen Demand (BOD), total suspended solids (TSS) concentration, Chemical Oxygen Demand (COD) concentration, pH, temperature and nitrogen and phosphorus concentration (Kebede, 2018; Simon et al., 2016). The organic content is the major component of brewery effluent as evidenced by high BOD and COD (Simate, 2015). COD and BOD are the important factors used to test the quality of water in the waste streams and natural waterways (Simate, 2015). Furthermore, the brewing process generates wastewater such as the residual beer and the weak wort (Fakoya & Van de Poll, 2013). Returned beer, beer rejected in the packaging area, process tanks, pipes, diatomaceous earth filters and broken bottles in the packaging area are the main source of residual beer (The Brewers of Europe, 2002).

Brewery wastewater can be discharged in different ways including the following (Simate, et al., 2011): (i) directly into a waterway for example in lakes, streams, oceans or rivers (ii) discharged into a municipal sewer system, (iii) can be treated and discharged into the waterway or municipal sewer system and (iv) into the brewery's own wastewater treatment plant.

Undesirable industrial effluent from the breweries and distilleries may be removed completely by primary and secondary treatment before there are discharged into acceptable media (Essaghah & Oloyede, 2013). Nevertheless, if proper treatment is not carried out the receiving body will be contaminated. When such an incident happens it is necessary that monitoring and treatment are carried out to guarantee that the water bodies are not polluted.

Various studies have shown that brewery wastewater is not properly treated before disposed of or liquid waste is not effectively monitored. Dawodu and Asanaka (2008) conducted a study in four brewery industries at different locations in Benin, Ibadan and Lagos to investigate the effect of brewery industries effluents disposed of in their surrounding surface and ground waters. The results of the surface waters showed that they have been influenced by various

pollutants while the groundwater tended to fall within the World Health Organisation (WHO) and Federal Ministry of Environment and Urban Development (FMEUD) recommended standards. The consequences of the results of the study could lead to habitat destruction and alteration of species diversity. Another study by Odior (2007) on the management of brewery effluents from Guinness Nigeria PLC showed that the wastewater from the brewery is not effectively treated before discharging them into the river.

Emongor et al. (2005) studied the effluents of different industries in Gaborone (Botswana), to investigate the major sources of industrial pollution. He concluded that the brewery is one of the industries that cause pollution; therefore, these industries need to be monitored strictly in order to reduce and prevent environmental pollution.

Wastewater emission can increase significantly with production. Due to increasing beer production the breweries of Grupa Zywiec in Poland, their wastewater emission rose (Kawa & Luczyk, 2015). The total amount of wastewater produced constituted 60% of the water used. For the sustainable character of beer production, proper water management by breweries is important.

A study by Enitan et al. (2015) indicated that the wastewater from the brewery was high in COD, BOD, TSS, ammonia, and protein content. These results showed that the quality of the wastewater did not meet the required effluent regulatory standards, which meant that the particular brewery needed to treat its wastewater.

Despite the pollution caused by other breweries, there are some breweries that are working hard to reduce their wastewater emission. Kompania Piwowarska brewery in Poland has a wastewater treatment based on anaerobic methods of treatment with granules; therefore, it treats its wastewater before disposing of it off in the environment and it reuses the treated wastewater (Kawa & Luczyk, 2015).

Bedu-Addo et al. (2013) studied the effluents of a certain brewery in Ghana (brewery x). The results of the study showed this brewery treats its wastewater before disposing of and this was evidenced by the characterisation of its wastewater.

i. Brewery wastewater treatment

Water pollution is controlled by treating wastewater. Brewery wastewater needs to be treated in a safe and least costly manner before disposal according to the discharge regulations that are prescribed by the government (Simate, et al., 2011). Olajire (2012), described different methods for treating brewery wastewater, ranging from physical, chemical to biological treatment. Physical deals with the removal of coarse solids and other materials. The chemical treatment method includes pH adjustment and flocculation which are used in removing toxic materials and colloidal impurities. The biological treatment can either be aerobic (with oxygen supply) or anaerobic (without oxygen).

2.4.1.2 Solid waste

The solid waste consists of organic material from the brewing process including spent grains and hops, trub, sludge, surplus yeast diatomaceous earth slurry from filtration (Kieselguhr sludge), and packing materials (Olajire, 2012). In Ghana, the utilisation of brewery solid waste by-products is not known apart from selling spent grain as animal feed and disposing of the rest in landfills (Puplampu & Siebel, 2005).

i. Brewery Spent Grain

Brewery Spent grain is the most generated by-product; it represents about 85% of the total by-products generated (Mussatto, 2014). It is generated during the mashing process (Kerby & Vriesekoop, 2017).

There are many ways to utilise brewery spent grain. It has a commercial value and can also be sold as livestock feed (Fillaudeau et al., 2006). It contains an essential nitrogen nutrient which

animals need in their feed (Mussatto, 2014). According to Farcas et al., (2014), spent grain has nutritional value for the human diet. It can be used in human food such as high fiber bread and cookies. It provides a number of benefits, as it helps in the prevention of diseases such as coronary heart diseases, gastrointestinal disorders, cancer and diabetics (Stojceska et al., 2008).

Spent grain can be used in composting when mixed with other waste streams (Stocks et al., 2002). These authors showed that the growth of plants such as geranium and tomato were enhanced by brewery compost from spent grain. Spent grain compost could be the cheap source of compost on contaminated soil (Thomas & Rahman, 2006).

It can be utilised in energy production, through bioethanol through fermentation or the production of biogas (methane) or direct combustion (Kerby & Vriesekoop, 2017).

Spent grain can be used in the production of bricks (Aliyu & Bala, 2011). Russ et al. (2005) found that bricks produced with spent grain have more advantage than those produced from clay, because of their better properties of thermal insulation that has higher water absorption, higher strength, and low density. Spent grain can be utilised in metal adsorption and immobilisation. Lu and Gibb (2008) found that spent grain has significant potential as a bioadsorbent for application in the remediation of metal-contaminated wastewater streams; therefore, it can be used in the removal of heavy metals from wastewater.

Spent grain can be used as a growth medium for microorganisms and enzyme production (Aliyu & Bala, 2011). The carbohydrate composition of spent grain makes it suitable for the production of various enzymes (Nigam, 2017). Ethanol can be made available at a cheaper cost using spent grain (Nigam & Singh, 2011). The various studies have reported that spent grain contains primarily grain husks and other residual compounds such as lignin, cellulose, and hemicelluloses (Mussatto et al., 2006; Kanauchi et al., 2001) which makes it good for ethanol production. Spent grain can be utilised in lactic acid production. Lactic acid production is a

good option using spent grain as a substrate in solid-state fermentation employing fungal cultures (Nigam, 2017).

ii. Spent Hop/ Hot Trub

Spent hop or hot trub is an insoluble protein, generated during the wort production and it is obtained during the cooling process (Olajire, 2012). It is the second generated solid residue in the brewing process (Mathias et al., 2014). For each hectolitre of beer produced between 0.2 and 0.4Kg of wet trub is generated (Briggs et al., 2004). According to Huige (2006), about 85% of hop material used during the beer production will become waste; therefore, disposal is required. Spent hop can be utilised as an animal feed and is mixed with spent grain. It can be used as a fertiliser or compost (Mathias et al., 2014) and as an insect repellent (Bedini et al., 2015).

iii. Spent Yeast

Spent yeast is recovered at the end of the fermentation and maturation process (Ferreira et al., 2010). Per 100 liters of beer produced, this brewing by-product generates about 1.5 and 3Kg of the total volume of beer produced (Olajire, 2012).

Spent yeast has many potential uses such as; animal feed and human nutrition (Mathias et al., 2014); Food industry (Rakowska et al., 2017; Coldea et al., 2017; Podpora et al., 2016); pharmaceutical industry (Jung et al., 2011; Briggs et al.,2004); biogas production (Zupanic et al., 2012); flavoring agents production (Viera et al, 2013); single-cell protein production (Chanda & Chakrabati, 1996); biosorptions and precipitation of heavy metals for remediation of soils and aqueous media (Chen & Wang, 2008); obtaining enzymes (Mathias et al., 2014); substrate for micro-algae cultivation (Byung-Gon et al., 2013); supplementation of maintenance and fermentation of medias for microorganisms (Ferreira et al., 2010); cosmetic products (Natakankitkul et al., 2016).

iv. Brewery Sludge/Kieselguhr Sludge/ Diatomaceous Earth Slurry

Kieselguhr is a material that contains silicates and is used during the filtration process of brewing to clarify beer and remove particles (Mathias et al., 2014). The disposal of kieselguhr can become problematic if not managed well because of their polluting effect. It is a hazardous waste, from a health perspective (Olajire, 2012).

Brewery sludge can be utilised in; generation of energy (Kanagarachndran, 2005); production of hydrogen (Fan et al., 2006); biogas production (Babel et al., 2009); soil amendment (Saviozzi et al., 1994); organic fertiliser (Dickson, 1966); pest control (Brewer Association, 2018) and construction material (concrete, cement & brick) (Brewer Association, 2018).

v. Packaging Materials

Around 86% of breweries claim that they use reusable/recyclable packaging (Patterson et al., 2016) thus reducing the amount of waste going to landfills both at the brewery and after the distribution of beer. The study by Patterson et al., (2016) covered sustainable practices being implemented across the United States and some breweries across the world. Some of the packaging wastes are usually disposed of at sanitary landfills and these include; paper, plastic, metal, wood, broken glass, bottle caps, and labels (Olajire, 2012).

Most of the materials used for packaging are aluminum, steel, glass, and plastic polyethylene terephthalate (PET) and some of the materials are recyclable and reusable (Kawa & Luczyk, 2015). This is due to customer preference, climate, culture and the geographical area where the beer is being consumed. However, the challenges each brewery faces relate to minimising the impact of packaging on the environment. Recently, there has been a revolution to reduce the number of materials in packaging such as light-weighting, for example, minimising the amount of glass used in glass bottles. Furthermore, there is a balance between reducing the minimal waste due to breakages and the weight of packaging to reduce environmental impacts.

2.4.2 The role of Green Procurement

Society has become more conscious of its environment. Environmental obligations have grown and legislation relating to the environment is increasing and this requires companies to be more environmentally responsible (Zhu, Sarkis & Geng, 2005). Marron (2013), states that in recent years worldwide environmental issues have become a critical concern for business, due to public health concerns, persistent global poverty, resource depletion, environmental degradation, climate change, and costs of waste management. Therefore, procurement managers are called upon to include social and environmental criteria within the procurement process to contribute to sustainable development (Srivastava, 2007).

The first step in the green procurement process is supplier selection. Suppliers could be selected on a basis that would help organisations to achieve sustainable waste management. Selecting the best suppliers is the most important activity in the acquisition process. There is a variety of factors that must be considered when deciding on a purchase and this makes the buying process complex. The decision-making unit is made up of the decision-makers and decision influencers. The important task in the organisation is the selection and evaluation of suppliers. Kumar and Rahman (2015) suggested that in order to eliminate waste, strategic partnerships should be made with the right suppliers and it must be integrated within the supply chain. The origin of supply chain management comes from the idea of minimising waste because economic profitability can be reduced through waste minimisation (Sarkis, Zhu, & Lai, 2011).

The brewing industry can contribute to sustainable development by working with suppliers and demanding them to be involved in environmental protection aspects. In order for sustainability to be achieved in the brewery, sustainability needs to be included in all stages of an organisation's supply chain. Most recently companies have become aware to assess suppliers from a sustainability perspective. The selection of suppliers has recently become a complex

task due to the emphasis on sustainability issues. Supplier assessment plays an important role in the management of a supply chain.

There is a huge gap between the desire of supply chain sustainability in theory and its implementation in practice, despite the efforts been made by many multinational corporations to implement environmental and social issues in their supply chain (Bowen, Cousins, Lamming, & Faruk, 2001). Traditionally when it comes to evaluation of the performance of suppliers criteria such as cost, quality and delivery are usually considered (Hashemi, Karim, & Tavana, 2015). The pioneer of supplier selection Dickson (1966), was the first to carry a study on the evaluation of suppliers. He defined 23 criteria by which the selection and evaluation of suppliers could be carried out. Dickson's (1966) criteria excluded the environmental aspect for selecting suppliers.

Various researchers in the supplier selection literature are now addressing supplier selection in relation to environmental aspects (Handfield et al. 2002; Lee et al 2009). Therefore suppliers should be evaluated on the basis of cost, service, quality, delivery, strategic alliance, ethics, education, safety, health, wages, reputation, philanthropy, child/bonded labour, environmental management, pollution control, distance, green product, use of green material, and green design (Gurel et al., 2015; Galankashi et al., 2015; Mani et al., 2014; Dubey et al., 2013; Igarashi et al., 2013).

Various types of waste are caused by production distribution and consumption of products. Different types of waste emerge within the production process during which waste materials and by-products are being generated. Certain types of waste also arise when the required product is not achieved. Raw materials, as well as finished goods, require certain packaging that needs to fulfill different functions such as transport, storage, selling or easier usage or handling. Volumes of waste are generated due to the lack of adoption of proper packaging.

This makes companies, to come up with different environmental practices to reduce waste generation.

Companies which are committed to waste prevention attempt to apply statistical procedures to collect data and monitor the process along their value chain with an aim to minimise the impact of the different variables (Burt, Petcavage, & Pinkerton, 2010). To optimize the efficiency of a given process, waste generation should be avoided. The type of materials entering the waste stream is positively correlated to the cost of waste (Salam, 2008). When dealing with a hazardous waste high level of safety is provided for sorting, labeling, and transportation by the company. Therefore, to ensure the efficiency of pollution prevention waste management system and monitoring is crucial.

Four types of waste are generally produced at breweries: brewing process wastes, packaging waste, food service wastes, and waste generated during special events. Taking this type of solid waste to landfills by front-loading garbage trucks has a large environmental impact of travel footprint because landfills are located further away from populated areas. The trucks used also generate diesel exhaust which contains toxic substances (Fish, 2015).

The concerns by industries on environmental issues have led to the emergence of green concepts in their organisational activities. Such green concepts include green management, green suppliers and green procurement. This green concern is growing throughout the world, and it is of great importance to purchasing and sustainable waste management strategies (Chepkoetch, Chenuos, & Kosgei, 2015).

Henceforth, buying green according to Burt et al. (2010) involves products that produce less waste or last longer and easily recycled. Therefore, money is saved on waste disposal. Furthermore, savings can be made on water, energy, fuel, and other natural resources as manufacturing green products require fewer resources. In addition, green products generally

contain fewer toxic or hazardous materials. Generally, the intention of designing green products is to reduce the amount of waste created (Salam, 2008). For example, the supplier may have a take-back program and they may use less packaging or may contain recycled material.

Green procurement aims to eliminate or reduce environmental impacts. It is rooted in the principle of pollution prevention. Florida and Davison (2001) explained green procurement strategy as a three zero manufacturing paradigm whereby companies try to accomplish zero waste and emissions, zero defects and zero inventory. According to Lacroix (2008), green procurement means the evaluation of purchases based on certain criteria ranging from the reason of purchase in the first place to the available option for its disposal. When waste is not properly disposed of, it gets carried away to rivers during heavy rains and chemicals dissolve in the water, thereby affecting marine life and water quality for both domestic and consumption.

A study by Arvidsson and Stage (2012), investigated green public procurement of waste management. The tenders were evaluated using the price to quality scoring rule. It was found out that the role forced the municipality to opt for the high cost and better environmental characteristics.

Alaskan brewing company in Juneau was one of the first breweries in the United State to install a CO_2 reclamation system in 1998 (Pullman, 2009) to reduces emissions levels. According to the Alaskan brewery, the brewing company saves approximately 800 000 pounds of CO_2 from being released into the atmosphere each year.

2.5 Summary and Conclusion

This chapter has discussed the theoretical and empirical literature. The chapter defined the key concepts in the study and also discussed institutional and NRBV theories as well as the

conceptual framework adapted to guide the realisation of the study. It has also analysed the empirical literature on waste generation and waste management in the brewery and the role green procurement plays in sustainable waste management.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

Study site and research methodology, as well as the description of the study area, have also been discussed under this chapter. This chapter is composed of the research area, research approach, research design, sources of data and sampling techniques. It also describes the instruments of data collection and procedure; the data analysis and data management technique and the limitations as well as ethical considerations.

3.1 Research Area

The study area that was used in the study is Accra Brewery Limited (ABL), a brewery based in Accra, Ghana. Accra Brewery Ltd (ABL) is the oldest brewing company in West Africa. Originally founded as the Overseas Breweries Limited in 1931, ABL became a subsidiary of SABMiller in 1997. Today, ABL produces both alcoholic and non-alcoholic beverages and the company's leading brands include Club Beer, Club Shandy, Stella Artois, Castle Milk Stout, Eagle Lager, Eagle Extra Stout, and Beta Malt. In 2016, it became a proud member of Anheuser-Busch (AB) InBev after it acquired SABMiller Plc (Accra Brewery Limited, 2017). ABL was selected for the study because it is the oldest brewery in Ghana and it is operating under AB InBev, the largest brewer and ABL has a duty to deliver the parent company's 2025 sustainability goals, which aims to be sustainable in all its operations.

ABL plays a very important role in the economic development of the country. ABL contributes substantially to the tax income of Ghana, provides high-quality employment and its operations also support jobs throughout the economy and ABL buys its raw materials (maize and cassava) from local farmers (Kapstein & Kim, 2011).

ABL is located between latitude 5'33'12.8N and longitude 0'12'59.7W. Figure 3.1 shows the location of ABL with a black outline.

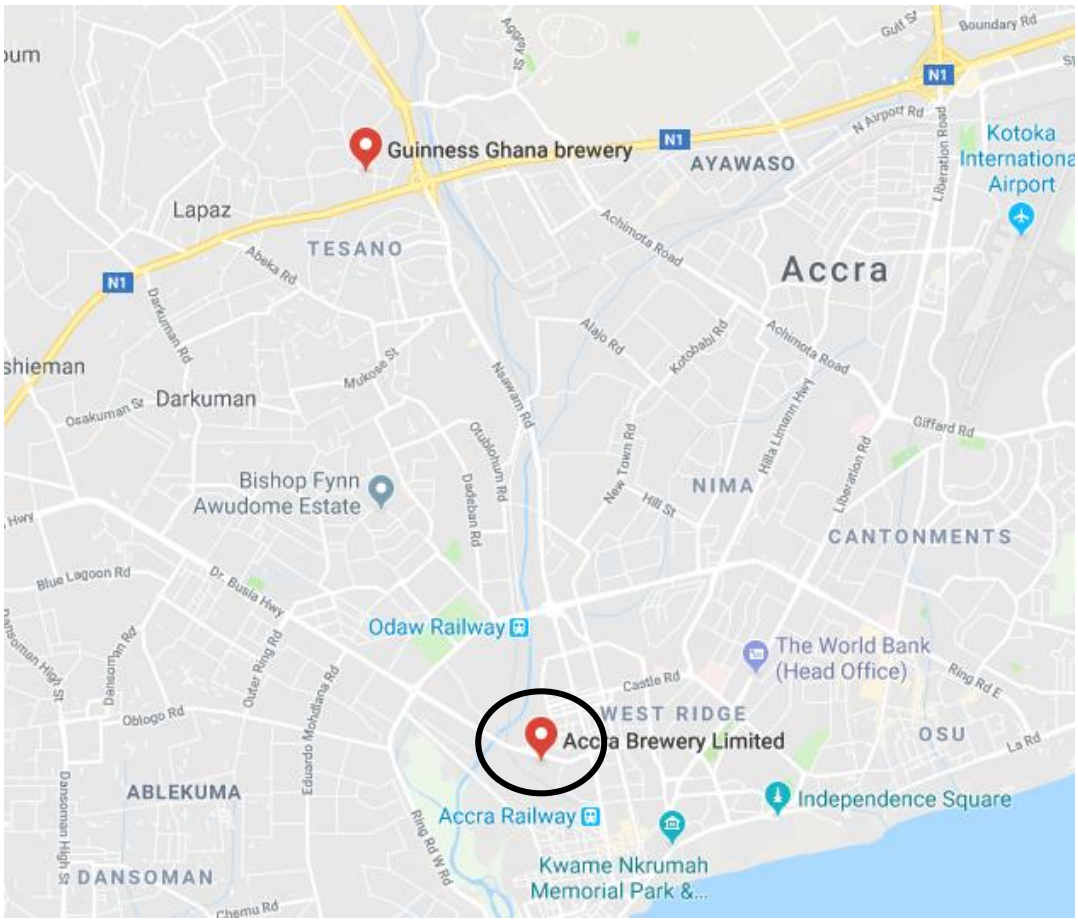

Figure 3.1 Accra Brewery Limited (ABL)

Source: Google Map (2019)

3.2 Research Approach

The study was carried out using the qualitative research approach. The key to qualitative research is that the researcher learns about the challenge from participants and obtain information to address the study (Creswell, 2003). The researcher examines why certain things happen and what those things mean to the participants studied (Bogdan & Biklen, 2006). Qualitative research is less structured in the description because it formulates and builds new theories (Leedy & Ormrod, 2001). Creswell (2014) explains that the advantage of this approach is that the researcher is the one who collects data and does not rely on questionnaires or other instruments developed by other researchers. Benohel (1985) argued that this approach enables

the researcher to collect data in a natural setting where the participants experience the issue under study. Furthermore, this approach is more humanistic and gives the researcher an opportunity to combine different types of data collection such as observations, interviews, documentary review and audio-visual information which enhances the findings of a study (Creswell, 2014). This approach also enables researchers to know the experiences of participants because of the interaction between the two of them.

3.3 Research Design

Creswel (2013) identified five traditions to the qualitative inquiry which are ethnography, narrative, phenomenology, case study, and grounded theory. A case study design is adopted for the study. A case study is "an idiographic examination of a single individual, family, group, organisation, community or society" (Babbie, 2001). A case study method is used when "the researcher explores in depth a program, an event, an activity, a process, or one or more individuals" (Creswell, 2003). Zack (2006), states that organisational research is one area in which case study design has remained popular because it focuses on certain work environments or work structure.

Case studies try to learn "more about a little known or poorly understood situation" (Leedy and Ormrod, 2001). The choice of the case study design is appropriate because it helped the researcher to understand how an organisation like ABL manages its waste and adopts sustainable waste management and also how it has employed green procurement.

3.4 Sources of Data

The study used both primary and secondary data. Information concerning ABL, green procurement, and sustainable waste management was derived from both primary and secondary data. For primary data, interview guides were used. This data was obtained from informants

selected from the selected organisation. Primary data was used together with secondary data for the enhancement of data validity and reliability.

For secondary data, information was collected from policy documents, sustainability reports, and other publications. Secondary data have an advantage because it saves resources, especially time and money (Ghauri & Gronhaug, 2005). It also provides an unobtrusive measure because it has already been collected (Saunders, Lewis, & Thornhill, 2009). Hansen-Thompson (2007), argues that secondary sources have the advantages of providing important information for identifying key issues needed to be addressed by the primary data. For this reason, the secondary data collected for this study is used alongside the primary data gathered through the use of an interview guide.

3.5 Target Population

Target population can be defined "as the group of individuals or participation with the specific attributes of interest and relevance" (Creswell, 2003). The target population of this study involved the entire procurement entities, waste management officers and production staff of ABL. This research explores the role of green procurement in sustainable waste management in ABL.

3.6 Sampling Techniques

The study used a non-probability sampling method called a purposive sampling technique. Saunder et al. (2011), state that a purposive sampling technique gives the researcher an opportunity to select cases that will help to answer the research questions and meet the objectives.

For this study, the inclusion and exclusion criteria were used. Only people who are involved in the waste management and supply chain process were included in the study. Other staff like administrators who are not technical or field people and directly involved in the process were

not included in this study. The procurement manager, procurement officers, waste management officers, environmental and safety manager, sustainability manager, and waste collectors were selected as participants because they have experience and knowledge concerning the problem under the study and they are expected to possess rich information about the issues under the study.

3.7 Sample Size

The sample size depended on the concept of saturation. When adding more participants does not result in obtaining any new information that is the point of saturation (Malterud, Siersma, & Guassora, 2016). Larger sample size can also lead to the risk of having repetitive data. Therefore, the sample size was large enough to uncover a variety of opinions and to limit the sample size at the point of saturation. Using this concept 18 respondents were interviewed. Table 3.1 shows the demographic characteristics of the respondents.

3.8 Data Collection Instruments

Interview guides were used for the data collection (see Appendix 1). To Wilson (2010), "interviews have the ability to engage in verbal communication which provides interesting insights into respondents' feedback and their general behavior which often allows respondents to answer questions in an in-depth way". An assumption about interviews is that people's experiences affect the way they carry out that particular research (Seidman, 2006). According to Robson (1993), the use of interviews gives the researcher the opportunity to follow up on the response given by respondents and dig deeper in order to enhance the reliability of the data. With the interviews, a semi-structured interview was used to collect the data for the study. The interviews were face to face and others were made through a telephone interview. Field notes were also taken during the interviews.

Table 3.1: Demographic characteristics of respondents

Brewery name	job description	Gender	Year of service
Accra Brewery Limited	Sustainability Manager	M	4 years
	Environment and Safety Manager	M	8 years
	Logistics and Transport Manager	M	2 years
	Production Manager	M	4 years
	Procurement Manager	M	1 year
	Waste Collector supervisor	M	3 years
	Procurement Officer	F	6 years
	Environmental Officer	M	1 year
	Wastewater treatment plant controller	M	1 year
	Wastewater treatment plant controller	M	3 years
	Wastewater treatment plant controller	M	2 years
	Production Staff	M	2 years
	Packaging operator	M	3 years
	Waste trucks driver	M	3 years
	Waste truck driver	M	2 years
	Waste collector	M	6 Months
	Waste collector	M	6 Months
	Waste collector	M	6 Months

Source: Author's own construct (2019)

3.9 Data Analysis and Data Management

A laptop was used to record the interviews. Recorded interviews were transcribed verbatim. Miles and Huberman's (1994) approach to qualitative data analysis was used approach to analyse the data gathered. According to Boije (2010) "performing data analysis on qualitative data basically involves dismantling, segmenting and reassembling data to form meaningful findings in order to draw inferences".

Data reduction, data display and drawing and verifying conclusions are the major components of qualitative data analysis (Schutt, 2012). In this study, the data was reviewed and categorised

under themes, patterns, and relationships and then conclusions were drawn. The objectives of the study and relevant literature were used to draw the conclusions.

3.10 Research limitations

In carrying out the research, the researcher encountered some challenges at the initial stage of the study. The researcher proposed to carry out a comparative case study but other breweries did not agree to take part in the study. Therefore, the researcher settled on carrying out a single case study. The time factor was also a great challenge. However, the researcher developed a strategy whereby some interviews were made through phone calls. Some of the management staff were not available to be interviewed. In the midst of all the challenges, the researcher used strategic measures to ensure the findings of this study are reliable and valid.

The study was limited to a single company ABL. ABL is a big company with different departments, it also has a cafeteria and a bar inside the brewery. Therefore, it would be very difficult to study all the different departments thus all the interviews were focused on the departments which were closely related to the study. Henceforth, there are many opportunities for future research to extend this study to another context. A single case study is a limitation as it could not give enough results.

3.11 Validity and Reliability

To enhance data validity and reliability, the researcher initially piloted the interview guide by discussing the results with managers and supervisors for their suggestions and inputs. Some of the comments provided by the supervisors and peers were considered and used during the comprehensive face-to-face data collection process. Since this study is an academic exercise, the participants were made to understand the high ethical considerations; the data was collected by the researcher herself. Secondary data were compared with in-depth interview responses

collected from ABL staff members for purposes of triangulation and providing a useful background for identifying key questions and issues addressed by primary research.

3.12 Ethical Considerations

The researcher obtained ethical clearance from the College of Basic and Applied sciences (see Appendix 2). After obtaining the ethical clearance the researcher obtained permission to collect data from the brewery with an introductory letter from the University of Ghana Centre for Climate Change and Sustainability Studies (see Appendix 3). Consent was sought from the participants. The respondents were informed that the data will be used for academic purposes only. The researcher ensured that participants take part in the study voluntarily. Therefore they were told that they have the liberty to withdraw from any stage of the study. A high degree of confidentiality was observed during the data collection. Therefore, respondents were made to withhold their names to ensure anonymity in the responses provided.

3.13 Summary and Conclusion

In conclusion, the chapter presented in detail the methodology used for the study. It justified the reason behind the selection of the research approaches, research design, sources of data, target population, sampling technique, sample size, data collection instruments, data analysis and data management, research limitations, validity and reliability, and ethical consideration. A qualitative approach was selected to fill in the gap where quantitative approached had extensively been used (Walker & Brammer, 2009; Walker & Brammer, 2012; Neupane, et al., 2014).

CHAPTER FOUR

DATA PRESENTATION AND DISCUSSION OF FINDINGS

4.0 Introduction

This chapter presents the findings and discussions of the study based on the data obtained from eighteen in-depth interviews (Table 3.1) obtained from participants who were purposively selected from ABL. This chapter discusses the waste generated in ABL. It presents the sustainable waste management adopted by the brewery. It highlights the role green procurement plays in sustainable waste management of the brewery.

4.1 Nature of Waste Generated in the Brewery

Throughout the history of brewing beer, there have been some improvements but the general technique of brewing beer is relatively the same. The only difference is in the ingredients, recipes and process techniques being used. The ingredients are from the same four categories malted barley other grains such as maize, wheat, and hops, rice yeast, and water. According to Bamforth (2003), these main ingredients can be used to brew any type of beer is just a matter of recipe and brewing techniques and sometimes the difference is determined by the craft brewmaster. According to Olajire (2012), there are different kinds of waste generated in the brewery industry: brewing process wastes, packaging wastes, food services wastes and waste generated during special events like staff parties or festivals. This section identified the waste generated in ABL. Interviews with ABL staff revealed that the brewery generated two major types of waste which are solid waste and liquid waste and these wastes are generated from the brewing process and the packaging process.

4.1.1 Solid Waste

4.1.1.1 Brewing process waste

In order to get a better understanding of the waste generated in ABL, the respondents were asked to explain the type of waste they generate in the brewery. The majority of the respondents listed the type of waste generated during the brewing process. Therefore, they were also asked to explain the brewing process and the waste generated at each stage of the brewing process. They explained the several steps in the brewing process which include milling, pre-mashing, filtration, wort boiling, fermentation, filtration, and packaging. In almost every stage of the brewing process, there is waste being generated. One of the respondents explained the process of brewing beer. Figure 4.1.1 shows the process of making beer in ABL and the wastes generated at each stage.

4.1.1.1.1 Sacks and Bad Malt

The milling process generates sacks and bad malt as waste. According to the brewers, milling is the first process for making club beer, one of the beers produced in ABL. The main ingredients are maize and malt. The first thing the brewers do during this process is that they empty the malt and the maize in the sacks into the silos. For making club beer, the ingredients are maize and malt and for making eagle lager beer the main ingredient is cassava. Cassava is also packaged in sacks. After the ingredients are emptied, the brewers explained that the ingredients are sent to the silo with the help of an aspirator. The aspirator separates the dust from the malt. After the malt is sent to the malt silos via the aspirator, it is then sent to the dehusking. Dehusking is the process of removing the husk from the grain. Before it is sent for the dehusking it passes through a separator. The separator separates the good malt from the bad malt.

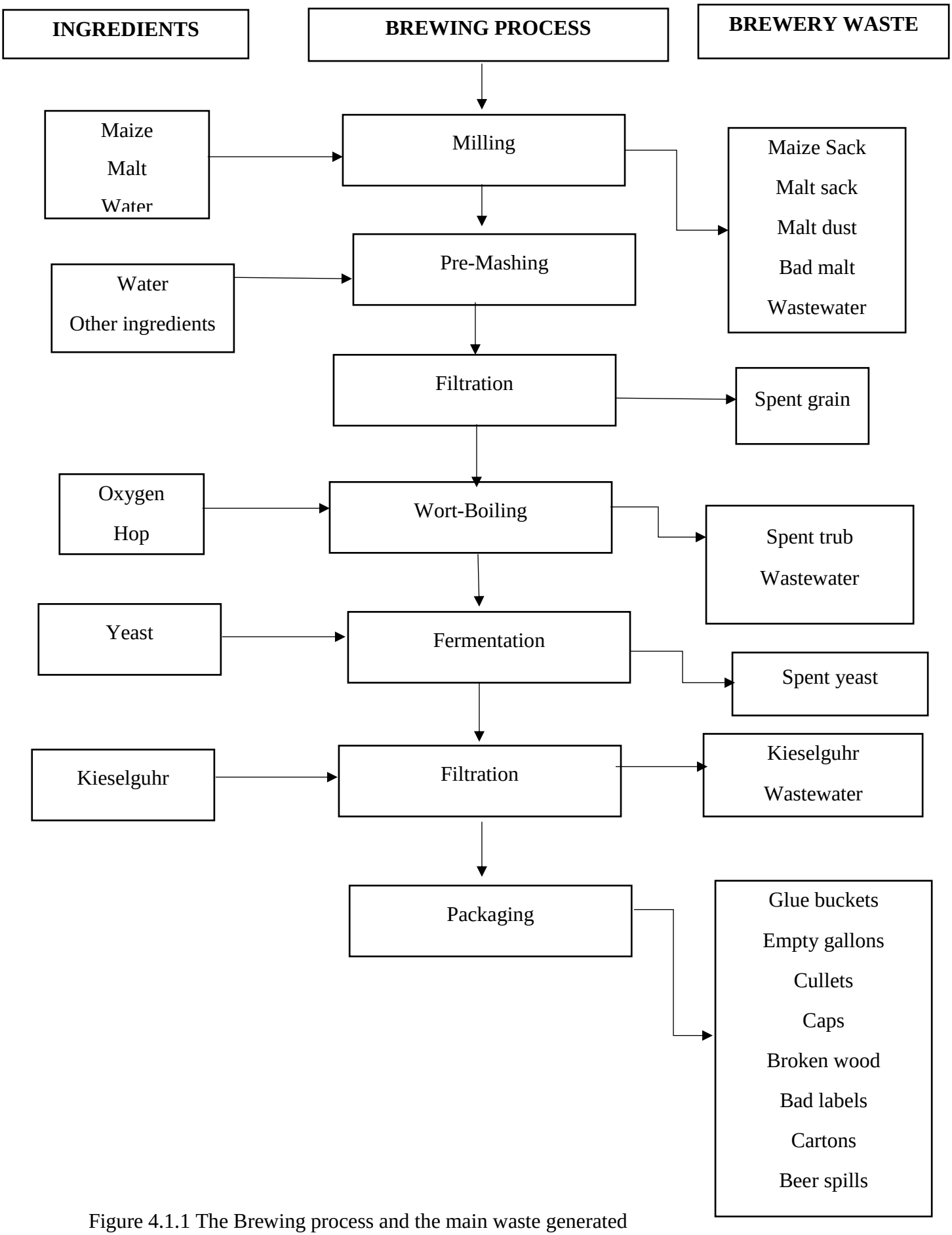

Figure 4.1.1 The Brewing process and the main waste generated

Source: Author's own construct (2019)

The production senior staff explained:

> *"So number one, this process is the first waste that is being generated in the brewery which is empty malt sacks and maize sacks. The second waste that is produced is dust, malt dust. So, the good malt which is the wanted malt is sent to a machine to be dehusked and the bad malt is packed sold together with the spent grain to the farmers as another waste. That is the third waste- the unwanted malt together with the water and substances in the malt which was separated by the separator."(Production senior staff, spent 4 years in ABL)*

One of the production staff added:

> *"Yes, this is sold to farmers and other buyers. After the malt has been dehusked the malt is also sold as waste to the farmers or sold with the spent grain to the farmers." (Production staff, spent 2 years in ABL)*

After the de-husked malt and maize are combined, the next process is the pre-mashing process. The brewers explained that the pre-mashing process is the start process for the brewing of beer and the ingredients are cooked. There is no waste produced in this process.

4.1.1.1.2 Spent Grain

After the combination, the respondents stated that two mashes are passed through something called the mash filter. The mash filter separates, extracts the liquid in the mash like the juice the which is called wort in the mash. This wort is where the beer is gotten from. The liquid which is the wort is sent to a vessel which is called the wort kettle. The substances or the solid gotten from the extraction in the mash filter which is called spent grain is sent to a vessel called spent grain hopper. Therefore, spent grain is another waste produced and the sustainability senior staff explained thus:

> *"So there is another waste generated which is called spent grain. The spent grain is stored in the spent grain hopper and sold to farmers, they bring their trucks. Then farmers come and buy it and use it as feed for their pigs, cattle and other animals." (Sustainability senior staff, spent 4 years in ABL)*

Most of the respondents explained that spent grain consists of the largest portion of the solid waste produced during the brewing process. This waste is considered a by-product meaning that it can be reused and it has a commercial value.

4.1.1.1.3 Spent trub

Now in the wort kettle, the respondents stated that the extracted liquid, the wort is boiled for some time and other ingredients are added to it. After the wort (the extracted juice) has been boiled and cooked, it is sent to another vessel called the whirlpool. In the whirlpool, the wort is made to settle so every substance, any solid particles which couldn't be removed in the mash filter are removed in the whirlpool and made to settle by gravity. Anything that has been made to settle by gravity in the whirlpool is taken out and these substances are named trub. One of the production staff mentioned that this trub is waste:

> *"This trub is another waste generated. It is sent to the spent grain hopper. It is mixed with spent grain and it is sold together with the spent grain." (Production staff, spent 2 years in ABL)*

So after the settling has been done in the whirlpool, the clean wort goes to be cooled. After it has been cooled, oxygen is added to it and yeast for the fermentation process and sent to silos for fermentation.

4.1.1.1.4 Spent yeast

The next process was the fermentation process which takes place at the cellars (Figure 4.1.2). In this stage, the yeast is propagated in the propagation vessel which means it is nurtured in this vessel. When it is ready for use, it is sent to the pidgin vessel. From the pidgin vessel, yeast is transferred to the fermenting vessel. Before it is transferred, wort from the brewhouse is then brought to the fermenting vessel ready for fermentation. The yeast that is ready to be used is picked from the pidgin vessel into the fermenting vessel. Now the yeast and the wort are in the same vessel ready for fermentation. After 12 days the beer will be fermented.

> *"Now the yeast that has been collected in the collecting vessel can be reused in another fermenting process. So if it is going to be used, it is sent to the pidgin vessel. If it is not going to be reused it is sent to the autolysis vessel. With this vessel, yeast is heated to above 100degrees or so to kill all the yeast. Then it is sent to the BTS (the effluent treatment plant) this yeast is another solid waste generated in the brewery*." *(Production senior staff, spent 4 years in ABL)*

Even though the yeast can be reused several times, it is typically gets thrown away once the live cells have died. It gets thrown away to the sewer and gets treated with the rest of the liquid waste in the wastewater treatment plant.

After fermentation, the yeast is cropped out and separated from the fermented beer in the vessel. It is cropped out and collected in the collection vessel. The beer that has been fermented with the alcohol percentage inside is sent to the filtration section for further treatment. The carbon dioxide (CO_2) generated is used in the next process and the rest is sold to other companies and breweries.

4.1.1.1.5 Kieselguhr

Figure 4.1.3 shows the filtration process. After the beer has been fermented at the fermentation section, the beer now has a high percentage of alcohol. So, it is called high gravity beer. It is stored in the high gravity beer tank (HGBT). The beer has some yeast particles in them and some other things that need to be taken out so the beer is filtered. There is one thing used for filtering which is kieselguhr powder. The kieselguhr is in two types. The first kieselguhr is mixed in the kieselguhr dosing pot (KDP). After this, it is dosed in the line while the beer is flowing. The dosing helps to coagulate most of the yeast particles and other unwanted particles in the beer. Thereafter, the kieselguhr is prepared in the second kieselguhr dosing pot and then transferred into the kieselguhr filter (KF). The kieselguhr is like candle filters. The second kieselguhr is coated around the candles for filtration.

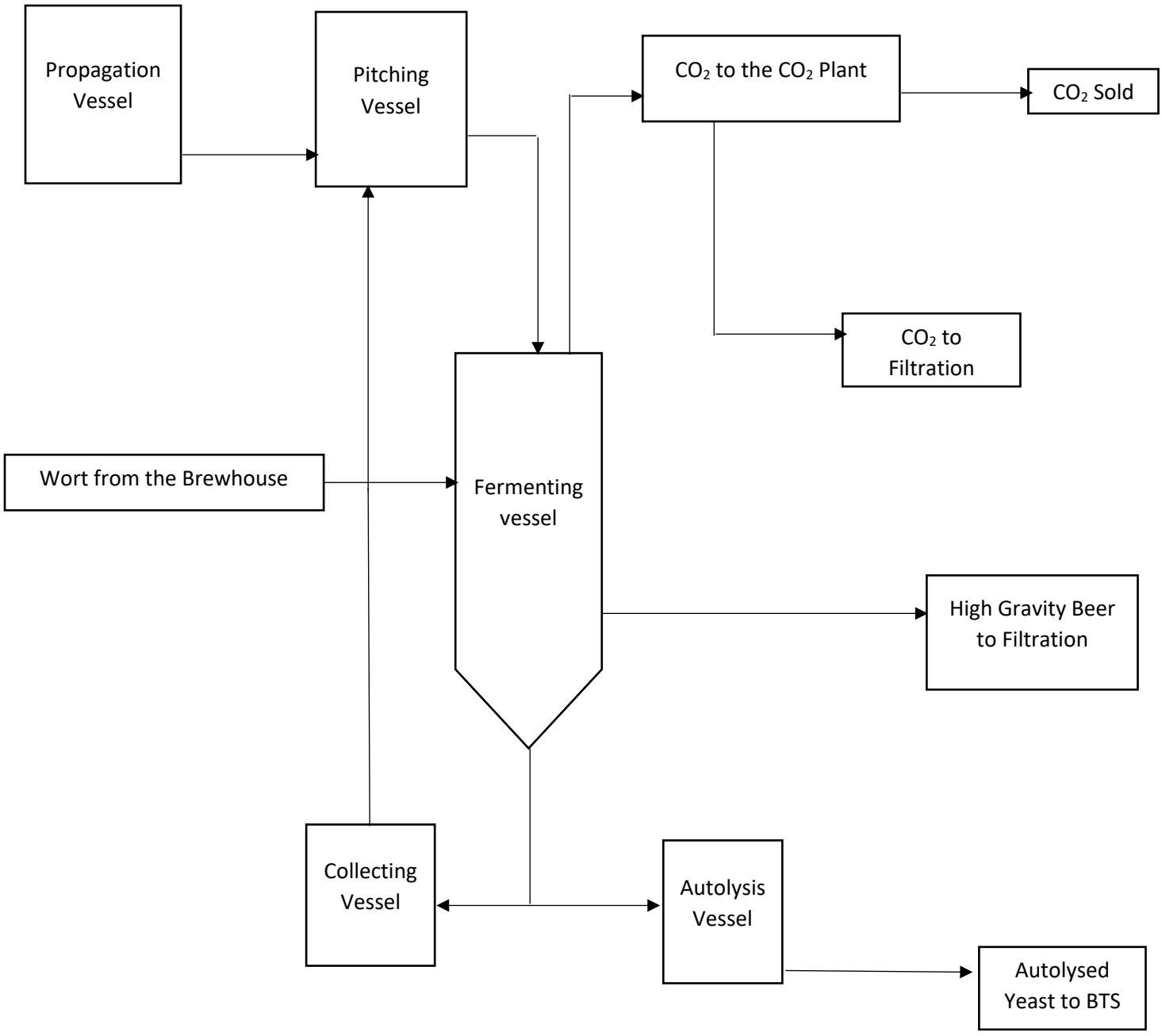

Figure 4.1.2 Fermentation Process

Source: Author's own construct (2019)

The unfiltered beer goes into the kieselguhr filter to be filtered. After the filtration takes place, the beer comes out into the bright beer tank (BBT) which is ready for packaging. The beer has a high alcohol content so it is diluted. One of the production staff reported that kieselguhr is disposed of as waste:

> *"So the kieselguhr that was used for the filtration is now waste and it has to be disposed of. So this kieselguhr goes into a waste kieselguhr tank. As the beer goes out and it has been filtered ready for packaging the kieselguhr goes out into waste kieselguhr tank. It is stored there for a while until the tank is full and it is left to settle so that the liquid is separated from the solid particles in the waste kieselguhr tank. The liquid is drained from the top from the waste kieselguhr tank is sent to the BTS. The solid part of the residue that stays under the tank is collected by a waste truck." (Production staff, spent 2 years in ABL)*

Kieselguhr comes in a form of sludge and this sludge is considered hazardous to the environment (Olajire, 2012). This sludge is can be difficult to dispose of, that is why the liquid part is sent to the BTS for treatment and the solid particles are collected by a waste truck.

4.1.1.2 Packaging

When it comes to packaging beer, the respondents explained that they use bottles and kegs. The beer bottling process involves a series of steps, as shown in Figure 4.1.4. The solid waste generated during packaging includes; glue buckets, empty gallons, cullets, broken wood, caps, bad labels, and cartons. The environment and safety senior staff pointed out:

> *"We have a variety of waste generated during packaging. We can talk about bad labels, not all labels can be good. We also have cullets (broken glasses), cartons, broken wood, glue buckets, empty gallons, and empty alcohol drums." (Environment & safety senior staff, spent 8 years in ABL)*

The brewers discussed the different wastes and how the wastes are generated during the packaging process.

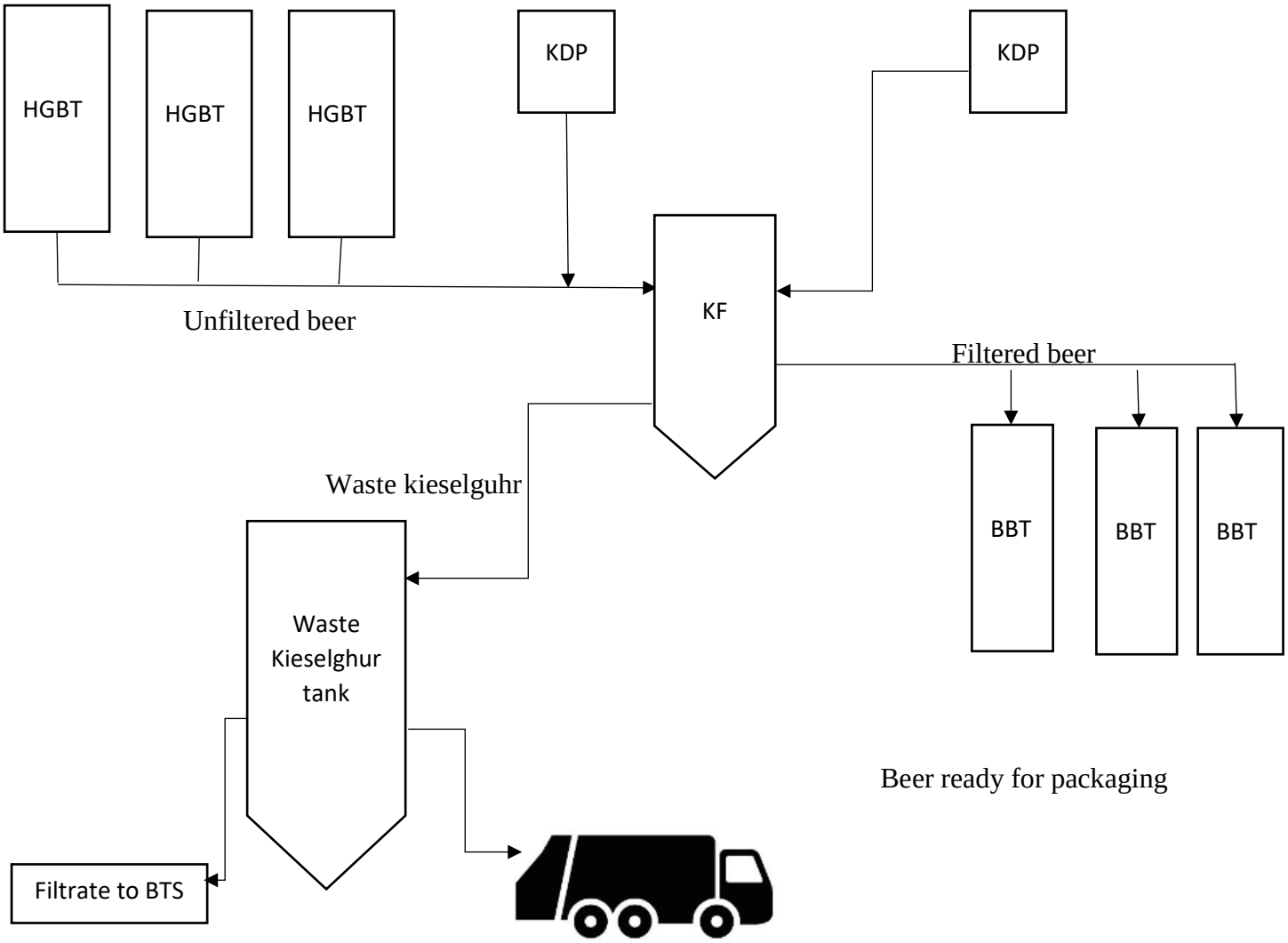

Figure 4.1.3 The filtration process

Source Author's own construct (2019)

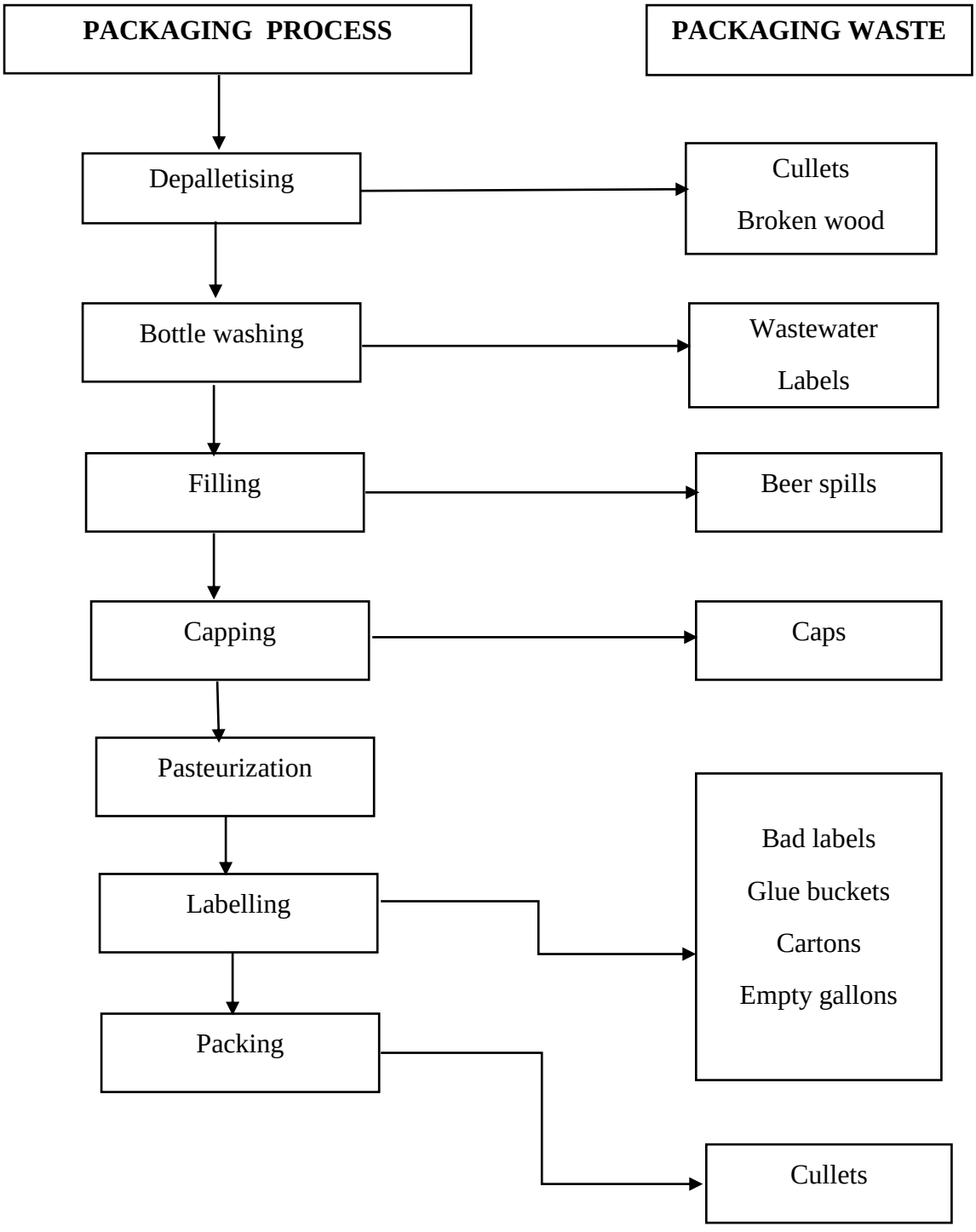

Figure 4.1.4 The packaging process and the main waste generated

Source: Author's own construct (2019)

i. Cullets and Broken wood

The people in charge of the packaging narrated that depalletizing involves the process of removing empty bottles from pallets. During this process accidents can happen, bottles can break when they are removed from the pallets. The broken glasses (cullets) which are the waste will be collected and kept in the skips. Some of the pallets can break thus broken wood will be collected as waste.

Bottles are packed in crates (Figure 4.1.5) and sent to the warehouse and ready for sale. The crates can be used over and over again. Some of the beer is rejected due to overfilling and some of the bottles also break during the packaging process. One of the packaging operators stated that:

> *"The rejected beer is poured in the drain and sent to the BTS. Also, when the beer is not handled well some of the bottles break. These broken bottles are sent to the dedicated skips. So the waste produced during packaging is the waste beer and the broken beer bottles." (Packaging operator, spent 3 years in ABL)*

The brewers explained that the advantage of using wooden pallets is that they can always be fixed in the brewery when they get broken. Also, they use crates (Figure 4.1.5) because they are very durable, they can reuse them several times.

ii. Labels

The respondents explained that bottles are rinsed after the bottles are removed from the pallets with water to remove impurities and cleared of labels especially bottles that are being reused. Any bottle that is not properly cleaned is rejected. Wastewater is generated during this process and small solid waste particles from the labels.

Figure 4.1.5 The crates which are used for packaging club beer

Source: Safo (2018)

iii. Bottle Caps

The capping process (Figure 4.1.6) as explained by the respondents is whereby the already filled bottles run through a capping machine. The capping machine seals the bottles with a cap. Due to machine errors, the respondents explained some caps are rejected and disposed of.

i. Bad Labels, Glue Buckets, Cartons, and Empty Gallons

After pasteurization (process for the longevity of beer) labels are applied. The filled and sealed beer bottles are run through a labeling machine. During the process, the respondents pointed out that they use glue to apply the labels. They explained that some labels are rejected because they did not come up nicely. These labels are collected as waste. The glue buckets, the cartons, and empty gallons are also collected as waste.

Figure 4.1.6 The capping process

Source: Safo (2018)

4.1.2 Liquid Waste

Large volumes of water are used by the breweries for two main purposes; one as the main ingredient of the beer and for the brewing process for cooling, steam raising, packaging, cleaning of the brewhouse and washing of floors (Enitan et al., 2015). This section focuses on the liquid waste produced during the brewing and the packaging process. Table 4.1 summaries the main areas where wastewater is produced during the brewing and packaging process.

4.1.2.1 Brewing waste

A large amount of wastewater is generated in the brewery. Wastewater is one of the significant waste products produced in the brewery (Olajire, 2012). It is estimated that approximately 3-10 liters of wastewater are generated per liter of beer produced in breweries even though there are some technological improvements been made (Zhu, Sarkis, & Geng, 2005). Wastewater is

generated almost at every stage of the brewing process. It is generated during the pre-mashing, filtration, wort-boiling, fermentation and filtration process. The sustainability senior staff explained:

> *"We have liquid waste. Beer is like 90% water. We use a lot of water in our process. At every stage, there is liquid waste being generated. Also when you go to the brewhouse there are a lot of processes like boiling and wastewater is being generated." (Sustainability senior staff, spent 4 years in ABL)*

The brewing process generates a lot of wastewater because the main ingredient of making beer is water which is about 90% of the beer. Most of this wastewater is treated at the wastewater treatment plant in the brewery.

4.1.2.2 Packaging waste

ABL brewers pointed out that water is used for cleaning brewing equipment, for cleaning floors and in the packaging process. In the packaging area, water is used to wash bottles and kegs. Bottles and kegs are cleaned to remove any kind of contamination that might be inside. Wastewater is generated from the washing bottles and kegs. It is also generated during the pouring of beer when some of the beer spills as explained by one of the packaging operators:

> *"The washed bottles are sent to filling machine which fills the bottles with beer. During the filling, some of the beer spills, therefore, will be washed away during the cleaning of the machine and it will be sent to the BTS." (Packaging operator, spent 3 years in ABL).*

All the water that is not lost by evaporation or by secondary products or not contained in packaged beer will be wastewater. This wastewater has the potential to pollute and it is a priority for the brewery. Therefore ABL reduces their polluting potential by treating their wastewater on-site in its wastewater treatment plant.

Table 4.1 Summary of Main areas of wastewater generation

Brewing Process	**Source**
Pre-Mashing	Rinsing in the mash tun and lush tun
Filtration	Last running and washing of spent grain
Wort-boiling	Rinsing hops and hot trub in the whirlpool
Fermentation	Rinsing
Filtration	Cleaning
Packaging Process	Beer spills
	Bottle washing
	Keg washing

Source: Author's own construct (2019)

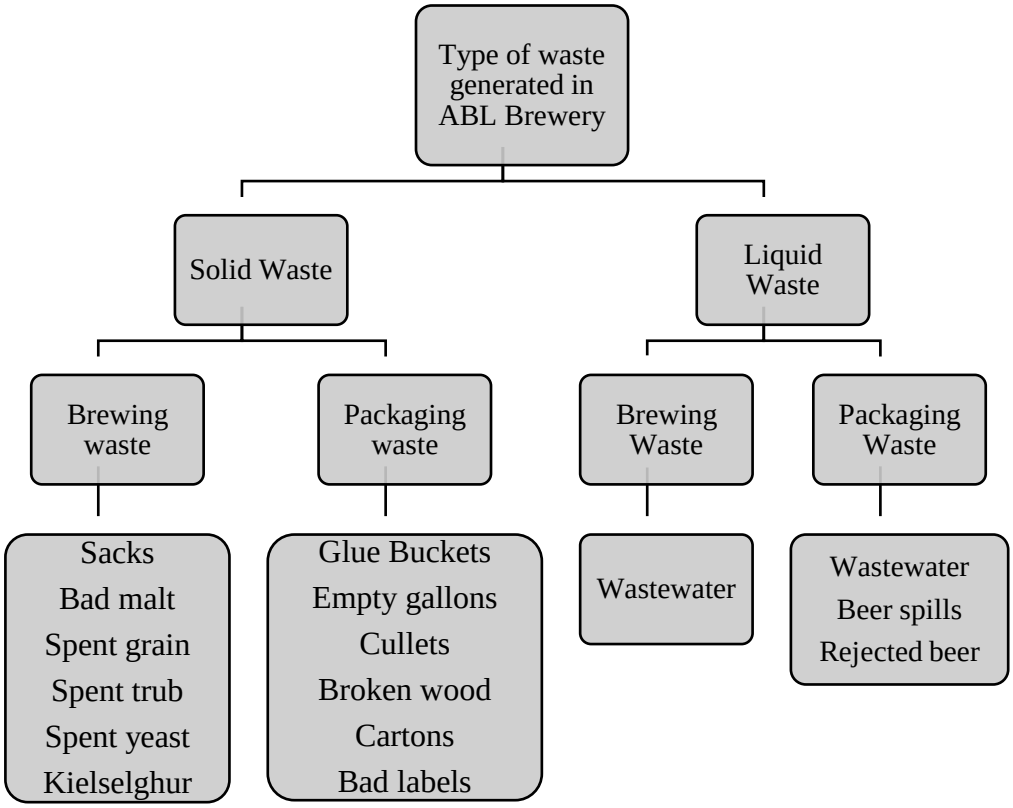

Figure 4.1.7 Representative summary of the type of waste generated in ABL

Source: Author's own construct (2019)

4.2 SUSTAINABLE WASTE MANAGEMENT IN THE BREWERY

Breweries around the world generate relatively large amounts of waste. Sustainable waste management is becoming a crucial issue while other methods such as storage, the disposal of liquid waste via sewage and landfill for solid wastes have a negative impact on the environment and very unsustainable and expensive. Most breweries would have to adopt different disposal options for their waste. Waste minimisation and finding other alternatives are key methods for environment protection. This section presents sustainable waste management practices in ABL. In order to understand the waste management in ABL, the respondents were asked questions like, "how do you sort, collect, treat and dispose of your waste?" The study found out that the different waste generated in the ABL is managed in different ways.

4.2.1 Solid Waste Management

When the respondents were asked how they sort out their waste, they explained that they segregate most of their waste but they were not satisfied with the level of waste segregation. They have trained the waste collectors on waste segregation but still, the majority of them mix the waste. The Environment and Safety senior staff criticized:

> *"I will say waste segregation is poor. Waste segregation is all about mindset and culture. We need to sensitize the guys. We tried it but second, third it didn't work. So we want to use it as a focus throughout the year and bring the guys on board. So we can provide appropriate bins, color-coded. First all we need to have a waste map. Once we have a waste map we will know where we are going to place every bin." (Environment & safety senior staff, spent 8 years in ABL)*

One of the Waste collectors (Figure 4.2.1) lamented:

> *"Even though we are trained on the separation of the waste, when we collect the dust bins sometimes we find the glasses mixed with the general waste and we cannot separate it when it is like that. Some of our guys want the dustbins to get filled quickly so they mix everything. We have different dust bins for different types of waste. The green bin we put the general waste and the blue bin we put the paper waste. For the skips, we put the broken glasses inside." (Waste collector, spent 6 months in ABL)*

Even though the waste collectors are trained on how to separate waste and still fail to do a good job, what is left is for them to be monitored so that they can do a proper job. By segregating the waste can also help the brewery to utilise waste as a secondary product and these will minimise the waste going to the landfill.

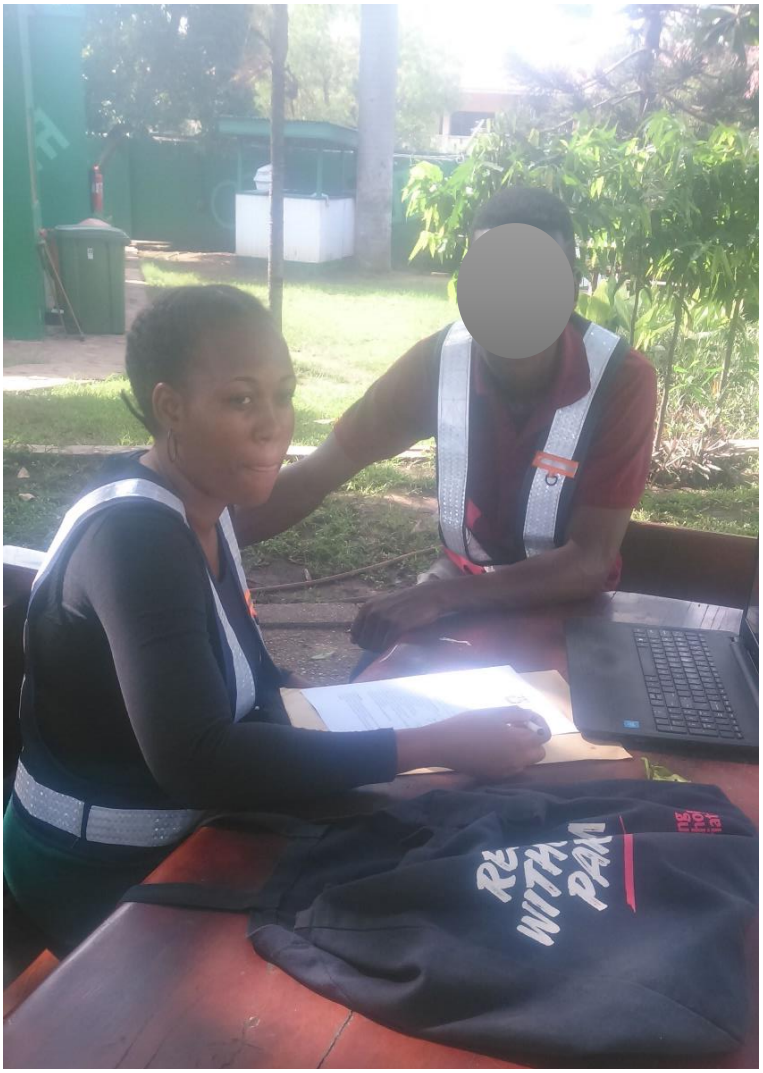

Figure 4.2.1 Interview with one of the waste collectors

Source: Fieldwork (2019)

4.2.1.1 Waste Storage

The respondents were asked how they store the different waste generated in the brewery. The results are presented in Table 4.2 overleaf. The malt and maize sacks are stored in large bins. The bad malt spent grain and spent trub are stored in the spent grain hopper (Figure 4.2.2). This mixture is rarely stored in the brewery because almost every day the farmers come for it. Figure

2.2.2 shows a silo at ABL that is used to store spent grain. The spent yeast is stored in the autolysis vessel. The kieselguhr which is used in the filtration process is stored in the kieselguhr tank. As for the cullet are stored in dedicated skips. Lastly, the general waste is stored in green dust bins and card boxes or papers are stored in blue dust bins.

Table 4.2.The waste storage

Solid Waste	**Storage**
Sacks	Large dustbins
Bad Malt Spent grain Spent trub	Spent grain hopper
Spent yeast	Autolysis vessel
Kieselguhr	Kieselguhr tank
Cullets	Skips
Organic waste	Skips
General waste	Green dustbins
Cardbox or paper	Blue dustbins

Source: Author's own construct (2019)

4.2.1.2 Solid Waste treatment

Waste treatment is important for waste management, but solid waste produced in the brewery cannot be treated because it can be used by other companies and some groups of people. Therefore, as for the solid waste, the respondents explained that they do not treat it. Henceforth, after storage the waste is taken to different places for disposal, some wastes are sold, some are recycled and some wastes are sent to the landfills. Table 4.3 shows the main summary of solid waste management. As for the emissions, the respondents explained that they perform some air quality tests as instructed by the Environmental Protection Agency (EPA). This was captured in one of the interviews with the Environment and Safety senior staff:

> *"We don't treat our solid waste hahaha! The only thing we do is that for recycling once we sell them. We perform some air quality tests that EPA has given so that we don't exceed the emission." (Environment & safety senior staff, spent 8 years in ABL)*

Figure 4.2.2 A silo or spent grain hopper

Source: Safo (2018)

The brewery is required to minimise its emission level as required by the EPA, failure to do so will result in the brewery being penalised by the EPA. Some of the equipments in the brewery like the CO_2 reclamation system helps the brewery to reduce its CO_2 emissions.

4.2.1.3 Reuse

i. Sacks

The main ingredients for making club beer are maize and malt, and for marking eagle beer is cassava. It was reported that these main ingredients are packaged in sacks. These sacks are sold to the general public.

ii. Spent Grain

ABL sells its spent grain to farmers. The Environment and Safety senior staff pointed out that they sell their spent grain to poetry farmers:

> *"Spent grain is sold to poultry farmers and those who are into pigs. We have given that to a third party to handle though."(Environment & safety senior staff, spent 8 years in ABL)*

They explained that they generate a lot of money from selling spent grain. The Sustainability senior staff explained there is a high demand for spent grain:

> *"Spent grain is a hot cake it sells a lot. Sometimes people come and we don't have it for them. Just in a year, we generate a lot of money from selling spent grain." (Sustainability senior staff, spent 4 years in ABL).*

Selling spent grain is usually the cheapest option for brewers. Spent grain is high in protein, therefore, there are other options for reusing it which ABL has not yet explored.

iii. Spent trub

The respondents reported that spent trub is mixed with spent grain and it is sold together with the spent grain.

iv. Spent yeast

Even though spent yeast can be used numerous times, the respondents explained that once the live yeast cells have died it is thrown down to the wastewater treatment plant. They explained that they have not explored other means of reusing yeast apart from reusing it in the brewing process.

v. Glue buckets, Plastic drum, and Empty gallons

As for the glue buckets, plastic drum, and empty gallons, ABL brewers explained that they sell them to the general public. One of the packaging operators commented that the general public usually uses the buckets of drums as a storage tank for water:

> *"Do you know some people in Ghana here have water challenges? Therefore they come and buy the buckets and drums and use them for storing water." (Packaging operator, spent 3 years in ABL)*

By selling the buckets and drums to the general public does not only help ABL to reduce its environmental footprint it also help ABL to generate money.

vi. Glass bottles and Kegs

ABL brewers that were interviewed explained that bottles and kegs can be reused several times. Figure 4.1.5 shows the club beer which is packaged in returnable glass bottles. The brewery opted for this type of packaging so that the bottles and kegs can be reused and reduce the brewery waste to landfill.

4.2.1.4 Recycle

i. Cullets

Materials which have no further purpose at the brewery are recycled. The respondents stated that broken glasses are recycled. A Nigeria based company comes and collects the cullets. The Environment and safety senior staff explained that there is currently no glass recycling company in Ghana that is why a Nigeria based company comes for the cullets.

> *"As for our cullets (the broken glasses), we have a company coming to collect them. A Nigerian company called Bolagee comes for the cullets. Even during packaging when some of the glass bottles break we send them to the dedicated skips so that the company can come for them." (Environment & safety senior staff, spent 8 years in ABL)*

The respondents also explained that the advantage of using glass bottles is it is 100% recyclable, the only disadvantage is that it is brittle and breaks easily. That is why they have a company that comes for the broken glasses.

4.2.1.5 Disposal

ABL has tried to divert a lot of their solid waste away from landfills by finding alternatives to recycle or repurpose their waste materials. Regardless, other wastes such as cartons, paper, broken wood, kieselguhr, general waste and organic waste from the effluent plant or the BTS, are not carefully disposed of. These wastes are currently sent to landfills.

The challenge the brewery face in terms of waste management is that the available landfills are currently full. Therefore they use a lot of diesel when the trucks spend the whole day looking for a space to dump the waste. This was captured in an interview with one of the truck drivers:

One of the truck drivers explained that:

> *"The landfill site is full and sometimes we go there and spend the whole day because we cannot find space for dumping our rubbish and that is the main challenge." (Waste truck driver, spent 3 years in ABL)*

The waste collector senior staff explained that:

> *"Another one has to do with the segregation, the mentality and the mindset of the people and that's to me its a national problem. They need to change their mindset. It is not easy and that has been a challenge. The other challenge is that sometimes the community people break the main drainage behind the wall. They break it and then they dump their own staff inside break the slab and they don't even dump liquid waste they dump all sorts of waste including solid waste. So we are faced with the challenge of removing that waste." (Waste collector senior staff, spent 3 years in the brewery)*

However, it can be deduced from their explanation that the landfill being full is a concern to the brewery as they use a lot of diesel searching for space to dump their waste. This means the brewery has to look for other alternatives to utilise their waste instead of sending it to the landfill.

Table 4.3 Main summary of solid sustainable waste management

Reduce	**Reuse**	**Recycle**	**Disposal**
Toxic substance	Spent grain Spent trub Spent yeast Sacks Plastic drum Empty gallons	Cullets	Kieselguhr Organic waste General waste Paper or cartons Broken wood

Source: Author's own construct (2019)

4.2.2 Liquid Waste Management

The pollutant load of the brewery wastewater is mainly composed of organic material from process activities. These wastewater effluent have a negative impact on the environment if it is discharged into the environment untreated. These effluent leads to eutrophication which increases aquatic plant growth and decreases dissolved oxygen and kills animal life (Hospido et al., 2005). The chemicals which are used from the cleaning products are also harmful to aquatic life (Olajire, 2012). Figure 4.2.3 shows the researcher during the tour at the effluent treatment plant or the BTS. During this tour, the researcher had an opportunity to interview the wastewater treatment controllers. They were asked how they treat the wastewater if they reuse the water after treatment and how they dispose of the wastewater.

Figure 4.2.3 The researcher at the effluent treatment plant at ABL

Source: Fieldwork (2019)

4.2.2.1 Wastewater Collection

The wastewater treatment plant controllers mentioned that there is a large tank or an effluent tank that has been installed in the brewery. The tank is used to temporarily store wastewater from all the brewery operations for treatment. Figure 4.2.4 shows one of the effluent tanks in ABL.

4.2.2.2 Wastewater Treatment

The wastewater treatment controllers explained that all liquid waste drains are channeled into the onsite wastewater treatment plant the Biological Treatment Section (BTS). They reported that the liquid waste is treated there to align with EPA requirements before it is discharged into the municipal drain. The coercive pressure, one of the elements of the institutional theory which

is adopted by the study state that certain rules and laws are imposed on companies to adopt environmentally friendly practices. Therefore, ABL is pressurized by the EPA to meet certain limits before they discharge their wastewater. The brewery has installed monitoring points to ensure their wastewater meets the requirements set by the EPA. The EPA also comes and get the sample of water to check if the brewery is compiling with the regulations. The wastewater treatment plant controllers explained the process of treating the wastewater to the researcher.

Figure 4.2.4 One of the effluent treatment tanks in ABL

Source: Safo (2018)

In this section at different stages, different parameters are tested. There is seven analysis that is done on the samples taken at different stages by the BTS controllers. This is done to make sure that the wastewater is safe to be disposed of so that it does not harm the environment. Figure 4.2.5 shows the different stages of the BTS.

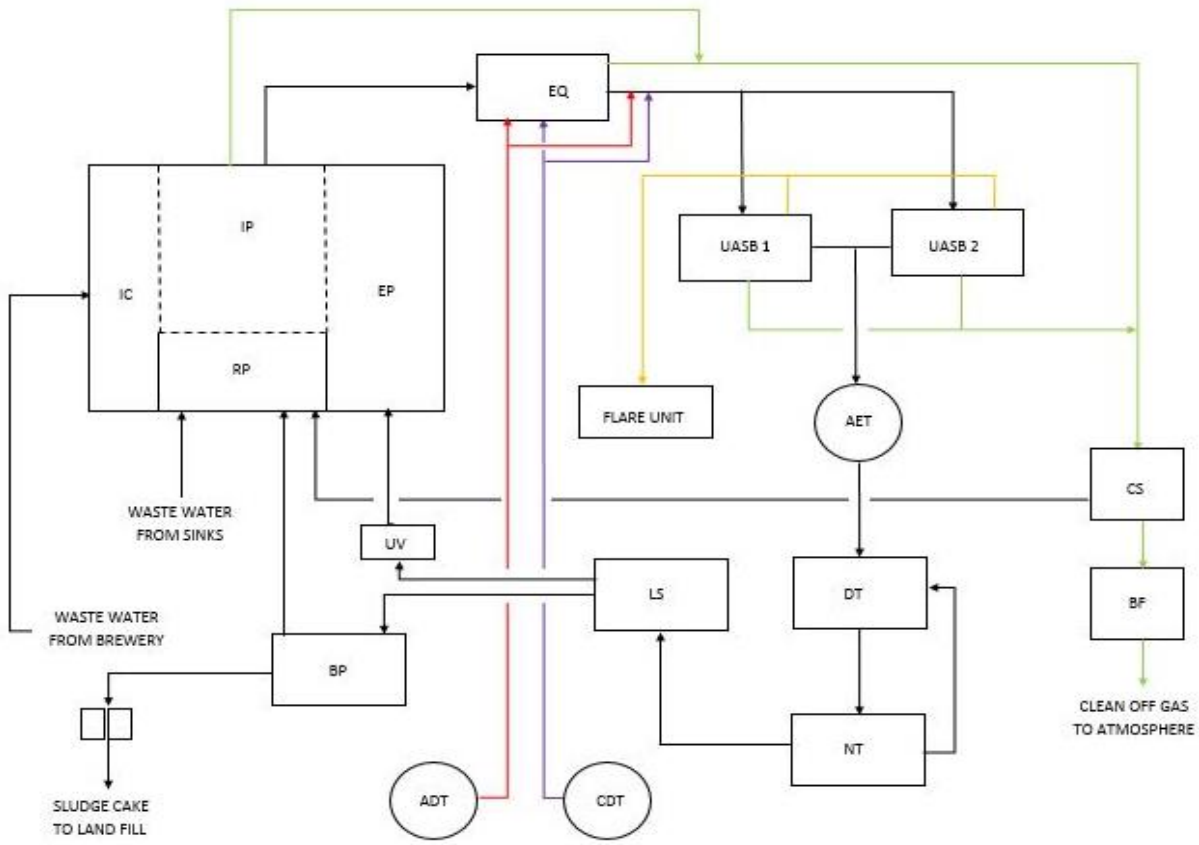

Figure 4.2.5 The Biological Treatment Section (BTS)

Source: Wastewater treatment controller's construct (2019)

i. Screening

Screening is usually the first step to remove some solid waste from the wastewater including labels, glass, bottle caps, spent grain and some plastic items. The wastewater treatment plant controllers explained how the wastewater is treated. They explained that every wastewater from the brewery comes to BTS. This wastewater comes through the effluent channel which is labeled as the (IC) in Figure 4.2.5. In the effluent channel, there is mechanical separation. The wastewater goes through a coarse screen and then goes through a fine screen. One of the wastewater treatment controllers explained what a fine screen is:

> *"The fine screen is a screen press so every debris and unwanted particles are taken out of the wastewater in the effluent channel before it goes into the effluent pit." (Wastewater treatment controller, spent 6 months in ABL)*

The majority of all the unwanted particles and debris are taken out when the wastewater goes into the effluent pit (EP). Then the wastewater is pumped into the Equalisation tank (EQ). In the EQ the wastewater is made to remain till the water stabilises in terms of pH and flow rate. It stays there for a while until the water stabilises. There is a stirrer in the EQ to make the wastewater homogenous. From the EQ the wastewater goes to the anaerobic treatment section. The equalisation allows the discharge to the municipal to be more consistent by level in terms of high and low pH this was captured in the interview with one of the wastewater treatment controller:

> *"Equalisation tank is used because the composition of the wastewater differs at various times of the day. The equalisation tank is beneficial to neutralise acidic or basic water, equalise temperature differences and dilute high concentrations of chemicals. The pH of wastewater that is too acidic (low pH) or too alkaline (high pH) can seriously corrode the pipes and affect the effluent treatment facility. High-temperature wastewater can also cause issues at the BTS." (wastewater treatment controller, spent 3 years in ABL)*

Therefore is very important the wastewater treatment controllers monitor the plant because if it is not monitored it can cause an issue at the BTS. They explained that they work in shifts, some come at night and some come during the day to monitor the wastewater treatment plant. Also, failure to monitor would lead to pollution when the water is disposed of in the municipal drainage system.

ii. Anaerobic treatment

Anaerobic means without an oxygen supply. So in the anaerobic treatment section, as narrated by the wastewater treatment controllers, the COD (chemical oxygen demand) or organic materials in the water is treated by the sludge. The sludge contained in the UASB (Anaerobic Slash Blanket) does the treatment. The water flows from the bottom of the UASB through the sludge upwards and then the wastewater comes to the top.

One of the wastewater treatment controllers added:

> *"That is why it is called up-flow anaerobic blanket water flows from the bottom of the tank upwards through the sludge and then water comes to the top." (Wastewater treatment controller, spent 2 years in ABL)*

After the treatment, water goes from each UASB into the anaerobic effluent tank which is labeled as the (AET), it goes there for temporal storage before it is distributed. From the UASB's after the first level of treatment which is the anaerobic treatment the wastewater now goes to the AET into the denitrification tank (DT). From the DT wastewater goes to the nitrification tank (NT). One of the wastewater treatment controllers explained the use of the denitrification tank:

> *"The purpose of the denitrification tank which is part of the aerobic treatment section is to take out ammonium ions. The ammonium ions in the wastewater are reduced to nitrogen gas." (Wastewater treatment controller, spent 3 years in ABL)*

From the denitrification section, it goes to the nitrification section. In the nitrification section, the wastewater is treated by sludge which is activated sludge. There are two types of sludge one is the anaerobic sludge and the other one is the aerobic sludge which is also called the activated sludge. The aerobic sludge which does not require oxygen to work is what treats the wastewater in the UASB 1 and 2. In the aerobic section, the aerobic sludge which is the activated sludge needs oxygen to work. In the denitrification, all the ammonium is converted to nitrate and nitrite ions later into nitrogen gas. In the nitrification section the remaining COD is now converted into carbon dioxide (CO_2). In nitrification and denitrification section the nitrogen gas and CO_2 are produced and while these are taking place the sludge is multiplied.

In the anaerobic section, there is seven analysis that takes place. One of the waste treatment controllers explained that they test for COD, pH, TSS (total suspended solids), total nitrate, total phosphate, VFA (volatile fatty acids) and sulphate. The pH that is the alkalinity or the acidity of the wastewater affects both the environment and the wastewater treatment. Low pH indicates increasing acidity and high pH indicates increasing alkalinity and a pH of 7 is neutral. This was captured in an interview:

> *"In the Anaerobic treatment, in UASB 1 and 2 there is seven analysis that we perform. We test for COD(Chemical Oxygen Demand), for pH, for TSS(Total Suspended Solids), for total nitrate, for total phosphate, for VFA(Volatile fatty acids) and for acid sulphate. We test for these things once a week. For the pH it should be between 4 and 11, that is it is not supposed to be below pH 4 and is not supposed to be above pH 11. For COD it should not be above 6000 it should be below 6000 milligrams per liter. The TSS, that is solids such as spent grain, yeast, trub, and hops are capable of settling can restrict the flow in the pipelines or cost more to treat therefore we need to make sure everything is removed."(Wastewater treatment controller, spent 3 years in ABL)*

The brewery performs seven analyses in order to be alignment with the EPA requirements. They perform this analysis so that they do not pollute the environment when they dispose of the wastewater in the municipal drainage system. Failure to perform to the tests will cost the brewery to repair its pipes and also suffer penalties from the EPA.

After the sludge works on the wastewater in the UASB that is after the aerobic treatment, biogas is produced. The orange line in Figure 4.2.5 represents biogas. The biogas is collected and currently is being flared. From the UASB's it goes to the treatment section the drying until part of the flair unit gas is dried and every moisture is taken out of it and made ready for flaring and it burnt in the sky. From the IP and the EQ and UASB 1 and UASB 2, the green line in Figure 4.2.5 represents off-gas. As wastewater is coming off-gas is been produced but this off-gas is treated before is left out into the environment. Offgas comes from the effluent pit from the EQ and UASB and they come together and they enter a section called the (CS) in the caustic scrubber all the harmful gases, that is the caustic gases and acidic gasses are washed/rinsed out with water. In Figure 4.2.5 the red line represents acid and the purple line represents caustic. The water used for rinsing goes to the rinse pit so that it can be sent back to the process. The off-gas from the caustic scrubber (CS) goes into the biofilter (BF). The biofilter also treats the gas before it is given off to the environment.

iii. Aerobic treatment

Aerobic means with oxygen supply. As for the aerobic treatment, one of the wastewater treatment controllers explained that in this section they do not perform a lot of analysis. From the nitrification section, the wastewater goes to a lamella settler (LS) which is the clarifier. The LS separates the wastewater from the sludge because after the aerobic treatment (which is the denitrification and nitrification) the wastewater is mixed homogeneously with sludge so all these go to the LS. Then the LS by gravity separates the wastewater from the activated sludge. When there have been separated the wastewater goes through the ultraviolet disinfection unit (UV) then straight into the effluent pit (EP) which is to be discharged into the drain then the sludge which has been separated in the LS goes to a section called the belt press unit (BP).

In the belt press (BP) unit the sludge is washed with normal water in the unit and squeezed (pressed and rinsed) and now become like a cake. It is made to coagulate using some polymer. There is a polymer unit for the slugged to coagulate and the water squeezes out the sludge. Cakes are formed and are dropped into skips and are taken to the landfills. The water that comes from the rinsing and the belt press unit goes to the rinse pit (RP).

The RP is used to take three different types of water. Water from the zinc in the brewery, water from the belt press and water from the caustic scrubber (CS). The assert dosing tank (ADT) and a caustic dosing tank (CDT) these two tanks the other contains acid and the other caustic. These tanks are used to stabilize the pH of the wastewater because given these is a biological treatment section there is some living organism that treats the wastewater. These living organisms can only be tolerated in wastewater otherwise they will die. So the pH is made to stabilizer by these acid and caustic. The acid can be dosed either in the IQ or the EQ in the pipeline just to neutralize the wastewater before it gets to the UASB where the sludge is.

4.2.2.3 Wastewater disposal

The wastewater controllers explained that after the wastewater is treated is disposed of through the effluent pit (Figure 4.2.6) to the municipal drain.

Figure 4.2.6 The Effluent Pit

Source: Safo (2018)

4.2.2.4 Reuse

The wastewater treatment controllers also explained that some of the treated wastewater are been reused for watering plants and used as flushing water in the toilet. The Environment and Safety senior staff explained that they have installed a sand filter which enables them to reuse the treated wastewater:

> *"We have started installing a system which contains sand filters to enable us re-use for gardening and in toilets as well as for washing of the floor."*

Reusing water to water plants and flush toilets helps the brewery to save money. This practice is not only good for the brewery because it is economical but because it is sustainable, and reduces their negative environmental impact.

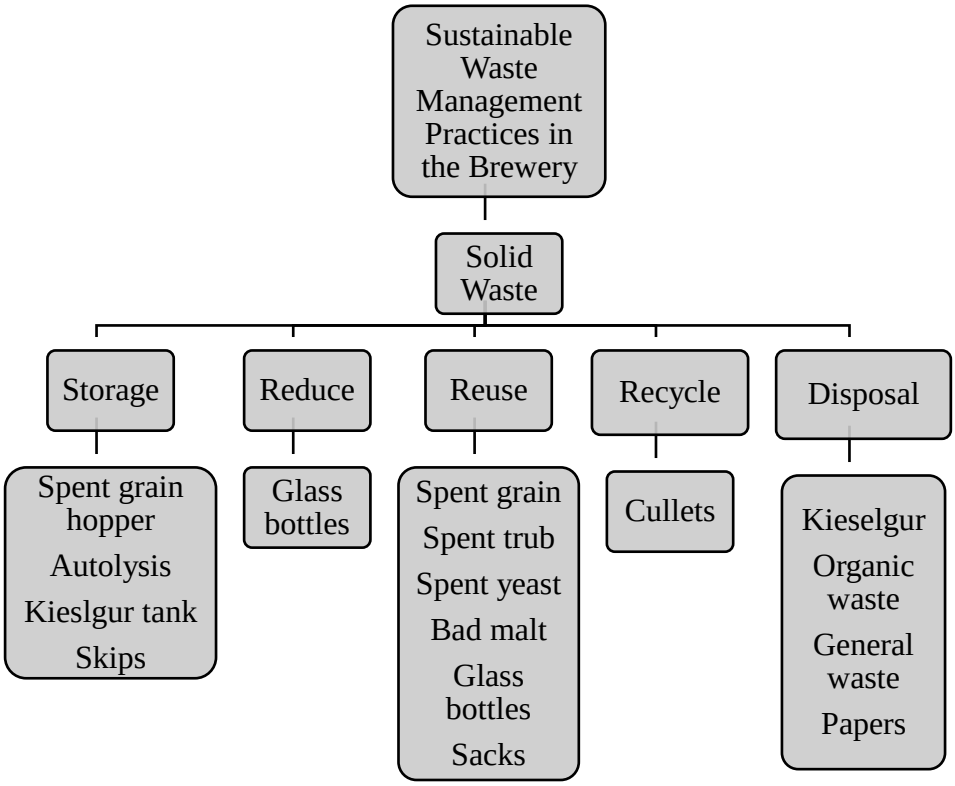

Figure 4.2.7 Representative summary of Sustainable waste management practices at ABL (Solid Waste)

Source: Author's own construct (2019)

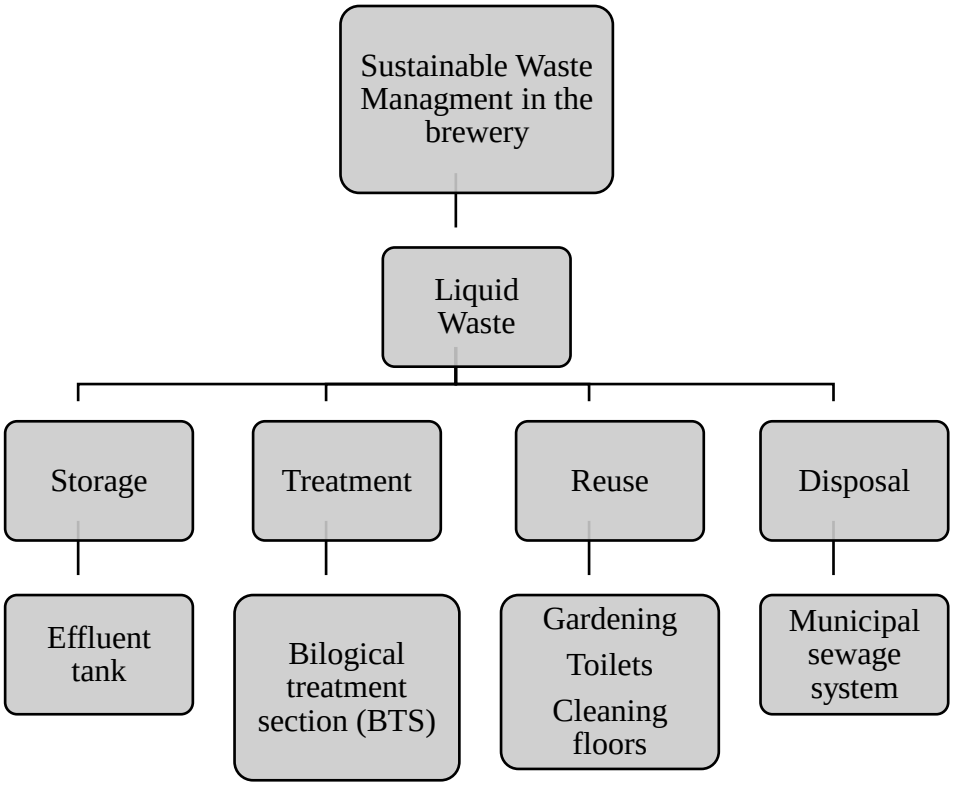

Figure 4.2.8 Representative summary of Sustainable waste management practices at ABL (Liquid waste)

Source: Author's own construct (2019)

4.3 The Role of Green Procurement in Sustainable Waste Management

From purchasing ingredients to packaging, brewers are faced with numerous challenges to make sure their activities are environmentally friendly. Brewers and procurement officers are always checking their operations to see what other steps they can take to lessen their environmental impact. Companies which are more sustainable in their supplier assessment involve the process of screening suppliers based on their environmental performance and doing business that only meets certain environmental standards or regulations. Green packaging and green product pollution control are some factors that these companies consider when it comes to supplier assessments (Mathiyazhagan, et al., 2013). The study identified that the brewery select suppliers that will help them achieve sustainable waste management. This section presents findings on the third objective of the study: examining the role green procurement

plays in the sustainable waste management of the brewery. The study identified the criteria that ABL uses when it comes to selecting their suppliers and the role green procurement plays in sustainable waste management.

4.3.1 Level of Awareness of Green Procurement

To make sure the response given by the respondent was valid and not hindered by deficient knowledge on the subject under study the researcher first assessed their level of awareness on green procurement. They were asked questions like *what is your knowledge regarding green procurement?* The study found out that out 11 of 18 of respondents did not understand what green procurement was even though they were practicing it except for the environmental, sustainability and procurement officers. However, the researcher explained the concept to all of them after they shared their own views on the concept. The procurement senior staff tried to explain the concept:

> *"So green procurement I would say is purchasing of environmentally friendly goods and providing environmentally friendly services as well. The first thing that comes to mind when I hear green is sustainability. To brew our beer we use natural resources. Best ingredients result in quality beer. For us to continue to brew beer we must be sustainable. Whether it is purchasing barley or maize or cassava we have to make sure of the availability of resources. We talk of the four goals we need to purchase returnable bottles which are in line with our circular packaging goal."*

The explanation given by the procurement senior staff implies that he has knowledge about green procurement. It also means that they are environmentally conscious when it comes to making purchases in the brewery.

4.3.2 Environmental criteria ABL uses to select suppliers

ABL is committed to selecting suppliers who will work with them to achieve their sustainability goals and to uphold their principles of environmental protection, fair working conditions, and ethical conduct. ABL requires all of its suppliers to agree to their principles of responsible sourcing.

ABL 2025 sustainability goals are (ABInBev, 2019):

- **Smart agriculture**: "By 2025, 100% of our direct farmers will be skilled, connected and financially empowered".
- **Climate action**: "By 2025, 100% of our purchased electricity will be from renewable sources and we will have a 25% reduction in CO_2 emissions across our value chain".
- **Water stewardship**: "By 2025, 100% of our communities in high-stress areas will have measurably improved water availability and quality".
- **Circular packaging**: **"**By 2025, 100% of our product will be in packaging that is returnable or made from the majority of recycled content".

Even though the company does not have a policy on green procurement, their 2025 sustainability goals and their responsible sourcing policy are in line with the concept of green procurement. As a subsidiary of ABInBev, ABL follows every policy given by its parent company. In ABInBev's global responsible sourcing policy, there is a section on the environment that requires all their suppliers to observe their laws and regulations concerning the environment and to ensure the protection of the environment. Therefore, ABL also requires its suppliers to have a focus on the following (ABInBev, 2019):

- **Energy**: "Measure energy usage and commit to reducing it both in manufacturing operations and transporting products".
- **Water**: "Measure and commit to reducing water usage and discharge".
- **Waste**: "Measure and commit to reducing the production of non-hazardous solid waste. Maintain a list of hazardous and non-hazardous substances, and establish procedures for the safe handling, transporting, and disposing of waste with international, national or local regulations".

This was also captured in the interview with the procurement staff:

> *"As a subsidiary of ABInBev, we are working towards achieving our 2025 sustainability goals which are focused on smart agriculture, circular packaging, water stewardship, and climate action. Our procurement function plays an important role in achieving our brewery's 2025 sustainability goals by training our suppliers to adhere to our supplier code conduct: operating a transparent pricing structure with suppliers; and conducting a financial and governance audit with all raw material and packaging suppliers before they are on barded onto our approved vendor list. With our 2025 goals sustainability will financially empower the farmers from which we source our raw materials such as maize and cassava, use more recyclable packaging, improve the availability of water in high-stress areas and reduce our carbon increased renewable energy use by 100%. All our suppliers adhere to the strict compliance standards set in the business in order to further strengthen our business reputation." (Procurement staff, spent 6 years in ABL)*

In procurement, a company is as good as its supplier network and it is important that ABL invests in and develops not only a strong network but a network that is made up of the right partners and suppliers.

4.3.3 Green Procurement practices in ABL

4.3.3.1 Circular Packaging

One of the sustainability goals of the company is circular packaging. Packaging materials offer some of the best opportunities for material reuse, recycling, and waste reduction. The company is constantly looking for ways to increase the recycled materials in their packaging, to reduce the number of materials they use in packaging and to increase the rate of recycling through the reuse and recovery of materials. ABL purchase wood pallets which they use for holding empty bottles to carry to the filling areas and to hold finished products. Wooden pallets can be reused and when they are broken they can be recycled. They also use crates for packaging the beer to take to the retailers. Crates are used because they are used to return the empty glass beer bottles back to the brewery. The procurement staff mentioned the benefits of using glass bottles:

> *"The lifecycle of returnable glass bottles is approximately 8 times less carbon-intensive than one-way glass bottles. The returnable bottle enables us to recycle, reuse and hence reduce our environmental impact. Mind you, glass is brittle by nature and therefore it breaks as a result of age or the way people handle it. As our approach to environmental sustainability broken glasses is collected and taken by a recycling company based in Nigeria. This is where it is melted and remolded into a new glass bottle. Our brewery does not benefit from this, but it's our environmental responsibility and a way to reduce our waste footprint." (Procurement staff, spent 6 years in ABL)*

As one of the brewery's initiatives in circular packaging, they purchase multiple way glass bottles and kegs. This is to ensure that the glass bottles and kegs are used and returned to the brewery for reuse in packaging. The brewery also works with their distributors and consumers to return their bottles.

Currently, the brewery is not working directly with all of its suppliers. There are planning to work with them directly. They would want their suppliers to tell them their initiatives and projects they are working on and how they are impacting change in their own value chain. The procurement officers are continuously identifying new materials from the suppliers which have less impact on the environment. The procurement senior staff reported:

> *"Yes, we look at how our products affect our environment. Last week I spoke to one of our suppliers. We have a recycling program we want all our products to cause less impact on the environment. I asked them to come up with a recycling plan since they are supplying us with the plastics. This our ideal and preferred supplier who can supply us products which can be recycled." (Procurement senior staff, spent 1 year in ABL)*

Identifying the right supplier is a challenge for ABL. The right supplier is the one that understands the vision of ABL. Therefore, the procurement officers are always looking for suppliers who are in line with their sustainability goals, the kind of suppliers who are environmentally friendly.

4.3.3.2 Local Sourcing

Most of ABL's ingredients such as maize and cassava are sourced locally. One of the company's sustainability goals is smart agriculture and as a brewery, they depend on agricultural crops to brew beer. Therefore, they are planning to work directly with the farmers. ABL has helped the local farmers it buys from. It has helped solve the water crisis in drought-prone areas. The brewery also believes that when they purchase locally they save tonnes of CO_2 from being emitted. The senior procurement staff shared their initiatives with the researcher:

> *"As for Smart Agriculture, the availability of our raw materials is very important. If we are not sustainable we won't have a business. For maize and cassava that we are buying we want to understand what the constraints with farmers are. One thing we have realized is that in Ghana there is a yield issue. Yield issue is due to a lack of knowledge, poor planning, and poor planting. So we need to know what can be done to improve the yield. As we want to work directly with our farmers we love them to also reduce the use of fertilizers in crops thus reducing carbon emission in the chain. We also believe that we reduce our emission when we source locally." (Procurement senior staff, spent 1 year in ABL)*

Working directly with the farmers will help ABL to achieve one of its sustainability goal which is smart agriculture, which they plan to empower their farmers. Also working with the farmers will help them to increase their yield and help them to choose the right seeds that will produce more yield.

4.3.3.3 Fuel Efficiency

The brewery has purchased a system called the sunstone tracking system. It has been installed in the trucks. This system allows them to track their drivers. It allows them to know how much fuel was used per trip. In a situation whereby the driver is over speeding or takes a different route, the system alerts the person in charge of transport and logistics. Therefore, if drivers drive at the normal speed they conserve fuel. Henceforth, this system is making the brewery to

be fuel-efficient. The researcher asked the respondents if they have also put the same device in their waste trucks, which they said 'no'. The Logistics and transport senior staff explained:

> *"Ooh well as for the waste trucks we have not put the device in them because our main priority is our products and our ingredients. We have installed only in our delivery trucks because we need to know where they are going and how long they take and how much we can save in our fuel usage."(Logistics and transport senior staff, spent 2 years in ABL)*

They stated that some of their suppliers have installed the system after they explained to them how it works. As for those who did not patronize it they are constantly asking them what they are doing in terms of fuel efficiency. The procurement staff stated that:

> *"Is something we are trying to do. For example, I constantly ask the suppliers what they are trying to do about their fuel efficiency and how much they are using per kilometer. As we are starting to work directly with our suppliers we will love them to increase their recycled content and reduce emissions in the chain." (Procurement staff, spent 6 years in ABL)*

In everything that they do, the procurement officers are always trying to know what their suppliers are doing in terms of the environment. The fact that they are conserving fuel they also want their suppliers to do the same.

4.3.3.4 Energy Efficiency

When procuring equipment, energy efficiency is taken into consideration. Apart from purchasing energy-efficient equipment, the brewery has purchased and installed energy meters. Procurement officers explained that the company bought these meters to help them to know how much they are using and so that they can try to come up with other ways to avoid wastage. The brewery is planning to generate electricity using biogas from the wastewater treatment plant. The brewery is also planning on installing solar panels energy to support their current source of energy they use. The procurement officer explained how they have purchased and also installed solar street lights to try to conserve energy. The procurement staff explained:

"Non-renewable energy degrades the environment, our plan is to reduce our dependency on it. We are also working towards achieving a 100% dependency on renewable energy. We are seriously venturing into solar energy. Currently, we have some solar street lights which we have installed in our brewery." (Procurement staff, spent 6 years in ABL)

Figure 4.3.1 Solar-powered streetlight at ABL

Source: Safo (2018)

4.3.3.5 Staff Education on Green Procurement

The procurement officers explained that they educate staff on energy efficiency, water conservation, and resource conservation. In relation to energy, they tell their staff to shut down equipment when they are not using them. Also, they tell them to shut off lights in areas where light is not required and when they leave the office they should switch off the air conditioner. The senior procurement staff narrated:

"We always try to educate our staff on issues of green practices. From the use of our machinery to the lights in our offices. We educate them on switching off machines or their office lights when they are not in the office. We also have a

policy whereby the staff of the brewery is only allowed to print 10 copies a month". (Procurement senior staff, spent 1 year in ABL)

ABL has a policy within the brewery where they only allow a staff member to print not more than ten copies a month that way they also save paper. This policy helps ABL to save paper and reduce wasting paper.

4.3.3.6 Hazardous Material or Chemicals

The brewery tries by all means not to purchase hazardous or toxic materials or chemicals. Whereby there are no other alternatives for example chemicals and sanitizers which are used for cleaning in the brewery, the workers are trained. The workers are trained on how to handle, how to mix and proper disposal of the containers after use. The workers are also advised to wear protective clothing when using toxic chemicals.

4.3.3.7 Water Stewardship

One of the brewery's sustainability goal is Water Stewardship. They believe that water is a global challenge, that is why they look beyond their operations and plan to improve water access and security to communities they work and live in. The brewery is engaged in a project called the Eagle farmer project whereby they provided the farmers in Tidongo Upper East Region with a solar-powered irrigation system and solar-powered mechanized borehole. This was captured in an interview with the procurement staff:

"About two years ago, we invested in our farmers because they had some water issues. So we invested in their irrigation system. Farmers across the country have benefitted from our Eagle farmer project. We have installed solar panel furrow irrigation systems. One of the recipients of our irrigation systems were from the Upper East Region, Tindongo and Gambibgo. Where drought is a serious problem." (Procurement senior staff, spent 6 years in ABL)

They purchased this irrigation system to offer an alternative to rain-fed agriculture for their locally-sourced cassava beer Eagle lager. This is one of their initiatives to try to conserve water through their value chain.

4.3.3.8 Wastewater Treatment Plant

ABL brought some equipment for the construction of a two-step anaerobic and aerobic treatment plants that purify and reprocess all water produced from their brewing operations. The process involves the removal of solids from the wastewater, restoration of pH balance of the water and conversion of organic material into biogas. The biogas that is produced is currently being flared to minimize the impact on the ozone layer.

> *"In the near future, we will be able to use the biogas we generate from the wastewater treatment plant to generate electricity and power our brewery. Concerning our organic waste from the wastewater treatment plant, we are currently talking to one company which wants to pilot our organic waste and use it as a fertilizer on their farm." (Environment & safety senior staff, spent 8 years in ABL)*

ABL does not plan to flair the biogas forever, it has plans to use the biogas to power the brewery in the future and to use or sell the organic waste from the wastewater treatment plant as a fertilizer.

4.3.3.9 Monitoring Checkpoints

The brewery has installed monitoring points to measure for TSS, pH, COD, VFA, total nitrate, total phosphate, and sulphate. This is to make sure that the wastewater is treated well before it is discharged to the municipal drainage system. The EPA also requires the brewery to dispose of clean water to the municipal drain.

4.3.3.10 Water Meter

The brewery monitors the use of water on a daily basis. They have installed water meters to measure and control water consumption. The procurement explained further:

> *"We bought water meters to monitor our water usage. We did this with a goal in mind to decrease the brewery's water intensity. So far, we have been able to know which areas we need more improvement in terms of water conservation. When we use less water it means less wastewater will be generated".*

4.3.3.11 Sand Filters

The brewery has purchased and installed a system which enables them to reuse the water in other areas in the brewery. The Environment and safety senior staff explained:

> *"The request we made for the brewery to purchase sand filters was a smart move from my department. In the past, we were just treating our wastewater and then dispose of it in the municipal drainage system. The sand filters enable us to reuse our wastewater in flushing our toilets and watering our gardens. "*

4.3.3.12 CO_2 Reclamation System

The brewery has installed a CO_2 reclamation system. The system captures the CO_2 produced during the fermentation process and distributes it for other processes like the filtration process. The brewery also sells this CO_2 to other breweries and other companies. The production senior staff explained why they bought the system:

> *"Buying the CO_2 reclamation system was no brainer. The system helps us to capture CO_2, use it in other processes and reduce our carbon emissions. It is more cost-effective for us to use this than purchasing CO_2. Instead, we are now the once selling to other breweries and other companies."*

4.3.4 The Role of Green Procurement on Sustainable Waste Management

In relation to the green procurement activities in the brewery, the study has established that there is a role that green procurement play in sustainable waste management. Green procurement plays a role in solid waste, liquid waste, and emission levels reduction and waste elimination.

4.3.4.1 Solid Waste Reduction

The brewery reduces solid waste from going to the landfill by applying the principles of green procurement. They reduce waste by purchasing materials with less packaging and reusable packaging like sacks. They also make sure they use less packaging and use returnable packaging for their own products. They also reduce solid waste by reducing the printing of hard copies and they utilize the use of paper invoicing and electronic funds transfer. ABL as a

manufacturing company it makes sure it plays its part by practicing extended producer responsibility by returning the beer glass bottles to the brewery after use. Therefore, everything they use for their packaging they return it back to the brewery, for example, the crates and the beer glass bottles.

4.3.4.2 Liquid Waste Reduction

The initiatives made by the brewery to minimise the water footprint supports green procurement. The purchase of water meters has helped the brewery to reduce the amount of water they use in production. The installation of the wastewater treatment plant has helped in cleaning the wastewater before is being discharged. Also, the installation of sand filters has helped in reducing wastewater by reusing some of the wastewater after treatment. The dilution of some chemicals used in cleaning also helps in wastewater reduction and this has a positive influence on the environment.

4.3.4.3 Waste Prevention

The brewery always tries to always use the raw materials that they have purchased to avoid wasting them. They always try to purchase only products or items that they need. The brewery eliminates waste by not purchasing items or equipment which they do not need or products which are toxic or which are not sustainable. The procurement staff elaborated that there are certain questions they ask themselves before they can purchase certain items to avoid having things that they do not even need:

> *"So most of the time before we make a purchase we ask ourselves some very important questions. Do we really need to buy this thing? Will this equipment or item do the work we require it to do? Does purchasing this item support our sustainability goals will it not harm the environment, is this item not potentially unsafe or hazardous? Does the consultant have good environmental credentials? Do we even know the supplier or we should stick to the one we know?"*

4.3.4.4 Emissions Levels Reduction

The production of beer inevitably leads to some waste products in the form of spent grain, spent hops and spent yeast. If this ends up in a landfill, it produces damaging methane a greenhouse gas at least 20 times more potent than CO_2. ABL sells its spent grain to farmers and reuses its yeast it does not send these waste to landfills. The transportation of waste to be disposed of creates even more pollution to the already negative impact of waste creation. ABL purchase, mostly materials which can be reused and recycled therefore there is less waste being sent to the landfills and thus reduce emissions. The environment is affected negatively by the combustion of fossil fuels in transportation. Therefore, since the brewery also monitors the use of fuel this also leads to a reduction of emission levels.

CO_2 reclamation system helps the brewery to reduce its emission to the environment as it captures the excess CO_2 generated in the brewery. Carbon dioxide, methane and nitrous oxide emissions are directly related to the use of energy and therefore when the ABL minimises the consumption of energy it leads to a reduction of greenhouse gas emissions. Thus this leads to the prevention of climate change.

4.3.5 Challenges of Implementing Green Procurement

4.3.5.1 Price

One of the challenges that the procurement and other workers complained about with purchasing of green products was the price. They lamented that most of the products they buy are from abroad and these products are coded in United States dollars instead of Ghana cedi which makes them very expensive for the company. Even though they realize green products cost more, they do acknowledge that they have more benefits and last longer.

4.3.5.2 Smallholder Farmers

The challenge when it comes to the farmers they have a challenge because they work with smallholder farmers. They are not delivering well in time, therefore, they get their raw material, not for only one farmer but a lot of farmers. So it becomes very difficult for them to monitor them in terms of the use of chemicals on their farms and to check if they do not use children in their farms. Therefore it's it becomes difficult for them to even have a relationship with their suppliers.

4.3.5.3 Availability of Green Products

They complained that local distributors do not stock the green products and sometimes when they stock they stock in small quantities. This delays them in obtaining the product. They sometimes import the products. Most of the time they settle with the available product.

4.3.5.4 No Other Alternative

The most challenging factor for the brewery is when the product they want does not have any alternative that does not have a negative effect on the environment; therefore, they end up buying a product which has a negative impact on the environment because they did not have an alternative.

4.3.5.5 Unreliable Information

Most of ABL's suppliers do not offer them information on their environmental responsibility and they do not produce any sustainability reports for them to know how they are performing in terms of their environmental footprint. They complained that a supplier can tell them that their practices are environmentally friendly but they do not have any written document or anything to prove that they are telling the truth.

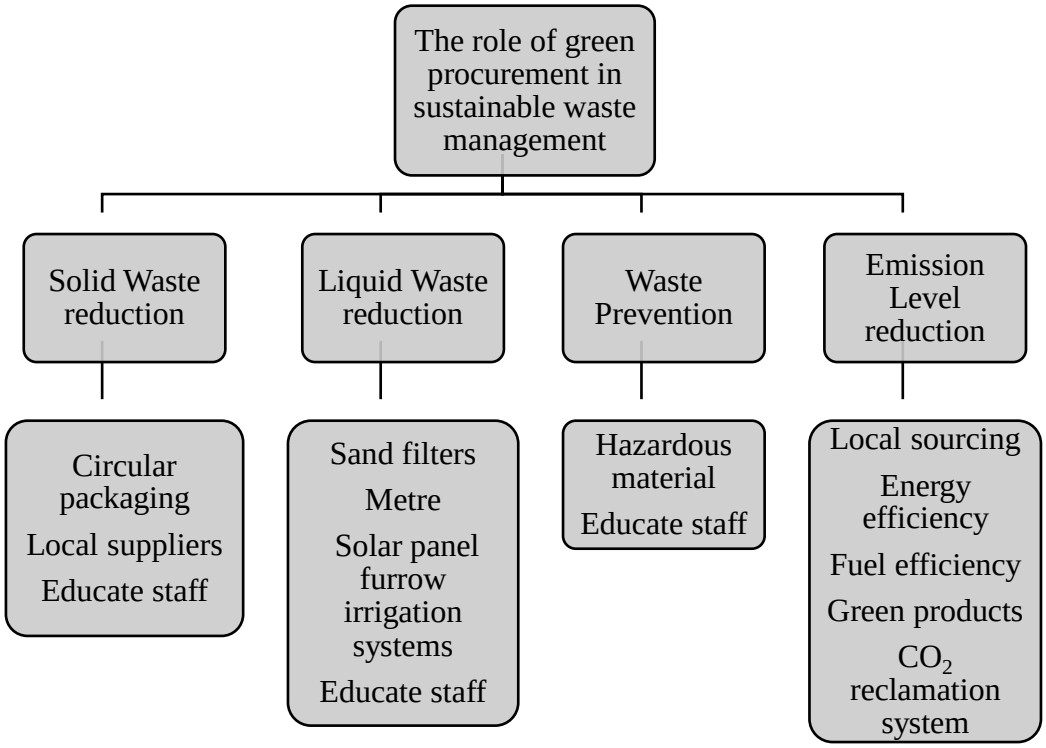

Figure 4.3.2 Representative summary of the role of green procurement in sustainable waste management

Source: Author's own construct (2019)

4.4 Discussion

In this section, after the review of the specific objectives, the key findings of the study are discussed. The study sought out to identify the nature of waste generated in the brewery; explore sustainable waste management practices adopted by ABL, and examine the role green procurement plays in the sustainable management of waste in ABL. The study discovered that solid and liquid wastes are the main wastes generated in the brewery. The study also found out that the brewery uses sustainable means to manage its waste. Lastly, the study attempts to explain the role green procurement plays to achieve sustainable waste management. These findings are compared with the existing body of literature to ascertain validations and variations.

4.4.1 Nature of Waste Generated in the Brewery

The results of the study build on the evidence that solid, wastewater and emissions to air are the types of water generated in the brewery (Olajire, 2012; Patterson, 2016). The results also validate the evidence that brewers generate a lot of hazardous waste, solid waste, massive amounts of wastewater, recyclable materials and reusable by-products (Fillaudeau et al., 2006; Olajire, 2012; Kerby &Vriesekoop, 2017). The study has found out that liquid and solid wastes are the main wastes produced in the brewery as illustrated in Figure 4.1.7. This validates the findings of Fillaudeau et al., (2006), Olajire (2012) and Kerby and Vriesekoop (2017) which explain that liquid and solid wastes are the main waste generated in the brewery.

The results indicate that solid wastes consist of organic materials from the brewing process and materials from the packaging process. Kieselguhr is one of the wastes generated in the brewery during the filtration process. However, based on the findings of a similar study by Fillaudeau et al., (2006) suggests that instead of using kieselguhr the brewery should use other alternative filtration processes that exist. Some breweries filter their beer using a centrifuge which uses centrifugal force to separate the solids from the beer, filter pressing using membranes to screen out particles, or simple sedimentation allowing the particles to naturally settle to the bottom. This is because kieselguhr has been classified as a very hazardous waste (Olajire, 2012).

While previous studies have focused on the solid wastes produced during the brewing process (Fillaudeau et al., 2006; Olajire, 2012; Patterson, 2016; Kerby &Vriesekoop, 2017) results demonstrate in Figure 4.1.1 and Figure 4.1.4 indicates that there are a lot of solid wastes generated during the packaging process as well. While previous studies focused only on solid waste generated during the brewing and packaging the present study also focused on some wastes generated in the brewery that is office wastes, wastes from the bar (the bar in the brewery) and waste from the kitchen. The study classified these waste as general waste as the brewery classified it as general waste and it mixes it up and disposes of at the landfill.

The study contributes a clear understanding that wastewater is generated at every stage of the brewing and the packaging process. As in one earlier study (Fakoya & Va de Poll, 2013), this study also found that the brewery processes also generate liquids such as weak wort and residual beer.

4.4.2 Sustainable Waste Management in the Brewery

The study found out how ABL manages its solid and liquid waste stream as illustrated in Figure 4.2.7 and Figure 4.2.8. Even though ABL segregates most of its waste. It does not recycle its paper and plastic; it sends it to the landfills which support the findings by Khidzir et al (2010) that most of the brewery waste is discarded to landfills. Recycling other materials used in the brewery like wood, plastics, and cardboard can result in fewer environmental impacts (Simon et al., 2016).

As it has been found by various studies, most brewers, including ABL, sell their spent grain to local farmers to be used for animal feed (Fillaudeau et al., 2006; Mussatto, 2006). Other scholars have found other means for utilising spent grain (Stocks et al., 2002; Aliyu & Bala, 2011; Farcas et al., 2014; Kerby & Vriesekoop, 2017). However, in Ghana, the spent grain is a commercial product only for the livestock industry (Puplampu & Siebel, 2005) while other scholars have found other means for utilising spent grain (Kerby & Vriesekoop, 2017; Farcas et al., 2014; Aliyu & Bala, 2011; Stocks et al., 2002).

The study found out that the spent trub can be utilised as an animal feed and is mixed with spent grain. Contrary to this, previous studies have found other means of utilising spent trub, such as a fertiliser (Mathias et al., 2014) and insect repellent (Bedini et al 2004).

During the fermentation process, ABL produces spent yeast and CO_2. There is a system it uses to capture CO_2 and redistributes it in other production functions and the rest is sold to other companies and breweries. ABL only reuses its spent yeast and when it cannot use it anymore

it sends it to the wastewater treatment plant. This validates the study of Puplampu and Siebel (2005) that most of the by-products from the Guinness Ghana Brewery are not utilised; the yeast is sent straight to the wastewater treatment plant. The study demonstrates that spent yeast in ABL is not utilised. Mathias et al. (2014) found out that spent yeast can also be used as an animal feed and in the food industry (Podpora et al., 2016). ABL has an anaerobic digester on site, spent yeast can be composted with the brewery's other organic wastes and used to generate natural gas (Kerby & Vriesekoop, 2017).

Previous studies have found that there are other ways of utilising brewery waste, but ABL has not yet explored other means of reducing some of the wastes it sends to landfills. Kieselguhr is considered hazardous waste and it also contributes 1-2 grams of hazardous waste per gallon of clarified beer produced according to Olajire (2012). The currents study has found out that even though kieselguhr is considered a hazardous waste, ABL has not explored other means of utilising this waste.

Currently, ABL sends the kieselguhr to the landfills just Puplampu and Siebel's (2005) finding that Guinness Ghana Brewery also sends its kieselguhr to landfills. There are many ways the brewery can utilise kieselguhr. Kieselguhr can be used in the generation of electricity (Kanagarachndran 2005), biogas production (Babel et al., 2009) and in the production of hydrogen (Fan et al., 2006).

The study indicates that the brewery uses anaerobic and aerobic treatment to treat its wastewater. This validates other studies which indicated that some breweries use the same method to treat its wastewater (Fillaudeau et al., 2006; Olajire, 2012). The study found out that ABL treats its wastewater before disposal. The findings are in line with Bedu-Addo et al., (2013) who found that a certain brewery in Ghana (brewery x) treats its water before disposing of it.

The study demonstrated that the wastewater treatment plant produces organic waste, methane, and biogas, which the brewery is currently not utilising. The biogas and methane are captured and flared. Instead of flaring these gases, the methane can be captured and used to power boilers (Olajire, 2012) while the biogas can be used to generate electricity for the brewery (Muster-Slawitsch et al., 2011). Organic waste produced during the wastewater treatment is revealed to be good for plant growth with high water retention (Zhu, Sarkis, & Geng, 2005). Instead of selling the organic waste the brewery disposes of it to landfills.

4.4.3 The role of Green Procurement on Sustainable Waste Management

The findings of the study revealed that green procurement has a role to play in sustainable waste management as illustrated by Figure 4.3.2. Green procurement has a role in solid waste reduction, liquid waste reduction, emission level reduction, and waste prevention. Various scholars have also examined green procurement as a possible tool that reduces the generation of waste at the sources (Guenther et al., 2010; Klassen and Vachon, 2003; Bowen et al., 2001). Furthermore, the study revealed that green procurement is a strategy that helps to improve efficiency, reduce waste and enhance the competitiveness of organizations (Yang & Zhang, 2012).

The brewery has adopted certain green procurement practices as illustrated by Figure 4.3.2. which is in line with what Olajire (2012) suggested. He stressed that breweries need to go green for effective cleaner production. Islam et al (2017) adopted certain green procurement practices which are in line with the study for example (i) Carbon reduction in the movement of products to facilities, ABL has installed a tracking device in their trucks to reduce the amount of diesel it uses and in return it reduces in the emission of carbon. (ii) Buying from small and local suppliers, ABL buys its raw materials like maize and cassava from local farmers. (iii) Products potential for recycling or reuse, ABL purchases products which are recyclable and which can be used again. (iv) The willingness of suppliers to commit to waste reduction goals,

procurement officers of ABL are constantly asking what their suppliers are doing in terms of waste reduction and some of their suppliers have installed a tracking device as suggested by ABL to help them to reduce their petrol usage.

The findings of the thesis also revealed that ABL practices circular packaging, sources locally, it has installed water meters, sand filters and educate its staff on issues of waste reduction and green procurements. These practices are helping the company to reduce solid and liquid waste, reduce emission levels and eliminate waste. Currently, the brewery is making sustainability reports internally so that they can see the progress they have made. These results validate the findings by Muster-Slawitsch et al. (2011) that when energy and water meters are installed, the brewery needs to measure the process made towards reaching sustainability goals.

According to Olajire (2012), a brewery concerned about its entire value chain can implement an ethical sourcing policy and focus on sourcing from local suppliers whenever possible. The study has revealed that ABL uses local suppliers and have a responsible sourcing policy. ABL includes environmental criteria when selecting suppliers. The responsible sourcing policy and the environmental criteria ABL uses to select suppliers, helps the brewery to be sustainable through its value chain.

Procurement officers in ABL educate the employees about sustainable practices. Training employees to understand how sustainable practices benefit them and not just the brewery being able to increase the employee retention rate and help to ensure employee health and safety as indicated by Olajire, (2012) and Patterson et al., (2016). Therefore, when the employees understand the importance of being sustainable, it helps the brewery to reduce the amount of waste they generate and reduce emission levels by conserving energy. Hospido et al. (2005), pointed out that using resource efficiency and reducing how much of each is utilised cuts back on the water and energy used and the amount of waste produced.

The CO_2 reclamation system installed by the brewery reduces emissions levels this is in line with the findings by Pullman (2009) who found out that the CO_2 reclamation system reduces emissions levels.

The challenges the study identified as constraints to implementing green procurement in the brewery include price, smallholder farmers, availability of green products, no other alternatives, and unreliable information. Various studies have also identified price as a barrier to implementing green procurement (Genovese et al., 2013; Zhu & Geng, 2013; Ageron et al., 2012; Giunipero et al., 2012; Walker et al., 2008; Zhu and Sarking, 2007). Challenges such as smallholder farmers have been identified in other studies as barriers to implementing green procurement. Therefore this information will add to the existing body of knowledge that reveals having small suppliers or multiple suppliers for raw materials is a challenge to implementing green procurement.

In a multinational investigation, Zsidisin and Hendrick (1998) identified a number of key factors influencing green procurement. In the case of ABL, there is a lot of unreliable information as to what the suppliers in terms of their environmental responsibility. Lack of transparency by most of the brewery suppliers poses a challenge to implementing green procurement as is supported by Genovese et al. (2013) and Mathiyazhagan (2013).

4.4.4 Operationality and the Theoretical Framework

The theories adopted by the study are institutional theory which tries to explain the reason the brewery adopts green procurement practices and NRBV theory, which try to explain how the brewery adopts green procurement practices.

4.4.4.1 The Institutional Theory Perspective

The study found that coercive (the rules or laws imposed on a company), normative (company values that a company should abide by) and mimetic pressure (imitation of other companies) influence the adoption of green procurement. The findings are in line with earlier studies by

Zhu and Sarkis (2007) and Bag (2017). The coercive pressure, that is the rules and regulations imposed by EPA on the brewery, forces the brewery to install monitoring points to check and treat the wastewater before it discharges the water into the municipal drain. Manufacturing companies like ABL facing increased pressures from regulatory bodies, tend to adopt green procurement to reduce the amount of waste it generates and its emission levels (Dubey et al., 2013). Recent studies have shown that 95% of breweries at least work to meet environmental regulations (Patterson et al., 2016). ABL also does the same thing. Therefore, institutional pressures influence companies to adopt green procurement as is supported by previous studies such as Dubey et al (2015), Dubey et al (2013) and Zhu and Sarkis (2007). The brewery has also introduced green procurement as a way to gain a competitive advantage towards sustainability. As it has other competitors, it is implementing the green design to enable it to be on top of its competitors as supported by Bag (2016).

In terms of the normative pressure, the norms and values of ABL push the brewery to adopt green procurement and green production. In order for the brewery to achieve its 2025 sustainability goals, it is implementing environmental criteria by selecting its suppliers who can help it to achieve its goals. In addition, in terms of the mimetic pressure, ABL imitates and adopts elements from its parent company ABInBev.

4.4.4.2 The Natural Resource-Based View (NRBV) Perspective

NRBV is a theory of competitive advantage based upon the brewery's relationship to the natural environment. Green procurement is seen as a tool to gain a competitive advantage in the market place (Bag, 2016). ABL is seen adopting green procurement to reduce wastage level and emissions as supported by Dubey et al. (2013) who found that organisations facing increased pressures from regulatory bodies are seen adopting green procurement. In relation to pollution prevention, the brewery has been pressurized to minimize or eliminate waste, effluents, and emissions. Therefore, ABL environmental and procurement managers

understand the stand of the brewery on the environment; thus they adopt green practices. This is done through the decisions they make before purchasing equipment. Gimenez and Sierra (2013) concluded that providing training to their supplies contributes to the development of their suppliers and in turn they obtain an environmentally friendly product or service. The argument is that ABL's attempt to collaborate with its suppliers will improve its sustainability and competitive advantage.

The selection of raw materials and product design is guided by product stewardship with the objective of minimizing the environmental impact of the products. This also entails carrying out the life cycle analysis of the products. The brewery purchases products which are less toxic. It also purchases bottles to use for packaging which has a lower life-cycle cost as bottles can be reused again. This study confirms that product stewardship is driven by the need for the lower life cycle.

The sustainable development perspective looks at the material consumption and environmental degradation. Therefore, ABL's long term vision of its 2025 sustainability plan. Sustainable development is dependent on pollution prevention and product stewardship strategies adopted by the brewery.

According to NRBV theoretical argument, manufacturing companies should adopt ambiguous strategies and implement socially complex practices to create the core competencies for the organisation's sustainable development (Hart 1995; Shi et al., 2012). When ABL collaborates with suppliers it enables them to develop trust and commitment and this encourages the exchange of knowledge which leads to casual ambiguity (Hart, 1995). Hence, the implementation and the adoption of casual ambiguous and green procurement practices lead to the appropriate use of the brewery resources (Fraj et al., 2013). Therefore, ABL achieves sustainable competitive advantage through the adoption of green procurement practices to generate environmental collaboration with the aim to reduce waste.

4.5 Summary and Conclusion

In a nutshell, this chapter has presented the findings of the study and discussed the key findings in terms of the theoretical framework of the study. The study sought to investigate the role green procurement plays in sustainable waste management in ABL. The findings revealed the type of waste generated in the brewery, the kind of sustainable practices adopted by the brewery and the role that green procurement plays in sustainable waste management of the brewery.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Introduction

This chapter summarises the entire study which sought to investigate the role of green procurement in sustainable waste management. The chapter consists of the summary of the study, the conclusion, implications of the study and recommendations for future research policy and practice.

5.1 Summary

This section presents a summary of the key aspects of the study. It consists of the research objectives of the study, the methodological approach used and the key findings.

5.1.1 Research Objectives

The study identified the nature of waste generated in ABL, explored the sustainable waste management practices adopted by the company and it examined the role green procurement plays in the sustainable management of waste in the company.

5.1.2 Research Methodology

The findings of the above objectives were achieved using a qualitative research approach with a case study design. The study used an interview guide via both face to face and telephone methods. Miles and Huberman's (1994) approach was used for analysing the primary data collected from eighteen (18) participants who were purposively sampled from ABL. The study discovered some interesting findings which are summarised in the next section. These findings were triangulated with the secondary data to ensure validity and reliability. The key findings are presented in the next section.

5.1.3 Key findings

5.1.3.1 Nature of Waste Generated in the Brewery

The first objective of the study sought to identify the nature of waste generated in the brewery. Through interviews, the study has found out that solid and liquid waste are the major types of waste produced from the brewing and the packaging process. The brewing process generates solid waste including sacks, bad malt, spent grain, spent trub, spent yeast and kieselguhr. The solid waste generated during the packaging process includes glue buckets, empty gallons, cullets, broken wood, cartons, and bad labels. Both the brewing and packaging process generates liquid waste.

5.1.3.2 Sustainable Waste Management in the Brewery

The second objective of the study sought to explore sustainable waste management adopted by the brewery. The study found out the brewery used the 3R's (reduce, reuse and recycle) to manage their waste, nevertheless, there are some areas which the brewery needs to improve in order to effectively manage their waste sustainably.

The findings revealed that the brewery segregates its waste. Even though it segregates its waste some waste is sent to landfills some wastes like paper, cartons, plastics, kieselguhr, and organic waste from the wastewater treatment plant. As for kieselguhr a hazardous waste generated during the filtration process, the brewery can opt to utilise this waste or use other methods for filtration as illustrated by Fillaudea et al., (2006). The gases produced during the wastewater treatment are flared instead of utilised. The biogas can be utilised to generate electricity and methane can be used to power boilers. These are some of the areas which the brewery needs to improve in order to achieve sustainable waste management.

5.1.3.3 The Role of Green Procurement in Sustainable Waste Management

The third objective sought to examine the role green procurement plays in the sustainable management of waste in the brewery. The findings of the study revealed that green procurement plays a role in solid, liquid and emission levels reduction and in waste elimination. The criteria that the brewery uses to select suppliers are in line with the brewery's sustainability goals which helps the company not to generate unnecessary waste. Green procurement helps the company to eliminate waste from the source because they make sure they only purchase when there is a need to purchase. They also make sure they purchase equipment and items which are environmentally friendly.

5.2 Conclusion

In conclusion, the study has indicated that green procurement has a role in sustainable waste management. The study has found out that the way the brewery operates has an environmental impact across the entire value chain. Therefore, the brewery has opted to use green production and procurement to try to reduce its environmental footprint. Even though green procurement plays a role in ensuring sustainable waste management, most studies have been conducted in developed countries. Therefore, this study adds to the empirical literature on green procurement. The study concludes that to ensure effective sustainable waste management, the brewery should form a partnership with suppliers and procurement officers to make decisions to minimise the waste generated and to reduce the environmental impacts.

5.3 Implications of the study

The study contributes to the existing body of knowledge in the area of green procurement and sustainable waste management. It provides insight into what the brewery is currently doing to prevent and reduce waste generation using green procurement practices. These practices adopted by the brewery would help policymakers and other stakeholders involved with the environmental affairs to come up with policies and programmes that would stimulate

sustainability. Insights gained from the study would help breweries and organisations to meet environmental goals such as improving water and energy efficiency and supporting recycling. The study has outlined the importance of green procurement in making organisations competitive and sustainable.

5.4 Recommendation

The thesis argues that green procurement has a role to play in sustainable waste management. This will contribute to Ghana's effort towards achieving SDG's 6, 9, 12 and 13. The following recommendations are made for the consideration of the brewery and relevant players.

The brewery needs to adopt green procurement practices in all its operations and processes because green procurement has a role to play in waste prevention in the brewery. The brewery needs to have a clear green procurement policy. Having a green procurement policy would help the brewery to procure more green products and practices. The brewery needs to build a solid relationship with suppliers so that they can purchase more green products. It should communicate with local waste authorities, environmental officers so that they can help come up with ways on how to utilise some of the waste generated in the brewery. In addition, the brewery should establish its own recycling facilities and acquire its own land for disposal of waste. The brewery should also use other means of filtration instead of using kieselguhr; it should also learn more on how to utilise kieselguhr instead of sending it to landfills. Lastly, the brewery needs to install boilers so that it can reuse methane and biogas to generate electricity.

5.5 Avenue for Future Studies

It is argued that breweries are less studied. Considering the limited research on the role of green procurement on sustainable waste management in breweries especially in Africa and Ghana, further studies should be directed in using a mixed-method using a multiple case study.

Individualised studies that focus on green procurement practices should be conducted to determine the influential factors. Studies that focus on packaging materials or energy use or water use could identify green factors or other initiatives that breweries have adopted. This study did not provide enough data to accurately suggest exactly which steps the individual brewery should focus on.

Further studies should be directed to linking the topic to Ghana's procurement policy. Lastly, similar research can be conducted in other breweries

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Appendices

Appendix 1: Interview guide

UNIVERSITY OF GHANA

Interview Guide

This Interview Guide is from a student pursuing an MPhil in Climate Change and Sustainable Development from the University of Ghana. It is meant to collect data to conduct a study on the topic: **The Role of Green Procurement in Sustainable Waste Management in selected breweries in Africa.** Kindly assist by responding to these questions. All information provided will strictly be used for research purposes only. Thank you.

A. Biodata

1. Gender:.....
2. Highest level of education:.....
3. Which brewery do you work with?
4. What is your current position?
5. How long have you been working with the brewery?

B. Waste generated and waste management

6. What type of waste do you produce in your brewery?
7. What is the source of the waste streams?
8. Explain the brewing process and waste produced at each stage.
9. Do you measure the waste at each stage?
10. Is the volume of wastes generated more than the amount of beer produced?
11. Is the volume of waste consistent with historical volumes for example last year or last month?
12. Do you have waste storage areas?
13. How do you collect these waste?
14. How do you sort these wastes?
15. How do you treat these wastes? And why?
16. How do you dispose of these waste? And why?
17. What is the quantity of waste in each storage area?
18. How frequently do you pick up these waste?
19. Do you train personnel to manage waste streams, sorting and storage methodologies and recycling awareness?

20. Are the waste bins labelled?
21. Do you have a sustainable waste management plan?

C. The role of green procurement on sustainable waste management

22. What criteria do you use to select your suppliers?
23. Do you use environmental issues in your criteria for selecting suppliers?
24. Is the supply chosen use environmentally friendly products?
25. Does your supplier supply environmentally friendly products? Can you mention them?
26. Do you use a local supplier?
27. Do you continuously identify new material from supplier packaging or product packaging that comes through the brewery which can be reused or recycled instead of directly sent to landfills after its use?
28. What type of materials do you use for your packaging?
29. Are your supplier selected based on their ability to supply green products and hence environment?
30. Is your supplier selection based on the supllier's ability to bring effective green packaging?
31. Are hazardous material avoided or miniminised?
32. Does the company take into account indirect water use, i.e. water used along supply chain?
33. What is the current state of sustainability reporting in the company?
34. Is the sustainability report verified by the third party?
35. What is your knowledge regarding green procurement?
36. Do you have a green procurement policy?
37. Are you familiar with "green" products and suppliers?
38. Are any environmental issues considered in your procurement policy?
39. Do you utilize paper invoicing and electronic funds transfer?
40. What are the challenges in implementing green procurement in the brewery?
41. Do you think green procurement has a role to play in sustainable waste management? Why?
42. In your own view what nature of green procurement is applicable to your sustainable waste management?

Appendix 2: Ethical Clearance

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES (ECBAS)
P. O. Box LG 1195, Legon-Accra

Ref. No: ECBAS 028/18-19

25th March, 2019.

Ms. Basetsana Rose Kapaya
Centre for Climate Change and Sustainable Development
University of Ghana
Legon, Accra

Dear Ms. Kapaya,

ECBAS 028/18-19: THE ROLE OF GREEN PROCUREMENT IN SUSTAINABLE WASTE MANAGEMENT IN SELECTED BREWERIES IN AFRICA

This is to inform you that the above referenced study has been presented to the Ethics Committee for Basic and Applied Sciences for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	24/03/2020
On Agenda for:	Initial Submission
Date of Submission:	15/01/2019
ECBAS Action:	Approved
Reporting:	Quarterly

Please accept my congratulations.

Yours sincerely,

Professor Daniel Bruce Sarpong
ECBAS Chairperson

ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES
APPROVED
25 MAR 2019
UNIVERSITY OF GHANA

Appendix 3: Introductory letter

UNIVERSITY OF GHANA
CENTRE FOR CLIMATE CHANGE AND SUSTAINABILITY STUDIES (C_3SS)

25th March, 2019

TO WHOM IT MAY CONCERN

Letter of Introduction: Basetsana Rose Kapaya

I write to introduce, **Basetsana Rose Kapaya**, a final year **MPhil. Climate Change and Sustainable Development** student of Centre for Climate Change and Sustainability Studies, University of Ghana. As part of the requirement for the programme, she is conducting a research on the topic **"The role of green procurement in sustainable waste management in selected breweries in Africa".**

The data is for academic purposes. I would therefore be most grateful if you could kindly assist her with relevant data for her study.

Yours Sincerely,

Dr. Theophilus Maloreh- Nyamekye
(Lecturer, UGBS/Supervisor)

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